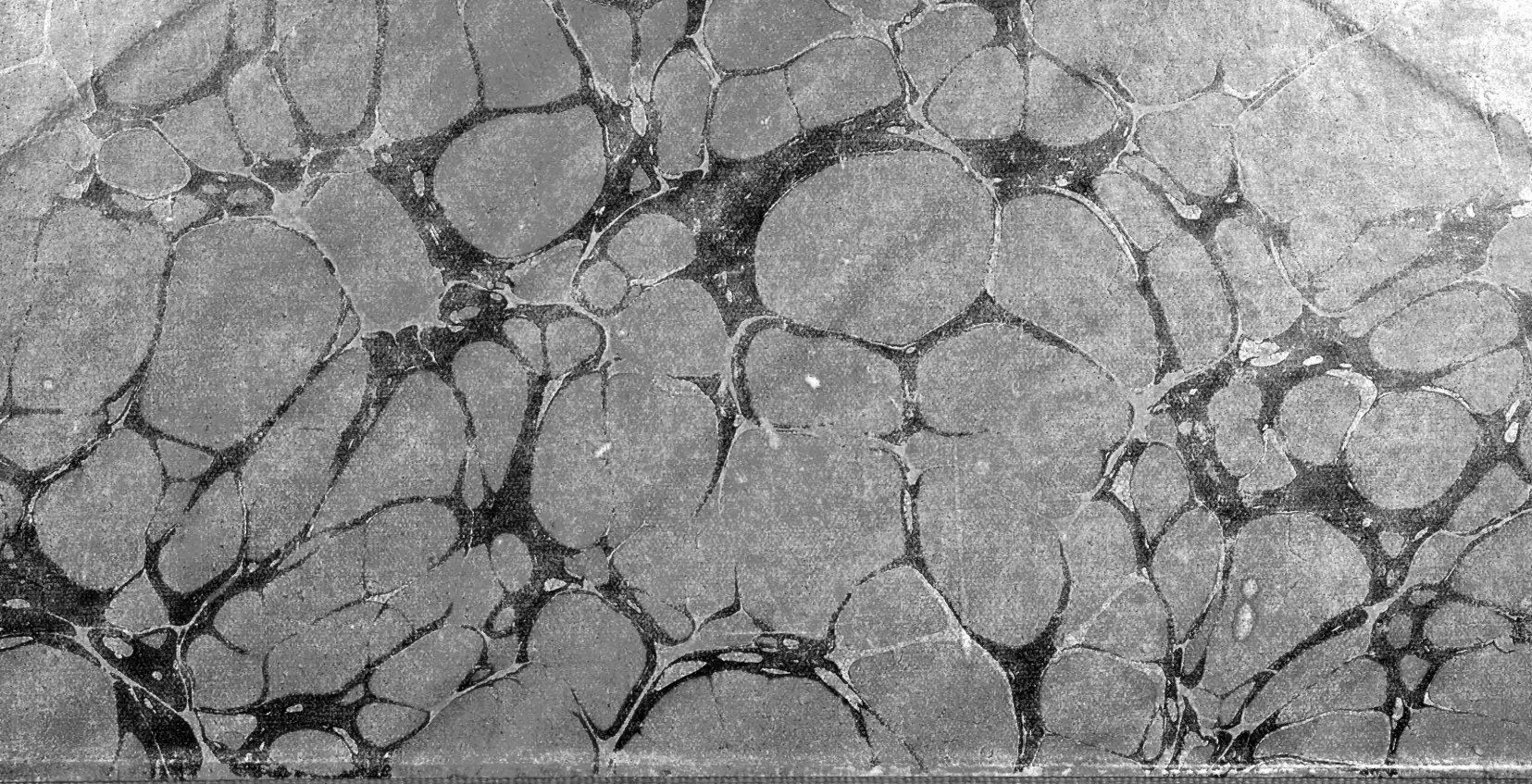

D. A. Kellicott

Buffalo, N.Y.
Jan. 1880.

THE

# TRANSACTIONS

OF THE

# NEW YORK MICROSCOPICAL SOCIETY,

No. 1267 BROADWAY,

NEW YORK.

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## VOLUME I.

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*PUBLISHED FOR THE SOCIETY.*

# INDEX

TO THE

# American Quarterly Microscopical Journal.

## VOLUME I.

# INDEX TO TRANSACTIONS.

# The American Quarterly Microscopical Journal.

"Go forth, under the open sky, and list
To Nature's teachings."—*Bryant.*

VOL. I NEW YORK, OCTOBER, 1878. NO. 1.

## THE STING OF THE HONEY BEE.

BY J. D. HYATT.

THE Honey Bee, *Apis millifica*, has been known from the remotest antiquity, and no other insect has been the subject of more careful study to the naturalist.

Its wonderful intelligence and remarkable habits of forming colonies and working in communities, whose united labors are rendered subservient to man in the production of a luxurious food; its curious anatomical structure, and the exact adaptation of all parts of the body to its habits of life and the nature of the work to be performed, have, from time immemorial, rendered this insect and its habits not only a subject of general interest, but of special study and investigation.

In this view, perhaps no less promising subject could be chosen for original investigation, and yet, if we place in the field of a microscope of very moderate amplification, a well dissected sting of one of these insects, we shall see before us a piece of mechanism which our naturalists have either imperfectly understood, or else the records of their knowledge are so concealed in voluminous reports of scientific societies as to be practically inaccessible to the amateur microscopist.

It is true that we have in most of our books that treat of microscopic objects, such as the works of Carpenter, Hogg, Gosse, Micrographic Dictionary, etc., as well as the better class of entomological works, a general description of the principal pieces of this mechanism, and if we go to the head waters and consult the more elaborate writings of such original investigators of insect anatomy, as Burmeister, Westwood,* and numerous

* Westwood's Introduction to the Study of Insects. 1840.

others, but above all the admirable "Researches of M. Lacaze Duthiers,"* we shall greatly extend our knowledge, not only of the sting of the Honey Bee, but of the correlated terminal pieces, such as ovipositors, saws, etc., with which the insects in the whole order Hymenoptera, are furnished. Having, at great expenditure of time, consulted all these and many other works, we may come back to our slide containing the dissected sting, and still find an inexplicable mystery in some of its parts. This has been my experience, and with a view of determining more accurately the entire mechanism of this intricate and complicated structure, I have carefully observed its action, so far as possible in the living insect, and by numerous dissections, in which I have traced every point of connection of the various pieces, and tested every possible movement of the parts upon each other, and made transverse sections through every point in its entire length, and I now venture to place before you the result of my investigations.

I have chosen the sting of the Honey Bee as the subject of

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DESCRIPTION OF PLATES I AND II.

The figures in the two plates are numbered consecutively.

The description of one side applies to both.

Fig. 1. View of entire mechanism of the sting, except poison gland; muscles being removed.

A, The sheath.

E, Palpi, or feelers.

D, Principal levers for projecting the sheath.

C, Articulated to D, at o, and slightly to B at i, affords muscular attachments to the compound lever composed of C and B.

B, Second part of this compound lever, articulated to D at s, and to the extremity of the lancet at c.

P, Neck of the poison gland: c, a, k, lancet.

Fig. 2. Lateral view of the same parts, with lancets removed to show the form of sheath; p, poison gland; d, duct leading from the secretory gland (not shown in the figure). The parts shown are lettered the same as in Fig. 1.

Fig. 3. Sheath with lancets lying along the grooves; levers removed to allow view of stop-valve attached to lancets, seen through the partially transparent cylindrical part at p; a, anterior curved arm of sheath; f, "*fourchette*," below neck of poison gland.

Fig. 4. A single lancet dissected, to show its attachments. From a to c, a thin flange along the arched part; P, stop-valve appendage; B, triangular piece of compound lever-moving lancet, with which it is articulated at c.

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*Recherches Sur L'Armure Genitale des Insects. Par. M. Lacaze Duthiers. Annales des Sciences Naturelles. 1848 to 1852.

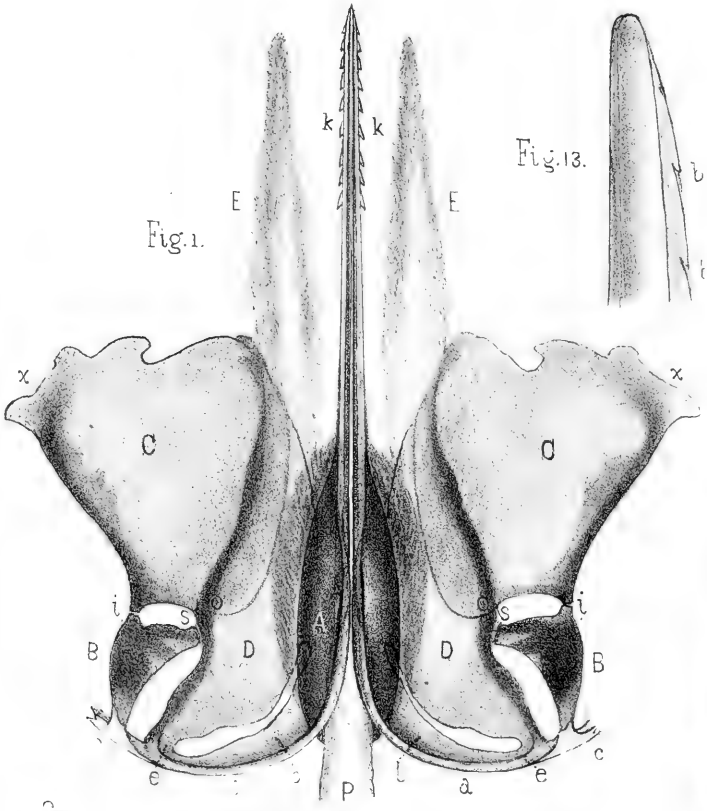


Fig. 1.




Fig. 13.

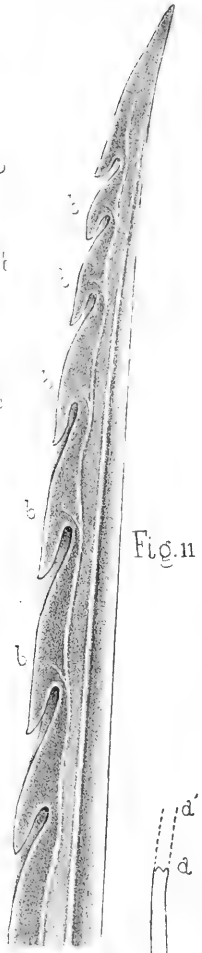


Fig. 11

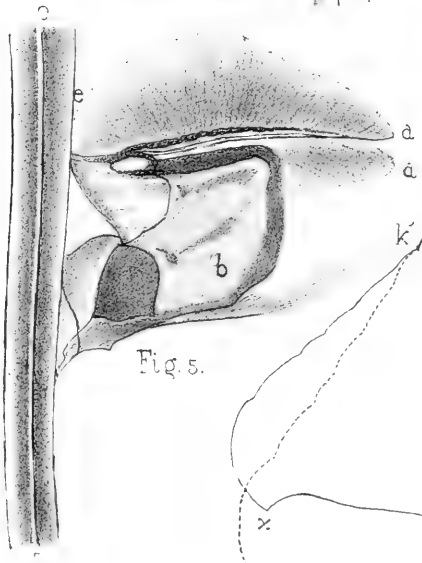


Fig. 5.

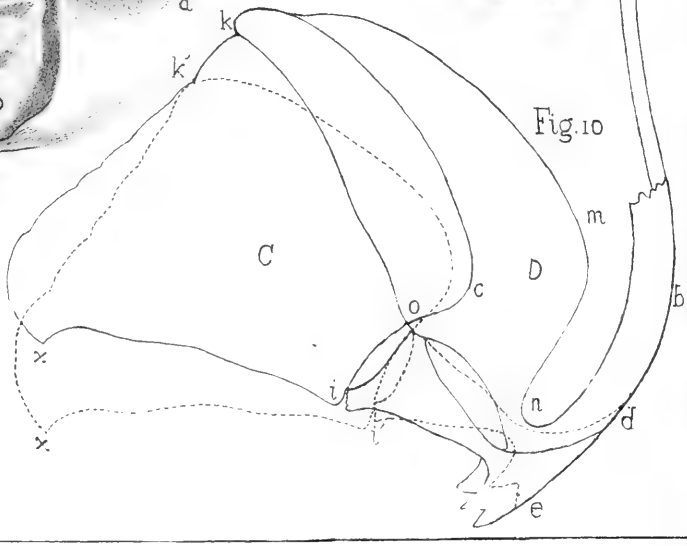


Fig. 10

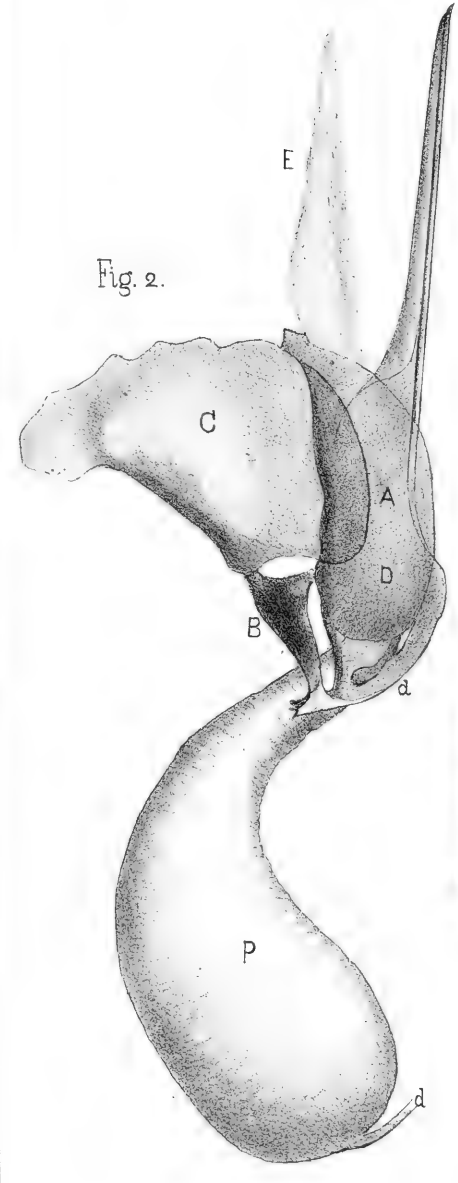


Fig. 2.

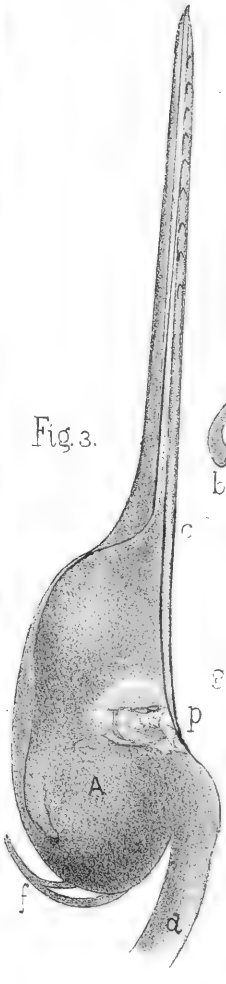


Fig. 3.

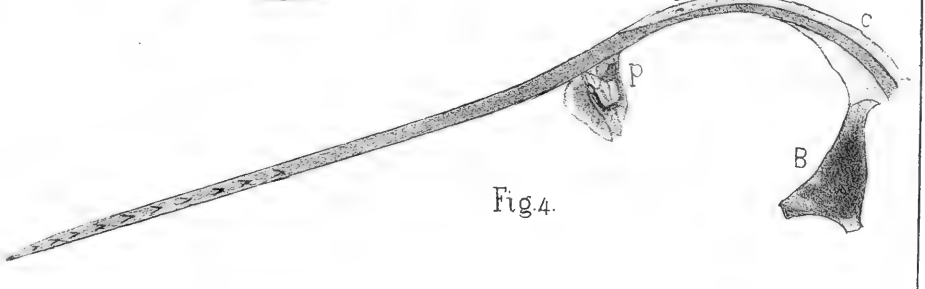


Fig. 4.


Fig. 9.

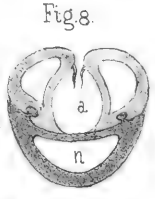


Fig. 8.

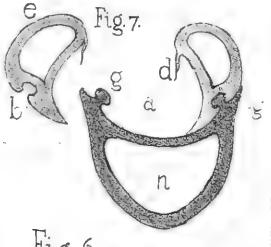


Fig. 7.

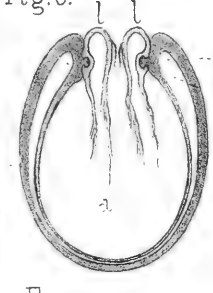


Fig. 6.

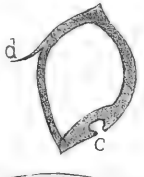


Fig. 12.

this paper because in some particulars it is different from the sting of any other insect that I have yet examined, though in its general features it may be taken as a type of the "terminal armor" in the whole order of Hymenoptera, for the difference between a sting and an ovipositor is more a difference of function than of structure.

It must be observed, however, that this difference is, of its kind, a very wide one, for the ovipositor is an apparatus of a perfect female for depositing the eggs, while in those insects furnished with a sting the female organs are so differentiated, aborted, or completely suppressed, as to render fertilization impossible, so that wherever this armor occurs, as it does mostly among social insects, it is confined to a class called neuters, or modified females.

The sting of the Honey Bee consists of a dark brown horny, chitinous piece, of a cylindrico-conical form, commonly called the sheath, which is cleft along its inferior surface, and terminates in an obtuse, but extremely thin cutting point. This is the chief instrument in effecting a puncture.

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Fig. 5. Portion of a lancet showing valve, a e, much enlarged; h, truss holding the valve in place; × 450.

Fig. 6.* Section across sheath and lancets at the point where the valves are attached to the latter; l l, the lancets and appendages; n, space between the outer and inner walls which changes its form to n, in Figs. 7 to 9.

Fig. 7. Section of sheath and lancets, at the point opposite, with section of one lancet removed, to show the form of groove, b, and guide-bar, g.

Figs. 8 and 9. Section of sheath and lancet, with latter held in normal position by T rails, or guide bars on each side, g g; a, channel between the lancets for passage of poison into the wound.

Fig. 10. Showing mechanism of compound lever-moving lancet (one side only); b, arm of sheath detached; D, lever-moving sheath, its form bounded by the line, k, o, n, m; C, lever moving the triangular piece attached to lancet at c; change of position of the piece, C, to dotted line, projects broken end of lancet from a to a′.

Fig. 11. Point of one lancet, showing barbs and small canals, b b b b b, between the last five; × 450.

Fig. 12. Section of lancet immediately posterior to valve, showing its tubular form and the valve, d, which prevents leakage along the sides of the lancets in contact.

Fig. 13. Point of sheath, showing thin convex end, and two lateral barbs; × 450.

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* Figs. 6 to 9 were inverted by the engraver; the parts toward the top of the page are on the inferior side.

Lying along, and partly in the cleft of the sheath, are a pair of tubular darts or lancets, having a fine cutting edge curved to the inward side, while the lateral margins are serrated near the point with ten deep retrorse barbs. These lancets are capable of being projected beyond the sheath, so as to increase the depth of the wound made by that instrument.

A sac or reservoir is connected with the base of the sheath and discharges into it by the rapid contractions of its muscular coats, a poisonous fluid which is conducted into the wound through a channel between the concave faces of the lancets; the escape of this fluid between the outer (inferior) convex edges being prevented by a valve, consisting of a thin flange projecting inward from each.

A mechanism resembling the hydraulic ram is found in the cylindrical part of the sheath, which serves to inject the poison with great force through several small apertures, near the points of the tubular lancets, into the extreme limit of the wound to which they are projected.

The sheath and lancets are protruded, not by the direct action of the muscles, but in order to impart great penetrating force to the former, and a quick motion to the latter, they are actuated through a peculiar combination of levers, which is perhaps the most curious and interesting feature of the entire mechanism.

Finally, a pair of palpi, or feelers, are uniformly projected, in advance of a thrust made by the sting, to determine the most vulnerable point of attack.

This being the general plan of this apparatus, the details of its structure, and the particular function of each part, will be better understood by a reference to the drawings and diagrams, which are exact delineations of the objects presented, and very correct as regards the relative proportion of connected parts, though the different figures are not drawn to the same scale of amplification.

Fig. 1 presents a view as seen from the inferior side of all the pieces connected with the "terminal armor" of the Honey Bee, with the exception of the poison gland, only the excretory duct of which, P, is here seen.

The median, or more darkly shaded piece A, extending the entire length of the figure, and loosely enclosed by the vulva,

has commonly been called the sheath, because it was supposed to enclose, like a scabbard, the two darts or lancets.

The sheath, in this view, is conical in form; the base being anterior, directed toward the head of the insect, and its apex posterior.

A lateral view, however, Fig. 3 A, shows the anterior portion to be cylindrical, but contracting on the upper side opposite the point c, diminishes gradually to the extremity, near which are two lateral teeth seen in the greatly enlarged view, Fig. 13 b b.

The sheath is double throughout its whole extent. The exterior and interior walls, which, in a rudimentary state, form two separate pieces, are firmly united at their edges, and in the cylindrical portions of the sheath are nearly in juxtaposition, forming, in lateral view, the oblong valve-chamber A, Fig. 3, but the inner wall abruptly contracting at c, Fig. 3, leaves a lunate space above it, as shown in the transverse section at this point, Fig. 7 n. A cross section at the point P, Fig. 3, is seen in Fig. 6. Between the walls at this point, and also throughout the entire cylindrical portion, there is an enclosed space shown at n, Fig. 6. At the point c, Fig. 3, where the contraction is seen, the space n begins to alter its form, and this alteration continues down to the apex, where the two walls unite. Several successive stages of this alteration are shown in Figs. 7 to 9 at n. It will thus be seen that n, Fig. 7, is a continuation of the smaller space n in Fig. 6.

It will be observed that n, Fig. 7, has no connection with a, Fig. 6, so that the poison injected into the cylindrical base of the sheath follows the channel a, Figs. 7 to 9, between the lancets.

Near the base of the sheath, on the inferior side, arise two flexible arms, b b, Fig. 1, which curve in arcs of a circle in a lateral and dorsal direction to their articulations e e, with the powerful levers D D.

The cylindrical part of the sheath is cleft along the lower side, and this cleft, taking the form of a shallow groove, continues to the end.

Lying in contact, in this groove, and along the inner margins of the cleft, are the two lancets, their barbed edges k k extending laterally over its sides, and following the curve of the arms before mentioned, are attached at c c, their anterior ex-

tremities, to the triangular pieces B B of the compound levers, composed on each side of the two pieces, B and C.

From the point p, Fig. 3, along their straight parts, the lancets are tubular, taking the form e seen in the section, Fig. 7, their incurved edges lying in contact in the groove of the sheath, Figs. 8 and 9, and forming a circular channel, a, between them, through which the poison is injected. Projecting into the channel a are seen the valves (one at d, Fig. 7), which, falling together, prevent the escape of the virus along the outer sides of contact.*

Along the inner margins of the groove, on each side and following the curved arms of the sheath, are two T shaped rails, Fig. 7 a, or guide-bars, which, exactly fitting into grooves of similar form, Fig. 7 b, in the lancets, hold them firmly to the sheath, and at the same time allow a free sliding motion for their projection.

Between each of the last fine teeth of the lancets is a small canal extending outward from the central cavity, rather indistinctly seen at b b b b b, Fig. 11, which presents a very correct view of this part as shown under the microscope.

The extent to which the lancets may be projected is limited by the stop attached to each at p, Fig. 3, and extending nearly across this cylindrical part of the sheath.

The protrusion being arrested at the angle c, Fig. 3, formed by the sudden contraction of the sheath at that point.

This appendage also acts as a valve to check the flow of poison through the channel between the lancets, as may be seen by observing its structure in the greatly enlarged lateral view, Fig. 5, and in the transverse section through both lancets and sheath, Fig. 6.

It consists of two nearly semi-circular pieces, Fig. 5, a e, attached at their inferior angle to the lancet, the straight sides being anterior. On this side, each piece is thick and chitinous, but diminishes to a thin, flexible edge on the curved side.

Both pieces are firmly braced and held in place by the heavy curved piece b, extending from the straight side of both to its solid attachment with the lancet.

A section through the point at which the two pieces forming this valve are attached, Fig. 6, shows an opening between them

* By an unfortunate misunderstanding, Figs. 6 to 9 were inverted by the engraver.

to the interior cavity of the lancets, through which the poison enters the moment this valve closes the channel between the lancets by striking into the angle of the sheath at c, Fig. 3.

By the sudden closing of this valve, an action comparable to that of the hydraulic ram ensues, for the fluid virus, poured into the wound at first through a comparatively large outlet, is suddenly arrested in its course, and if it may be supposed to have any momentum, will be injected with increased force into the deeper wound made by the protrusion of the lancets, passing out of them through the minute canals seen in Fig. 11, between the barbs. This comparison, however, in the case of the bee, ends with a single stroke ; for the sting is so firmly anchored, by the deep, recurved teeth, that in most cases it cannot be withdrawn, and the insect escapes leaving it in the wound.

By allowing the bee to sting a soft piece of leather, an excellent opportunity is thus offered for studying certain parts of the action and mechanism, for the whole apparatus, including the poison gland, or the entire parts, with this addition, seen in Fig. 1, will be beautifully dissected ; the bee not appearing to be seriously injured by the loss. Rapid automatic contractions of the muscular coats of the poison-gland continue to pump out its venomous contents, and the muscles attached to the broad lever, C, make ineffectual efforts to retract the lancets for several minutes after the parts have been detached from the body. These motions can easily be seen without a lens.

The lever mechanism, which enables the bee to thrust its weapon, nearly the entire length, beyond the abdomen, with a penetrating force, apparently so disproportionate to its size and strength, will be readily understood by reference to Fig. 1.

The pieces, C and D, furnish broad surfaces of attachment to the muscles, with which their upper (inner) superfices are closely packed. These muscles extend in groups forward to the sternites or lower segments of the abdomen. The points, D D, being fixed by a pair of ligaments connected with the segment above.

By the contraction of the attached muscles, all the pieces, C, D, and B, on both sides, are swept together around the

fulcrum D, and the flexible, curved arm being straightened, the sheath and attached lancets are projected.

By an additional contraction of the muscles of C, that piece, turning on o, its only point of attachment to the lever D, tilts over the triangular piece B, on the pivot, s, causing the lancet, articulated to its movable arm at c, to slide along e, b, and thus project its point into the wound beyond the sheath.

The beautiful and effective mechanism of this lever of the third class, by means of which the lancets are thrust deep into the incision first made by the point of the sheath, will, perhaps, be better understood from Fig. 10. This figure represents the levers of one side with a detached arm of the sheath and a piece of the lancet.

The form of the lever, D, is shown by the line, k, o, n, m, this lever being articulated to the arm at n. The broad lever, C, whose outline is denoted by x, i, o, k, with its anterior side beyond k, o, overlapping D, is articulated by a ligament to D, at the point o, and turning on this point, changes its position to that denoted by the dotted line of the same form, strikes its angle, i, against the triangular piece, which is also articulated to D, near o, and throws its movable arm, which curves over the arm of the sheath to its attachment with the lancet at e, to the position denoted by the dotted outline of that piece moving the end of the lancet, a to a′.

Fig. 1, E E, are two pieces attached to the levers, D D, and resembling, in every respect, the organs of sense appended to the head of many insects, and called palpi, or feelers. That they here serve the same purpose is shown by the fact that they are always protruded in advance of a thrust made by the sting, as if to ascertain the location or character of an object of attack.

The name sheath, applied to the principal piece used for making an incision, is a somewhat misleading term, for it can hardly be said to enclose the lancets in any part of its course, as may plainly be seen by inspecting the transverse sections; but I have deemed it best to adopt the English name by which it is most generally described. "Gorgeret" or Gorget applied to this piece by Lacaze Duthiers from its resemblance to the surgical instrument of that name, is much more appropriate, but would necessarily lead to the adoption of the entire nomenclature of that author, which, though unquestionably more in

accordance with the principles and plan of scientific description, would introduce a number of terms not yet familiar to our language, a proceeding foreign to the purpose of this paper.

The remarkable mechanical action described in connection with the valve attached to the lancets may be corroborated by any one skilled in the manipulation of small objects, by forcing a fluid through the opening in front of the valve and out of the small canals. I found no difficulty in doing this, but it might be inferred, *a priori*, that some such action was necessary, for, to make these pieces project only one-fiftieth of an inch deeper into the wound than the sheath, without any provision to introduce the poison, would produce no sensible effect upon the nervous system of any of the higher animals, much less on that of another insect.

The venomous effect of a wound made by the sting is entirely due to the poison introduced by it, but to construct a complicated mechanism for thrusting into the skin a pair of spicules the one five-hundredth part of an inch in diameter to the depth of one-fiftieth of an inch, without any other provision for producing an effect upon the nervous system, would be worse than arming soldiers with Gatling guns without ammunition, and a provision no naturalist would expect to find.

The following micrometric measurements will afford some idea of the dimensions of this formidable weapon.

| | |
|---|---|
| Whole length of sheath, about | 2.5 mm. |
| Length of penetrating part | 1.2 mm. |
| Length of that part of lancets projecting beyond the sheath | .4 mm. |
| Diameter of lancets | .04 mm. |

DEMODEX FOLLICULORUM.—In Vol. V. of the *Bulletin of the Museum Comp. Zoölogy*, at Cambridge, Mr. Walter Faxon gives a description of this parasite, as found in some cow-hides from the west.

Leather made from these hides appeared disfigured with pits, which often penetrated almost entirely through it. These cavities were seen in sections to be enlarged and diseased hair follicles. A full description of the characters of the species found is given as far as they could be made out in their imperfect condition when examined, and a valuable series of references to the literature of the subject.

## DESCRIPTION OF NEW SPECIES OF DIATOMS.

BY PROF. H. L. SMITH, LL.D.

*Homoeocladia capitata*, n. sp. H. L. S. *Hab.* Black Rock, Cal. Mr. C. Febiger. Frond membranaceous, umbellately branched: branches elongated, and with corymbose capitate apex. Frustules linear, valves lanceolate with acute and very slightly constricted apices: frustules densely packed, but not in series, or fascicles; marginal punctæ faint, 35 in .001. Length of frustule .0008 in, breadth, .0002 in.; Frond 1.5″ to 2″. Plate III, fig. 1.

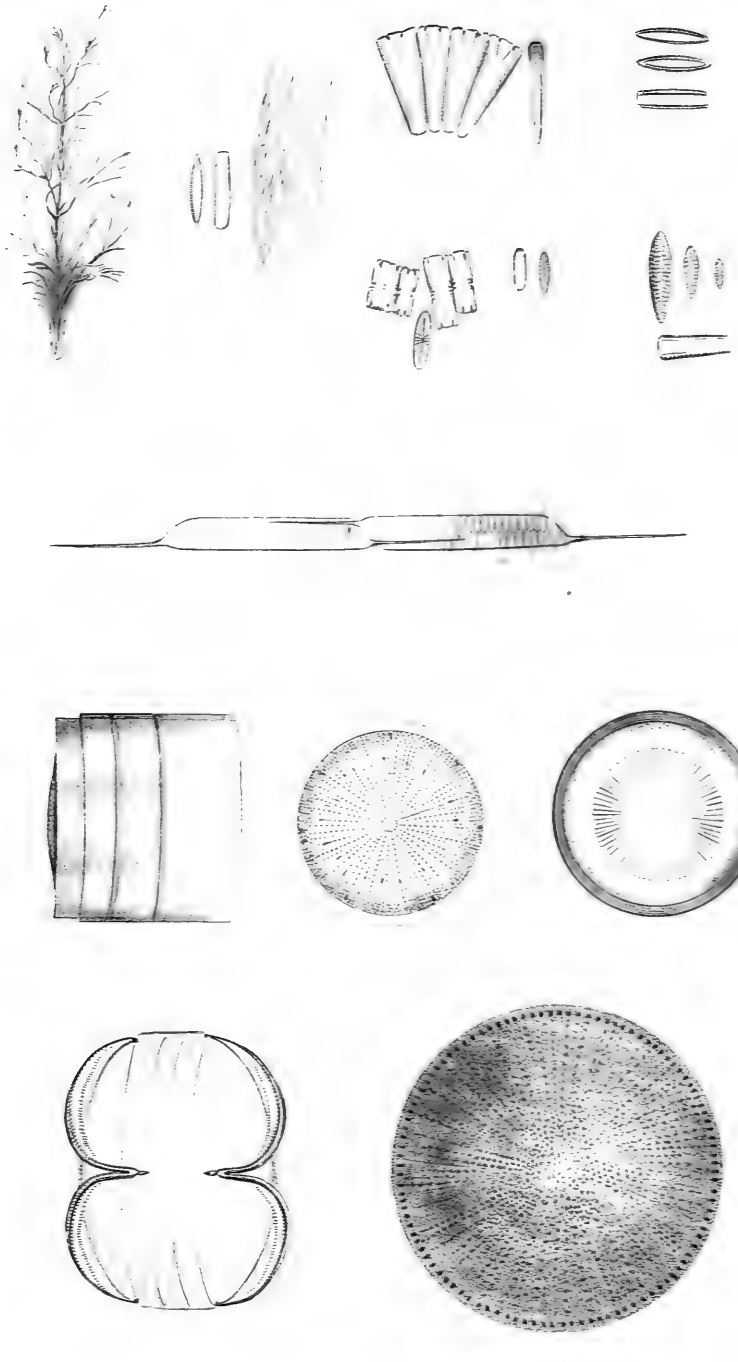
I received the material containing this well-marked species from Mr. C. Febiger, who procured it in California as a gathering containing his *Biddulphia Edwardsii*. In this gathering I found the fronds of the present species. The well marked peculiarity of corymbose apices, and the close resemblance to Kutzing's *Schizonema capitatum* suggested the name, possibly it may be Kutzing's species, though he states that the frustules are arranged in rows, but the outline figure which he gives of the frustules agrees, as also the size, with the present form. It is not, however, a *Schizonema* (*Micromega*) since the frustules are unmistakably *Nitzschioid*. The walls of the filaments are dense, and the frustules so closely packed as to appear opaque even after prolonged burning at a full red heat.

*Meridion intermedium*, n. sp. H. L. S. *Hab.* Knoxville, Tenn. Josiah Curtis, M. D. Frustules sessile, cuneate, margins nearly smooth, valves with very faint pervious costæ in f. v. which are scarcely discernable in s. v., cuneate, rounded at the larger extremity. Length .00166 to .003. Plate III, fig. 2.

This curious modification of *M. circulare* was found growing

### DESCRIPTION OF PLATE III.

Fig. 1. *Homoeocladia capitata*, n. sp. H. L. S.
Fig. 2. *Meridion intermedium*, n. sp. H. L. S.
Fig. 3. *Navicula Kutzingiana*, n. sp. H. L. S.
Fig. 4. *Navicula parvula*, n. sp. H. L. S.
Fig. 5. *Nitzschia Kitteni*, n. sp. H. L. S.
Fig. 6. *Raphoneis australis*, n. sp. H. L. S.
Fig. 7. *Rhizosolenia Eriensis*, n. sp. H. L. S.
Fig. 8. *Custodiscus Baileyi*, n. sp. H. L. S.
Fig. 9. *Amphora mucronata*, n. sp. H. L. S.
Fig. 10. *Actynocyclus Niagarae*, n. sp. H. L. S.



attached to *Hypnum*. And it is the only gathering hitherto made, so far as I am aware. It can hardly be considered other than an extreme variety of *M. circulare*, with the strongly marked pervious costæ of this species in s. v., and the consequent crenulation or intra-marginal punctation of the valves in f. v., nearly obliterated, approaching indeed the smoothness of *Licmophora*. The discovery of this intermediate form was the more interesting, as it enabled me to place Greville's and Arnott's *Peronia erinacea* where it belongs. This singular form, which was at first considered as a *Gomphonema*, and subsequently made the type of a new Genus, of which it is the sole species, is now related to *M. intermedium*, as the latter is to *M. circulare*, in other words it is a smooth form of *Meridion*, and of course the connecting link with *Licmophora*, all the species of which hitherto enumerated are marine. *M. intermedium* is No. 238, and *M. erinaceum* (*Gomphonema fibula=Peronia erinacea*) is No. 239 of my "Species Typicae Diatomacearum."

*Navicula Kutzingiana*, n. sp. H. L. S. Avranches, Normandy, France. M. de Brébisson. Frustules linear, valves scarcely inflated, with rounded ends, and three or four conspicuous striae radiating from the central nodule, and which are prominent also, along with the central nodule, in f. v. Frustules in f. v. quadrangular, frequently adhering and forming a short filament (*Diadesmis*), and with two distinct intra-marginal (bead-like) vittae, at either end. Length .0006 to .00085; breadth, f. v. .00033, s. v. .00021. Striæ about 50 in .001. Plate III, fig. 3.

This small, but distinct form, which from the coherence of the frustules into short filaments might almost be termed a *Diadesmis*, I received from M. de Brébisson labeled "*Amphiprora arenaria*." A glance at the figure I have given will show that it does not belong to the genus *Amphiprora* as now limited, but that it is a true *Navicula*. As there is already a *Nav. arenaria*, I give to it the name of the celebrated Algologist, Kutzing, whose numerous figures of Diatomaceæ, though but mere outlines, sketched by aid of a microscope, that would scarcely be looked at, much less through, at the present day, possess more of the character and catch more of the spirit of the living species, than many of the representations of modern days, and whose descriptions are models of accuracy and conciseness. The more I study his plates the more I admire their

conscientious accuracy and faithfulness. Grunow has described a *Navicula Kutzingii*, but it proves to be *N. Proserpinae* (*Diploneis*) E. thus leaving the name free. It is No. 287 of the "Species Typicæ Diatomacearum."

*Navicula parvula*, n. sp. H. L. S. Villerville, France. M. de Brébisson. Frustules small, valves lanceolate, with acute apices. Striæ divergent and readily seen. Frustules linear in f. v. with rounded ends. Length .0005; breadth .00015. Striæ 42 in .001. Plate III, fig. 4.

I have not been able satisfactorily to identify this form as belonging to any species hitherto described. It is extremely abundant in the gathering which I received from M. de Brébisson, labeled by him simply as "*Navicula*," indicating that he was not decided as to the species.

*Nitszchia Kittoni*, n. sp. H. L. S. *Hab.* River Catuche, Caracas, Venezuela. Mr. F. Kitton. Frustules linear, valves lanceolate with sharp and slightly constricted apices, marginal punctæ very distinct, 16 in .001, and quite prominent in f. v., striæ faint. Length .0007 to .001; breadth .0002. Plate III, fig 5.

Mr. Kitton, when he sent this diatom to me, referred it very doubtfully to W. Smith's *Nitzschia minutissima*, to the figure of which it has a remote resemblance, the apices, however, are less constricted, and Smith himself quotes *Synedra dissipata* of Kutzing as a synonym, from specimens sent to him by De Brébisson, and as I have from De Brébisson, specimens labeled "*Nitz. minutissima* W. S. = *Synedra dissipata*," which are quite distinct from the present form, and with the marginal punctæ much finer, 39 in .001, and not so prominent in s. v., I have not hesitated to name it after the eminent diatomist from whom I received it. It was collected from a water tank supplied by the river Catuche.

*Raphoneis australis*, n. sp. H. L. S. *Hab.* Royal Sound, Kergueland's Land. Dr. J. H. Kidder. Frustules somewhat variable in size, valves cuneate, rounded at the larger end, and coarsely monliform striate, striæ interrupted by a smooth blank space, frustules slightly cuneate in f. v. Length .0005 to .00086; breadth .00022 to .0004. Striæ about 30 in .001. Plate III, fig. 6.

This form constituted the bulk of a washing from black sand dredged by Dr. J. H. Kidder, Surgeon U. S. N., in from five to twelve fathoms water in Royal Sound, Kergueland's Land,

January, 1875, on occasion of the visit of the American party to observe the transit of Venus. Only two dredgings were made, and they were almost identical. *Plagiogramma Robertsianum* of Greville, was also abundant, and a small and doubtfully new *Surirella*. Besides these, there were a few larger diatoms, and especially a variety of *Auliscus coelatus*, and as the dredging continued fragments of *Hypnum*, *Bartramia*, and *Barbula*, washed off from the land, these explain the occurrence of a few fresh water forms; no *Foraminifera* were found, but spines of *Hemiaster caudatus* were abundant. It is but justice to add, that Dr. Kidder, who was the Botanist of the expedition, and was therefore mainly employed in collecting the land plants, was prevented from making other dredgings and collections of *Diatomaceæ*, by the sudden and unexpected recall of the party, which is the more to be regretted since the only dredgings that were made have proved so fruitful; and as so little is known of the *Diatomaceæ* of high southern latitudes.

*Rhizosolenia Eriensis*, n. sp. H. L. S. *Hab.* Buffalo, N. Y., Lake Erie, D. S. Kellicot, Esq.; Cleveland, Ohio, Lake Erie, H. C. Gaylord, Esq.; Lake Michigan, Chicago, S. A. Briggs, Esq. Frustules of medium size, compressed and somewhat flattened; six to twelve times as long as broad; annuli on the dry frustules conspicuous, altenate, and with a zig-zag median connection, valves finely striate, bristles nearly or quite as long as the frustules, and with the calyptra excentric, lying nearly in a line with one margin of the frustule when the flat side is in view. Length of frustules .003 to .006. Plate III, fig. 7.

This remarkable diatom, the only fresh water species of *Rhizosolenia* hitherto known, was first sent to me living by Mr. H. C. Gaylord, of Cleveland, O., who obtained it in a filtering of Lake Erie water, used for the supply of the city. The bulk of the collection was *Stephanodiscus Niagarae*, which is almost always obtained in such filterings; subsequently Mr. Briggs, then Editor of "*The Lens*," detected it in filterings from Lake Michigan, and I furnished him a description which he published in his list of "Diatomaceæ of Lake Michigan," in Volume I. of "*The Lens*," page 44. It was, however, a rare form, until Mr. D. S. Kellicot, of Buffalo, by making filterings at different seasons of the year, finally obtained it in considerable abundance. Many of the fresh water forms procured in these filterings are considerably modified, e. g *Tabellaria fenestrata*

is quite twisted, and also the variety of *Fragilaria capucina*, (if it be a variety of this diatom) known as *F. Crotonensis*, and also some of the *Synedræ*, Does this, when taken in connection with the occurrence of *Rhizosolenia*, and an *Actinocyclus*, to be described presently, indicate that salt or brackish water is to be found at the bottom of the great Lakes, in which these diatoms live, or by which they are modified? It is well known that the late Mr. Stimpson, in connection with Dr. Hoy, of Racine, and others, dredged in some sixty-four fathoms, from the bottom of Lake Michigan, a marine crustacean of the genus *Mysis*, and other forms of a decidedly arctic type; whence it has been inferred that the great Lakes formerly had communication not only with the Atlantic through the St. Lawrence, but with the Arctic Ocean through Hudson's Bay. Although the *Rhizosolenieae* have been found in tropical waters, they are far more abundant in those of high latitudes. *R. Eriensis* has never been found as a littoral form, and is only known from filterings of water taken at a great distance from the shore, and from a considerable depth.

*Cestodiscus Baileyi*, n. sp. H. L. S. *Hab.* Lower Lake Klamath. Lt. Williamson. Disc circular, diam. .0025 to .0028, inflated, and with distinct radiating granules; and showing more or less the characteristic subulate blank spaces of *Actinocyclus;* without umbilicus; processes intra-marginal, small, and numerous; the punctæ near the margin of the valve are in parallel rows, 27 in .001. Secondary plate or septum, with a large central opening, fringed with somewhat irregular rays, which do not reach the margin. Plate III, fig. 8.

This species constituted the larger portion of one of the "Infusorial Marls" from the neighborhood of Lost River, Lower Klamath Lake, Oregon, and was collected by Lt. Williamson, as noticed in Volume VI, "Reports of Pacific R. R. Explorations." I am not sure that this diatom belongs to Greville's genus *Cestodiscus* (or even that the genus itself is a good one); the intra-marginal processes, not connected by a furrow, or distinct line, would seem to place it here, but it has, on the other hand, many affinities with *Melosira*. Provisionally, I place it in Greville's genus, and name it after the distinguished microscopist from whom I received the material, and whose notice of these infusorial earths was received too late for insertion in

the government reports. The deposit is fluiviatile, recent tertiary.

*Amphora mucronata*, n. sp. H. L. S. *Hab.* Atlantic Marshes, Cape May, N. J., F. W. Lewis, M. D. Frustules in f. v. broadly oval, dorsum with distant longitudinal lines, ventral surface with indistinct longitudinal lines, or furrows, central nodule elongated and pointed (mucronate), and touching the margin of the connecting zone, which is of variable breadth, nodules at the end quite small. Median line strongly and sharply inflected and minutely punctate along its whole length, an irregular row of minute lines or elongated dots on the valve within the margin. In s. v. dorsum very convex; ventral margin straight, or nearly so, with slight constriction at the ends; central nodule indistinctly shown (out of focus). Striæ excessively minute. Length .0026; breadth .0012 to .002. Plate III, fig. 9.

I received the gathering containing this very pretty diatom many years ago from Dr. Lewis, and I had entirely forgotten a pencil sketch which he had sent to me at the same time, when I issued it as No. 38 of the "Species Typicæ Diatomacearum," under the name of *A. mucronata*. I regret that I did not name it after the discoverer, who, doubtless, would have described it, if he could have continued his excellent studies of the diatomaceæ. It has a close resemblance to *Amphiprora hyalina* of Dr. Greville, described in his paper on Hong Kong diatoms in "*Ann. and Mag. Nat. Hist.*, July, 1865," though his figure does not show the peculiar mucronate central nodule. The present species is not an *Amphiprora*, and, therefore, if it be Dr. Greville's form, which is not unlikely, his specific name must be changed, as there is already an *Amphora hyalina*. It belongs to the so-called "*Complex Amphorae*" of Gregory, and like *A. Complexa* it is very tender, scarcely standing strong acid treatment, or even continued burning at a red heat, without injury.

*Actinocyclus Niagarae*, n. sp. H. L. S. *Hab.* Lake Erie, Cleveland, O. H. C. Gaylord, Esq. Disc large, diam. .0038, valves very much inflated and densely packed with minute radiating punctæ, which are scattered loosely and irregularly at the centre, and sometimes radiate from *two* central blank spaces. In the living form, the connecting membrane is broad, and the highly inflated valves cause it to lie obliquely. There is a characteristic circlet of minute spines, within the margin of

the valves, and the subulate blank spaces so characteristic of *A. Ralfsii* are more or less apparent. Plate III, fig. 10.

I have been much puzzled where to put this diatom, which I have found only in this one filtering from Lake Erie water, it was associated with an abundance of *Stephanodiscus Niagarae.* At first sight it appears to be a *Coscinodiscus*, but as this genus is limited at present, it has many peculiarities that would prevent placing it here. Upon the whole, it seems to belong to *Actinocyclus* rather than to *Coscinodiscus ;* in either case, its occurrence in fresh water is sufficiently remarkable, as all the members of these genera, hitherto known, are marine. As it has never been found in shore or inlet gatherings, and is very rare among the filterings, having never been found except in this one case, we might suppose, either that it came from an accidental disturbance of some ancient marine deposit in the Lake, or was living only at extreme depths, and passing into the ordinary water supply after some storm which had raised it nearer the surface. As it was living, and with the endochrome perfect, as in the *Stephanodiscus*, so that I was enabled to make careful drawings of it, we must dismiss the first supposition and conclude that it is one of those diatoms living at considerable depths, and which are only brought up by dredging, or storms. That diatoms flourish in immense abundance, notably the *Coscinodisceæ*, at great depths, is indicated by many of the "Tuscarora" soundings, some of these, from depths of over three miles, were almost wholly *Coscinodiscus omphalanthus* and its varieties, fully charged with endochrome ; and belts of "diatom ooze" at considerable depths were also found by the "Challenger" naturalists.

## OBSERVATIONS ON SEVERAL FORMS OF SAPROLEGNIEÆ.[1]

BY FRANK B. HINE, B. S.

(*Received Sept.* 28.)

THE following results of recent observations made upon this group are not claimed to be in all respects new to science. They are facts as I have found them, and are given not only on account of their peculiar and interesting character, but mainly because this family has received but

little notice in English publications, also to introduce the study of American forms, and treat of some that have not been described.

According to Lindstedt (4,39),[2] the first mention of a form belonging to this group, is by Ledermüller, as early as 1760, who noted a form of Saprolegnia, probably *S. ferax* growing upon a fly, and placed it among Confervaceæ. Occasional notices have since been made of them but the most extensive memoirs are by M. Cornu (2) in French, and H. Pringsheim in German (6), while among other writers Hildebrandt (3), De Bary, Reinke (9), Lindstedt (4), Thuret (8), have published various specific accounts.

The Saprolegnieæ are aquatic, parasitic, nearly colorless plants, appearing to the unaided eye merely as a light grayish, or white cushion-like mass of fine filaments.

They were placed by early investigators (3) (5) (8) among the Algæ, chiefly on account of the resemblance of their mode of reproduction to that in certain Algæ, and because they have also the same habitat. There is yet a diversity of opinion as to their true position; but later writers generally place them among the Fungi. I made some experiments bearing on the determination of their position according to the distinctions of the two groups given by Rev. M. J. Berkeley (1), who says that "Fungi are distinguished from Algæ by deriving their nutriment from the substance on which they live, and not from the surrounding air or water-like Algæ;" also by Julius Sachs (7) who states that "All Algæ contain chlorophyll, and have therefore the power of assimilation; all Fungi are destitute of chlorophyll, and are therefore parasites, or live on organized products of decomposition." Specimens of *Menobranchus lanceolatus*, kept in a tank at the University, became attacked by Saprolegna, which caused death; and while the animal was yet alive, by taking hold of the filaments of the plant, the skin, when infested, could be readily lifted, thus showing an inflamed portion beneath. Also, plants removed at different times from the matrix on which they grew showed

[1] The greater part of the material in this paper on the genera, *Saprolegnia* and *Achlya* is taken from my thesis for the degree B. S.

[2] A list of works referred to is given at the end of the paper. The first figure designates the number of the list. The last the page.

quite a plenteous mycelium. It is known that *Achlya prolifera* troubles the roe of fishes in some breeding-houses, causing much loss ; also that forms of Saprolegna frequently attack fishes kept in aquaria, a good example of which is the following :

On August 31st, a number of fishes caught by means of a net, were placed in the University aquarium ; on September 2d, some of the perch and sun-fish were attacked by this fungus, appearing at a little distance as if covered by a delicate veil, and the next morning died, when it was seen that the plant had formed a mat of mycelium over the whole animal. At another time some specimens with a small amount of the matrix were carefully removed and placed in distilled water, the result was growth equal to that which had taken place on those left in their normal condition ; this can not be considered very satisfactory however, for the organic elements from the decomposing flesh would enter into the water, and thus tend to vitiate the experiment.

An experiment touching the point of assimilation was made as follows : a turtle which had died after being partly infested with *Achlya racmosa*, was placed in a dark closet for three days. The result was a very decided increase in growth, for, when

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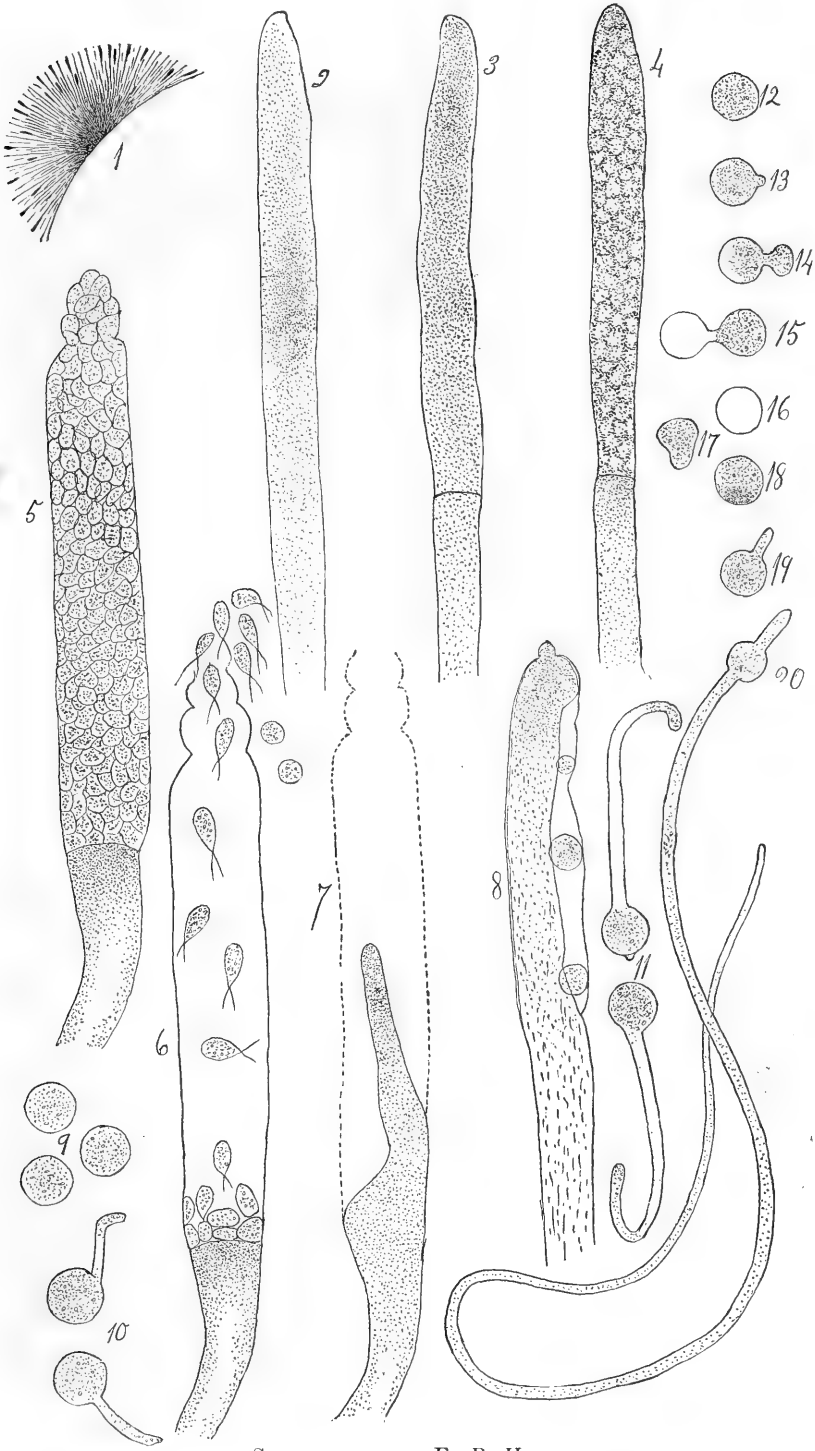
DESCRIPTION OF PLATE IV.

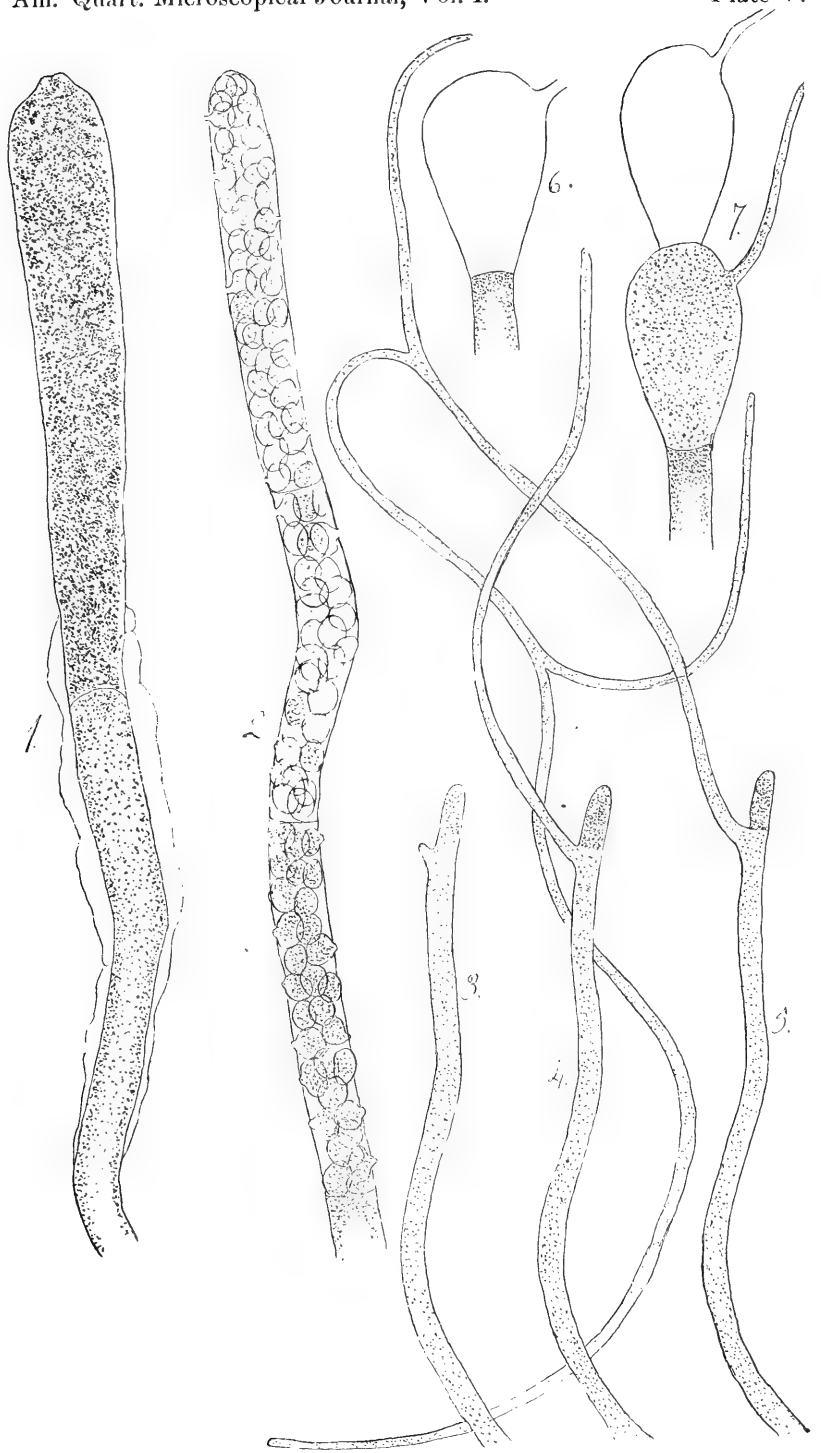
Fig. 1. Saprolegnia sp. natural size.
Fig. 2. Tip of growing filament.
Fig. 3. Tip of filament showing the aggregation of granules, and formation of the sporangium.
Fig. 4. Segmentation of the contents of the sporangium.
Fig. 5. Sporangium with zoospores formed.
Fig. 6. Zoospores passing out.
Fig. 7. Filament growing up in old sporangium.
Fig. 8. Another form of Saprolegnia showing zoospores held in old sacs.
Figs. 9–11. Zoospores at rest and germinated.
Figs. 12–18. Showing rejuvinescence of zoospores.
Figs. 19, 20. Germination of same.

DESCRIPTION OF PLATE V.

Fig. 1. Second sporangium formed on the same filament (350 diameters).
Fig. 2. Terminal portion of a filament from a triton.
Fig. 3. Growing filament magnified 200 diameters.
Fig. 4. The same one hour later.
Fig. 5. The same three hours later.
Fig. 6. A late sporangium of Saprolegnia sp. from a triton.
Fig. 7. Similar sporangia opening through longer tubes.




SAPROLEGNIEÆ.—F. B. HINE.




SAPROLEGNIEÆ.—F. B. HINE.

placed in the closet only a portion of its head and feet were covered, while at the time of being removed, a dense mat of radiating, branched filaments enveloped the whole animal. All the forms which I have met have either developed from decaying animal or vegetable matter, or caused its decay by their growth; and filaments separated entirely from all matrix, and placed under cover-glass, the whole covered by a bell-jar to keep it moist, showed, after some growth, that the protoplasm did not half fill the filaments. Hence, after this brief view, I have come to the conclusion that, according to the distinctions of the two groups given by our authorities, this family of truly parasitic plants must belong to the Physomycetes among the Fungi, where it is placed by Sachs (7,242) and Cornu. (2, 5).

M. Cornu (2) separates the entire family into two main divisions—the Saprolegnieæ proper, and the Monoblepharidæ—the chief distinction lying in the zoospores, which, in the first group, are uniform with two unequal cilia, one attached at either end, or oval with two equal cilia attached in front; while in the second group they are ovate, and provided with a simple cilium. Moreover, it has been noted that in all the species of the Saprolegnieæ proper the wall of the filaments is formed of cellulose, giving a bluish reaction on the application of Shultze's solution, whereas in the Monoblepharidæ no reaction is given, showing that the walls are not formed of cellulose. Under the first division are included six genera, among which I have paid special attention to but two; *Saprolegna* and *Achlya*, and of which I shall treat further on. The second division contains but a single genus, *Monoblepharis*, and under that but three species have been described, while one of the forms which I shall consider further on doubtless adds a fourth.

To the Saprolegnieæ are attributed two modes of reproduction, which give the group particular interest. In one case, zoospores are produced which germinate and grow without the intervention of any male product; while in the other both male and female organs are present, and fertilization takes place giving rise to a spore, which remains at rest a much longer time before germinating than in the former case. The first of these methods I have carefully studied, and a full description follows under the genus *Saprolegnia;* while the second form has been particularly noted in the genus *Achlya*.

SAPROLEGNIA.

I can give no specific designation to the plant which I have included under this genus, for, as far as studied, there were presented characters different from descriptions to which I have had access ; and yet I can not justly place it under a distinct species, since I have not been able to study the several modes of reproduction, in which rest very important characters. It is a form which seriously attacked *Menobranchus* kept at different times in a tank at the University. They seemed to produce considerable irritation, and death was sure to take place in a few days. In the cases noted, the plants first appeared just anterior to the brain, then posterior to each set of gills, and, finally establishing itself on portions of the body and legs soon completely covered the whole animal.

This is quite different from the way in which I have since noticed other forms to attack fishes, for with them growth took place equally on a large portion of the animal, the filaments being of the same age and covering the whole body. I have already noticed the effect of this plant upon the animal, i. e., that long before death, the parts infested had the appearance of decomposing flesh, and could be easily torn from the animal before the filaments would break ; the parts thus exposed had the appearance of being inflamed.

The fungus appears in dense, grayish mats of filaments, averaging about 6 mm. in length, and when closely observed the Sporangia are just noticable from their darker appearance. (Pl. VI., Fig. 1.) Carefully removing a cluster of filaments by means of a pair of forceps, and placing it under a cover-glass, a great difference is noted in different filaments according to age. When young the tip is always clear, while just below it becomes very dark from its granular contents, these granules becoming less dense so that the main part of the filament is nearly clear.

As they reach their growth the granules concentrate more at the apex, and, after becoming so dense as to render that portion of the filament opaque, a septum is formed producing a terminal cell with a length some eight times its breadth.

This sporangium is always larger than the filament; is sometimes cylindrical, but generally club-shaped. In four hours after the septum is formed, the granules have so rearranged themselves as to produce a mottled appearance shown

in Fig. 4, Pl. IV., and in four hours more the contents of the sporangium are arranged into many spherical bodies (Fig. 5) of about one-fourth the diameter of the sac, and in some cases that I timed they passed from the sporangium is about twenty-four hours after the septum was formed.

Just before escaping the zoospores at the base always take on an oscillating motion, which passes to the zoospores next above and so on to the summit, causing such a pressure that in less than a minute the power is such as to cause a rupturing of the sporangium, which, in normal conditions, always takes place at the summit. The zoospores now pass out, at first very rapidly, so that it is impossible to count them, but when about one-half out they become more quiet, seldom losing their motion however, until all have passed from the sac. In passing out they are very much constricted, so that if any lose their power of motion before they have escaped, it is impossible for them to pass out. Having passed from the sporangium, which was emptied in one minute, they swarmed around very lively for nearly four minutes, at the end of which time they settled down, lost their cilia and became spherical. (Fig. 9.) At the end of one hour and thirty minutes they had germinated (Fig. 10.) and one hour later growth had proceeded to the extent shown in Fig. 7. Except at the tip, the growing filament was perfectly clear. In another case zoospores given off at 12.30 o'clock were found germinated at 3.30, at which time they underwent a very singular change. A swelling appeared on the zoospore similar to that seen in germination, but, instead of elongating, it gradually enlarged into a spherical body, at the same time the contents of another cell shrank proportionately from the opposite side, and in forty seconds there was nothing left of the old zoospore but a delicate transparent sac. This new body took on an oscillating motion and in two minutes separated itself from the old sac, taking on an irregular form,[1] after which it swam around for three minutes, then settled down and became spherical, the larger granules settling to one side. Germination took place twenty-five minutes later. The same change took place in all the zoospores noted from this sporangium, and the same was seen in other cases, but as a rule it does not occur. The sporangium was

[1] I have since found this change spoken of by M. Cornu, who also says that this new body is provided with two cilia, but in these specimens I saw none.

the first formed on the filament, and appeared no different from the others of the same age. Why did this change take place? If we accept M. Cornu's statement, that the new form is provided with cilia, it would seem that the relation of this outer wall to the zoospore is like that of the pericarp to the seed. But in the specimens I examined with a magnifying power of 750 diameters (Fig. 17) I in no case observed cilia, and think that the slow oscillating movement which occurred could have been caused by the slight change in temperature from the inside of the spore-case to the surrounding liquid, and the change may have taken place on account of the cell wall becoming tough and distinct from the contained protoplasm, as these zoospores remained at rest much longer than those which germinated without the change. As soon as the sporangium was emptied, the plant commenced to swell up

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DESCRIPTION OF PLATE VI.

Fig. 1. Achlya sp. growing on a pine twig, natural size.

Fig. 2. A short filament bearing oogonia, magnified 120 times.

Fig. 3. Oogonium largely magnified, showing the fertilization of the contained gonospheres.

Figs. 4–10. Oogonium in different stages of development.

Fig. 11. A cylindrical, inter-filamental and spherical lateral oogonium on the same plant.

Fig. 12. Spores of sexual generation 20 hours from gonosphere.

Figs. 13, 14. The same germinated.

Fig. 15. Oogonium of *Achlya polyandra.*

DESCRIPTION OF PLATE VII.

Figs. 1, 2. Sporangia and zoospores of Achlya sp.

Fig. 3. Germination of zoospores and formation of a second sporangium.

Fig. 4. Branch of *Monoblepharis lateralis* showing position of oogonia, magnified 50 times.

Fig. 5. Young oogonium showing the male organ.

Figs. 6–7. Birth of the antherozoid.

Fig. 8. Empty sack attached to the oogonium.

Fig. 9. Antherozoid settled down after birth.

Figs. 10–12. Amœboid forms assumed. Fg. 12 was taken one hour and twenty minutes from oogonium.

Figs. 13–18. Antherozoid upon an oogonium. Figures made at intervals of twenty minutes.

Fig. 19. An oogonium showing the fertilization of the gonospheres.

Fig. 20. A rare and late form.

Fig. 21. Oogonium showing the openings in the membrane, also the attachment of an empty antherozoid sac and antherozoid after performing fertilization.


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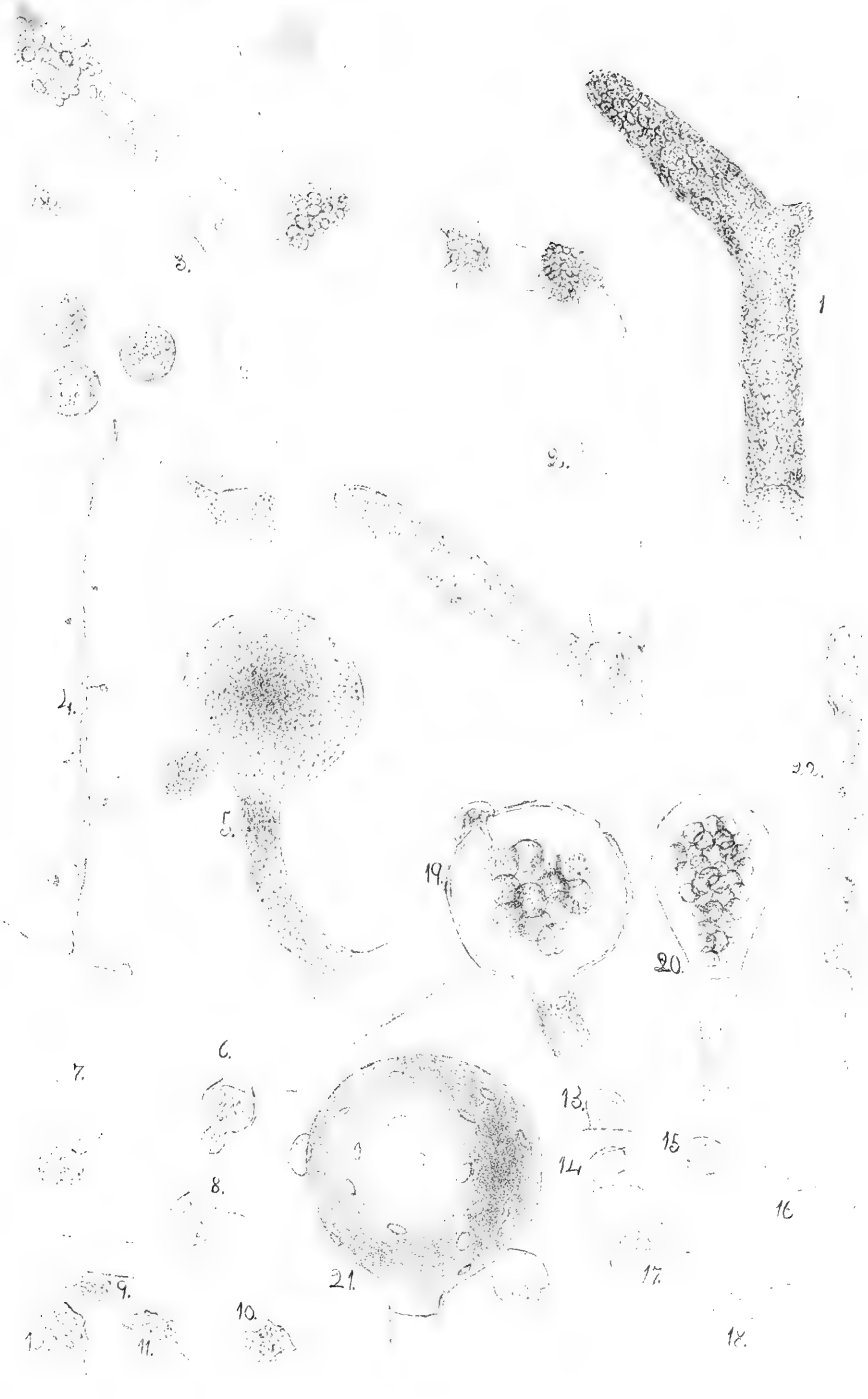


Saprolegnieae.

into it, and in two and one-half hours reached more than half way to the opening (Fig. 7, Pl. IV). A new sporangium may be formed when, or soon before the filament has grown through the old sac, or, as in some Saprolegnia since studied, the filament may produce even a greater growth after than it had made before the formation of the first sporangium. I found a form growing on some very small bull-heads, which after the first sporangium had developed, sent out, in many cases noticed, a very extended and branching growth. They were specimens preserved for study by being placed in a cell and kept irrigated.[2]

The form just referred to as growing upon small specimens of fish, and of which I was enabled to study out the parthenogenetic forms, was peculiar in having the zoospores differing greatly in size, for, in the same sporangium, it varied from .01 mm. to .021 mm. in diameter, the sporangia averaging about .04 mm., and the filament .025 mm. in size. There were also invariably a few zoospores remaining in the old sac after it had opened, the cause of which was that a large zoospore was unable to pass through the opening, thus keeping back all the remaining zoospores until they had settled down to the spherical form. The new filament is always constricted where it passes the opening of the sac, showing that it thus entirely closed it, holding the zoospores in a pouch on the side of the filament. The zoospores developed in each case were much less numerous than I have seen in any other specimens, there being from ten to eighteen in each sporangium. In some of the sacs which had been opened but a short time, there was an infusorian nearly twice the size of the largest zoospore. They must have passed in through the openings of the sporangia, and were unable to make their exit.

In studying, and especially in growing these forms, one can but notice the rapidity with which they develop, especially under favorable conditions. Illustrating this point I introduce the following table which embraces the results of timing the

[2] I find that a very satisfactory way to keep growing specimens in a fresh condition under a cover glass, is to place the slide by the side of a watch-glass of water, and, taking a short thread thoroughly moistened, place one end in the watch-glass, and apply the other closely to the edge of the cover-glass. If not placed under a bell jar evaporation will be sufficient to allow a supply of fresh water.

growth of a young and thrifty filament under a magnifying power of 200 diameters. For the first hour observations were taken every five minutes; during the second, every ten minutes, after which the time varied. The first column represents the time of measurement, and the second the length of filament.

TABLE SHOWING RAPIDITY OF GROWTH.

| *h. m.* | *length.* | *h. m.* | *length.* | *h. m.* | *length.* |
|---|---|---|---|---|---|
| 9.07 | 5. mm. | 9.47 | 54.7 mm. | 10.52 | 149. mm. |
| 9.12 | 11.1 " | 9.52 | 62.3 " | 11.02 | 169.8 " |
| 9.17 | 16 " | 9.57 | 70.1 " | 11.22 | 208.4 " |
| 9.22 | 22.3 " | 10.02 | 78.1 " | 11.32 | 221.7 " |
| 9.27 | 28.9 " | 10.12 | 91.2 " | 11.42 | 233.1 " |
| 9.32 | 35.2 " | 10.22 | 110.3 " | 11.52 | 241. " |
| 9.37 | 41. " | 10.32 | 125.1 " | 12.02 | 241. " |
| 9.42 | 47.5 " | 10.42 | 137.3 " | | |

From these data it will be seen that growth for the first hour averaged 6.5 mm.; for the second, 7.64 mm., and for the third about 6 mm.; this, it will be remembered, under a magnifying power of 200 diameters. Growth during the remainder of the day averages a considerable less, but judging from the appearance of the plant at 8 o'clock the next morning, I think that growth had taken place as rapidly as when the first measurements were taken. The branches shown were given off at 10.07 and 10.42 o'clock, and averaged 7.8 mm. per five minutes. The time required for a plant to develop fruit from the zoospore varies greatly with varying conditions. A mat of mycelium, from which the specimen was taken, developed fruit in four days, but this time was rather long when compared with other observations made on the same germs, considering that the mycelium was already well developed. In one case zoospores were placed upon a slide with a small fragment of a fly, the first sporangium opened in about thirty hours, and the second one on the same filament eight hours later. I have not yet made any satisfactory observations on the second mode of reproduction in this genus, but according to the best authorities on this group, it is in principle very similar to that described further on, under the genus Achlya. The number of times that this unsexual form may be produced without the intervention of sexual reproduction, or in a single vegetation period, I have not been able to ascertain. A series of experiments bearing partially upon this point, and showing a

great variation in the form of the sporangia have just been made. In August, 1878, a triton was so injured in being caught that a portion of the liver passed out from the body cavity and hung from the side of the abdomen. In this condition it was placed in a jar with some small fishes and allowed to remain. Observations made a few days later showed the appearance of filaments from the injured portion, and in two days later fruit was produced.

The sporangia and zoospores had the characters of the genus *Saprolegnia*; but differed from those already described, in forming the new sporangium to one side of the old—the filament elongating only sufficiently for the formation of the sporangium; about thirty hours later, other specimens were carefully removed and examined. The filaments had elongated to varying lengths beyond the old sacs and formed sporangia (Pl. v., Fig. 2), very similar to those which characterize the germs *Dictynchus*, Leitgeb. The zoospores, instead of raising out through an opening in the apex of the sporangium, burst through the side, leaving behind a clear membrane of its former size and shape. In the genus *Dictynchus*, the sporangium emptied of zoospores appears as if divided into many angular transparent cells, while in the form noted the old spore case remained rounded. Fig. 2, Pl. v., represents a filament bearing three of these sporangia, the lower one yet containing the zoospores. The sporangia varied from .04 mm. to .41 mm. in length, and in some cases the branches contained but a single row of zoospores.

August 30th, four days after the first triton was caught, another was taken and an incision carefully made in the side of the abdomen, allowing a portion of the intestines and liver to pass out uninjured. It was placed in a jar of water, which was kept changed by means of a siphon, and sown with spores from the first specimen. At 10 o'clock, Aug. 31st, the intestine had a delicate velvety appearance, caused by a very dense growth of filaments about .5 m m. long; at 4 o'clock P. M., the filaments were 2 mm. long, unbranched and bore no traces of sporangia. Sep. 1st, 10 o'clock, an occasional ripe sporangia was found, and Sep, 2d, 10 A. M., many; here also the new sporangium was formed on the filament to one side of the old; later observations showed that none of the Dictyo-sporangia were produced; the late sporangia, one or more formed on the same

filament, were ovate .064 mm. long by .041 mm. broad, and opened at one side near the top by a short, or, frequently, quite long tube. (Figs. 6 and 7. Pl. v).

They required a much longer time to develop fruit than in the first case. The zoospores were all distinct from each other .009 mm. in diameter, and generally underwent a rejuvenescence. The triton died in four days, but observations were made until the plant ceased to grow, and no sexual fruit was produced. Sep. 5th, a third triton was placed under the same conditions as the second, and sown with fruit grown on the second, the time of the appearance of the plant and its development was nearly the same as in the former instance ; the new sporangia however were produced as in the first forms described (Pl. v. Fig. 1), and the late forms were the same as in the former experiment, and in both cases the intestine had decayed and broken away. The triton died in three days. Sep. 10th, the egg sac of a fourth triton was exposed and sown with zoospores from the third experiment. The Saprolegnia dedeveloped were the same as in the last case. In six days the portion bearing the fungus was separated from the main part of the ovary by the growth of a transparent membrane closing the body cavity. Since then no filaments have appeared, and now the triton seems to be in good condition for another operation.

Although these experiments were not successful as far as the production of oogonia is concerned, they are of considerable importance as showing the great variability of the parthenogenetic forms in different generations and different stages of growth ; also the fact of their attacking healthy parts, although in an unnatural condition, and causing their decay.

*Concluded in our next issue.*

## THE "OIL IMMERSION" OF CARL ZEISS COMPARED WITH THE OBJECTIVES OF C. A. SPENCER & SONS.

BY PROF. H. L. SMITH, LLD.

Some four months ago I sent two objectives, by special request, one to Belgium, the other to Germany. They were made by C. A. Spencer & Sons, and were their then highest

grade, having a balsam angle of about 102°. I say their then highest grade, as they have since brought out a $\frac{1}{6}$th, and also a $\frac{1}{10}$th, on a new formula having a balsam angle of near 110°. One of the objectives sent to Germany was compared with the new "Zeiss Oil Immersion" by a personal friend of mine, not the owner of this objective; he pronounced it an excellent glass, but, to use his own words, "a long way behind his Zeiss Oil Immersion." I felt inclined to accept this decision, though the Messrs Spencer assured me, that there must be some mistake; yet, from the very high reputation of M. Zeiss, and especially from his connection with Professor Abbe, in the production of the new objective, I was prepared to admit that he had, really, made something of surpassing excellence, which would easily beat any competitor. True, Mr. Dallinger's report upon this objective showed that, upon the whole, the new optical wonder of Jena did not quite equal the Powell and Leland "$\frac{1}{8}$th new formula," but then I had not seen any of these new formula objectives of the world-renowned English opticians, and as the same able and wholly competent judge had decided that Mr. Tolles' $\frac{1}{6}$th was not quite up to this "new $\frac{1}{8}$th" though pressing it very closely, I felt inclined to believe that, really, M. Zeiss *had* stolen a march on the Americans. For the purpose then of satisfying myself, and for the grim satisfaction of convincing the Messrs. Spencer, I purchased in London a "$\frac{1}{20}$th" immersion by Zeiss, with the express notice that it was to be tested against the best American objectives, and more recently induced a friend, who had just received the "new oil immersion $\frac{1}{8}$th" to send me that for examination. The $\frac{1}{20}$th proved to be a good objective. I did not feel like complaining that I had not the worth of my money, but it was not so good an objective as I could have procured from either Tolles, or Spencer, though of higher numerical grade than they would have furnished for the same money. It proved certainly, that M. Zeiss was an excellent workman, and as I have said I did not feel disposed to think I had paid too high a price, as Franklin has it, "for the whistle;" but I did expect to see something far superior to the $\frac{1}{20}$th when the "oil" should arrive. This indeed proved to be the case, and I have no hesitation in saying, and all who have looked through it here agree with me, that up to this time, the new Zeiss "$\frac{1}{8}$th Oil Immersion" is the best foreign made objec-

tive I have seen. The mechanical work is very good, the appearance neat, and the lenses, when tested on the artificial star, appear to be very well centered and figured, and the coma is inward and not excessive. So far as could be judged from outside appearances, for I made no attempt to unravel its mysteries of structure, it is what is now called a "three-system" objective, though M. Zeiss in his circular mentions it as a "four-system"; the front lens is, apparently, too large for any "four-system" construction of equivalent focus. Considering the inexpensive character of the mounting, compared with the elaborate and nice workmanship required for the mounting of a first class $\frac{1}{10}$th or $\frac{1}{16}$th, this objective is put at an exceedingly high price—240 thalers in Jena, say 60 dollars gold, to which must be added duties, etc., if imported in the *regular* way. It *ought* to do superior work. The balsam angle of this objective, *i. e.* the angle of the emergent cone *in* balsam as actually measured, is the same as that of a $\frac{1}{10}$th Spencer, belonging to a gentleman of this place, which was made at the same time with, and indeed is the same in every respect as the two objectives I had sent to my friends in Europe. With this objective I compared the new Zeiss, and also with a $\frac{1}{16}$th of much larger balsam angle, not yet completed in its own mounting, though finished optically. I beg here to say that I am no partizan either of the Spencers, or of Mr. Tolles; I do not own an objective made by either of them, higher than a $\frac{2}{3}$ of 35°. With my friend, who owns the "Zeiss," I believe in the "survival of the fittest." I am only interested in seeing fair play, and I am sure that neither M. Zeiss nor my friend in Germany, who endorsed him so highly, in the comparison with the American objectives, will question my right either to criticize or to publish the result, so long as I state facts which rest not alone on my own testimony, though I may be pardoned for saying I deem that sufficient. The objectives were tried in as precisely similar conditions as possible. The same frustules of *Amphipleura*, the same light—alternately changing the objectives, with direct (axial) light, and with oblique, by day light and by lamp light. With the mirror alone, and with the "Wenham reflex." And this not once, but a great many times. The tests were both dry, and balsam mounted, *Amphipleura*, and for the axial light I had a remarkably excellent specimen of the *Podura* scale. With the day light used in any

way, the 1/6th and the 1/10th were manifestly superior to the Zeiss. Fortunately, I am relieved of any charge of improper manipulation, as the "Zeiss" came furnished with oil specially prepared for it, and needed no manipulation. There was nothing to do but change the objective, and make the "oil," which is abominably thin and runs almost like alcohol, stay in, especially with thin covers, and the stage at all approaching the vertical; this feat, however, was successfully accomplished, and I may add, that before applying the oil, the slide was thoroughly cleaned, so that no remnants of the glycerine, or water, used with the other objectives, should interfere; a process also necessary on again changing from the "Zeiss" to the "Spencer." If I knew how to do a fair thing, I am sure it was done at this trial, and I freely confess the result is not what I anticipated. With the Spencer objectives, the outlines of the frustule, and the lines themselves on the valves, were much more sharply defined than with the "Zeiss." There was no difficulty at all, with mirror alone, and ordinary sky light, in resolving the *Amphipleura* dry, with the "Zeiss," what would have been called superior resolution, if it had not been seen better with the same light, without touching the mirror, with the Spencer objectives. There was a smoky appearance with the "Zeiss" on the dry mount, and an indistinct outline of the valves, with a tendency to break down with the E eye piece, which was entirely absent from the two objectives compared with it.

The lines were also seen on *Amphipleura* in balsam, by day light, but requiring much stronger light to see them best with the "Zeiss," indeed, closer vicinity to the sun than with the "Spencer," the latter exhibited here also the lines considerably sharper. With lamplight and mirror, the results were the same, all the objectives resolved the balsam mounts, but the difference was unmistakably in favor of the 1/10th and the 1/6th. With the Wenham reflex, tried many times on the balsam mounted *Amphipleura*, the "Zeiss" did its best work, and more nearly equalled the 1/10th than it did the 1/6th; but still here, the American objectives not only showed the markings blacker and finer, but stood the test of deepest eye pieces without flinching, better than the "Zeiss." In all these trials other witnesses were present, and the difference was clearly recognizable—markedly so with ordinary day light and mirror.

On *Podura,* after what I have already said, I need scarcely remark that the same difference was apparent. Indeed, as the same oil is not suitable both for extreme and for central illumination, and I had but that which the owner of the objective sent with it, it is not, perhaps, fair to M. Zeiss to dwell too strongly upon this test. Now, in all I have said, I beg not to be understood as depreciating the Zeiss objective. It is, by far, the best foreign objective I have ever handled. There was a satisfaction in being relieved from any responsibility in adjusting. For my own part, I felt so much satisfaction in this, that I hope the Spencers may be induced to make similar objectives. Finally, it must be remembered, even granting for a moment that my excellent friend in Germany did succeed in resolving test objects much better with the "Zeiss" than with the "Spencer," that the latter was also a very good objective as a dry, and there are hundreds of cases where an oil, which dissolves balsam, and asphalt, etc., cannot well be used ; or possibly he may have employed water as the immersion fluid, which is only proper for direct (axial) illumination, instead of glycerin, which is necessary for very oblique illumination

## THE MICROSCOPICAL EXAMINATION OF FIBERS.

BY W. H. SEAMAN.

Numerous isolated observations on this subject may be found in works on microscopy, but few attempts have been made to unite these in a connected system.* Many of the statements floating in popular journals are erroneous, and as the determination of the nature of fibres is one of the questions often presented to the microscopist, we offer the result of our experience.

A fiber is any flexible filament used in making cordage or woven or felted fabrics.

They may be compared with each other as regards their—

1. Origin, animal or vegetable.
2. Form of section, diameter and length.
3. In animal fibers, color, surface and general shape.
4. In vegetable fibers, diameter and length of ultimate cells.

* The best treatise yet published, is "Vetillart sur les fibres végétales employes dans l'industrie." See also a special report by Hunt & Schaffer, Bulletin Nat. Ass. Wool Growers, 1875.

5. Behaviour with reagents.
6. Relations to polarized light.

Animal fibers are either silk, feathers or hair. The smooth, solid, cylindrical form of silk fiber is too well known to require much description. The length is indefinite, and the diameter uniform or nearly so, which is a marked peculiarity. The ends are square, and, as seen in manufactured goods, there are usually particles of stiffening, etc., adherent to the fibers, which in certain forms seem to be regarded by some authors as permanent, and there is entire absence of cell structure.

Feathers, either in whole or part, have at different times been employed as fibers. They are usually covered with sharp barbs arranged at uniform distances, and may often be sharply differentiated from cotton, with which they are generally mixed in woven fabrics, by polarized light, in which they are quenched while the cotton glows brilliantly.

Feathers, in structure, are modified hairs, and display a somewhat similar arrangement of cells.

But most textile fabrics of animal origin are composed of hair, which varies from the rigid spines of the porcupine to the softest and most delicate fur or wool, without changing its type of structure. All hairs are composed of short overlapping scales forming a kind of tube, more or less serrated on the surface, and inclosing one or more rows of medullary cells arranged in symmetrical and characteristic modes, enabling the microscopist to assert with considerable certainty the animal from which they are derived. The shape is usually tapering; often the same animal wears two or more distinct kinds, as the fox, seal, or cashmere goat, coarse long hair forming the outer coat, and fine curly wool the inner. The duck bill (*Ornithorhynchus*) of Australia, and the common water mole (*Scalops aquaticus*), have hairs very long, slender, and with the ends flattened out like a trowel.*

All fibers of animal origin when burned give a disagreeable odor, and leave a crispy coal, while those of vegetables consume more perfectly without smell.

Both silk and wool are soluble in strong hydrochloric acid, the solution being hastened by heat, but in dilute acid silk is soluble and wool is not. Vegetable fibers in the same reagent are disintegrated but not dissolved.

* See Micrographic Dictionary for figures of a variety of hairs, feathers, etc.

In strong cold sulphuric acid, silk quickly turns yellow and dissolves, cotton disintegrates slowly without color, flax and hemp make a black mixture, and wool is scarcely affected.

Both silk and wool turn yellow and are soluble in nitric acid, the first the more speedily, while vegetable fibers are slightly affected. For these, cupro-ammonium sulphate is considered the only solvent.

When treated with iodine and dilute sulphuric acid, vegetable fibers, composed chiefly of cellulose, take a characteristic color, either yellow or blue, while animal fibers are not affected. These reagents, applied under the microscope, afford the means, in connection with the characters of the ultimate cells of which all plant fibers are composed, of determining the species from which the fiber is derived. The reagents should be prepared as follows :—Dissolve one part potassium iodide in one hundred parts of distilled water, and add an excess of pure iodine so that the solution shall always remain saturated. Mix one part of distilled water with three parts of sulphuric acid, and when cool add two parts of Price's glycerin. Both reagents should be kept in glass stoppered bottles, and as they are liable to change, should be occasionally tested on known fibers. When in proper condition they will give clear and uniform coloration without changing in the slightest degree the form of the fiber cells. If the acid be too strong the fiber takes an intense color, and swells enormously, often in a very symmetrical manner as figured in Sach's Botany, English Ed., page 592, etc., but this tumefaction should be carefully avoided in differentiating fibers. The simplest form of vegetable fiber consists of appendages to seeds like cotton; single cells almost without taper, but usually they are composed of bundles of tapering or spindle shaped tough, firm cells, lying side by side, and separable from each other by soaking in alkalies, rubbing with the fingers, teasing with needles, rubbing with a pestle, or recourse must sometimes be had to boiling in ten per cent. soda lye or Labarraque solution.

When the cells are separated a number of them should be extended on a slip and slightly moistened with glycerin, which will restrain any tendency to crisp or curl when the cover is imposed. By laying the slip on a rule the average length is determined, then a micrometer must be used for the diameter. Now observe the ends for shape, taper, and whether or no

## Synoptical Table for the Determination of Fibers of Vegetable Origin.

### Dicotyledons giving blue reaction.

| Common Name. | Botanical Name. | Length of Fiber Cells. | | | Ratio Diameter to Length. | Diameter Fiber Cells. | | | Measures in Millimeters. |
|---|---|---|---|---|---|---|---|---|---|
| | | Shortest | Mean. | Longest. | | Smallest | Mean. | Largest. | |
| Flax | Linum usitatissimum | 4 | 25/30 | 66 | 1200 | .015 | .022 | .037 | Cavity fine yellow line. |
| Hemp | Cannabis sativa | 5 | 15/25 | 55 | 1000 | .016 | .022 | 050 | Striate with yellow sheath. |
| Hop | Humulus lupulus | 4 | 10 | 19 | 620 | .012 | .016 | .018 | Yellow envelope, canal empty. [lations. |
| Nettle | Urtica, Sp | 4 | 27 | 55 | 650 | .02 | .05 | .07 | Central canal large, with yellow granu- |
| China grass | Boehmeria nivea | 60 | 120 | 200 | 2400 | .05 | .08 | ..... | Fine delicate striæ. |
| Paper mulberry | Broussonetia papyrifera | 6 | 15 | 25 | 430 | .025 | .030 | 035 | Canal scarcely apparent. |
| Sunn | Crotalaria juncea | 4 | 7.8 | 12 | 260 | ..... | ..... | ..... | |
| Broom | Genista scoparia | 2 | 6 | 9 | 330 | ..... | ..... | ..... | Yellow envelope. |
| Spanish broom | Spartium junceum | 5 | 10 | 16 | 500 | ..... | ..... | ..... | |
| Melilot | Melilotus alba | 5 | 10 | 18 | 330 | ..... | ..... | ..... | Cavity large. |
| Cotton | Gossypium sp | 10 | 25 | 40 | ..... | ..... | ..... | ..... | Flattened and twisted. |

### Dicotyledons giving a yellow reaction.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Hibiscus | Hibiscus sp? | 2 | 5 | 6 | 240 | .014 | .021 | .033 | Color more intense on surface. |
| Linden | Tilia Europœa | 1.25 | 2 | 5 | 125 | .014 | .016 | .020 | Canal very small. |
| Jute | Corchorus sp | 1.5 | 2 | 5 | 90 | 020 | .020 | .025 | Stiff, canal prominent. |
| Lace bark tree | Lagetta lintearea | 3 | 5 | 6 | 500 | .01 | ..... | .02 | |
| Willow | Salix alba | ..... | 2 | 3 | 90 | .017 | .022 | .030 | |

### Monocotyledons giving blue reaction.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Spanish grass | Stipa tenacissima | 5 | 1.5 | 3.5 | 125 | .007 | ..... | .018 | Curly, cavity small. |
| Esparto | Lygeum spartium | 1.3 | 2.5 | 4 5 | 160 | .012 | .015 | .020 | |
| Pineapple | Anauassa sativa | 3 | 5 | 9 | 830 | .004 | .006 | .008 | Cavity fine, coloration slight. |

### Monocotyledons giving yellow reaction.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| New Zealand Flax | Phormium tenax | 5 | 9 | 15 | 550 | .010 | .016 | .020 | Coloration intense. |
| Adam's needle | Yucca | 5 | 4 | 6 | 170 | .01 | ..... | .02 | |
| Bowstring Hemp | Sanseviera Zeylanica | 1.5 | 3 | 6 | 150 | .015 | .020 | .026 | |
| Century plant (Pite) | Agave Americana | 1.5 | 2.5 | 4 | 100 | .020 | .024 | .032 | |
| Manilla hemp | Musa textilis | 3 | 6 | 12 | 250 | .016 | .024 | .032 | |
| Palmetto and Palms in general | Chamerops humilis, etc | ..... | | | | | | | |

frayed and shreddy. In animal fibers, the latter denotes shoddy; in vegetable, paper. Now with a glass rod or medicine dropper allow a little iodine to flow under the cover and the fibers will soon assume a clear light brown. Any surplus should be absorbed by a piece of blotting paper, for with reasonable care there is not the least necessity for soiling the stage of your instrument. As soon as the iodine has penetrated apply the sulphuric acid in the same way, and carefully watch the result, comparing it with the annexed table. Several minutes will sometimes elapse before the coloration is complete, and it does not endure for more than a few hours. Bent or creased fibers color more deeply in the flexures, and striæ, either longitudinal or radial (in sections) will show more plainly as the coloration progresses. In many sorts, of coarser fibers especially, pieces of parenchyma will be seen, that always color yellow, and may readily be known by their irregular shape. Cross sections can be made with any section cutter by gluing together a little mass of fibers, or bedding them in paraffine, or as often practiced by the writer, rolling them somewhat like a cigarette in a piece of sheet wax such as is used for wax flowers. When cut the mass of mixed sections is placed in benzole or alcohol, when the wax soon floats on top and may be poured off.

We owe to Vetillart the classification adopted above, which is an important analysis of the reactions of cellulose. The observations in the last column indicate only the prominent characters of each fiber. Mirbel called fiber cells bast cells, a name still used. In Dicotyledons they form the inner layer of the bark, are usually more or less colored, long, supple, and tenacious; in Monocotyledons they are scattered irregularly through the stem, are white, coarse, light, and often brittle. The central cavity and shape of the ends of the cells are important features. The blue reaction of Monocotyledons is not so uniform as that of the other classes, quite a large proportion of alfa and esparto also turning yellow; there being apparently two distinct kinds of cells in these plants, which are not mixed indiscriminately in the stem but form separate layers, each of which maintains its characteristic reaction, but becomes intermixed in processes of manufacture.

An inspection of the column headed ratio, will show at once why certain fibers maintain so prominent a place in the indus-

try of the world. These figures arranged in order of magnitude nearly represent commercial value for textile fabrics, but for paper stock other conditions modify the result.

## EMIGRATION IN PASSIVE HYPERÆMIA.

BY W. T. BELFIELD, M. D., OF CHICAGO.*

(*Received Aug.* 11*th*, 1878.)

In March last I had occasion to superintend the *post mortem* examination of a case of pneumonia, in which death had occurred on the tenth day of the disease. There was found consolidation of the entire left lung, gray hepatization in the lower lobe, red in the upper. Nothing peculiar was noticed in the other organs except general engorgement, especially marked in the kidneys. There had been during our observation of the patient not a solitary symptom of renal disease except the presence of albumen (about 5%) in the urine—a presence known to be common in pneumonia, and attributed to mechanical congestion. For at least three features of pneumonia tend to the production of mechanical congestion, namely: the decrease in breathing surface, the increase in the demand for oxygen made by the excessive tissue change, and the feebleness of the heart's contractions. Hence the albuminuria and the *post mortem* engorgement of the kidneys were regarded as legitimate results of the disease. A happy curiosity, however, led me to make a microscopical section of the kidney. I found the tubules rather smaller than usual, the intertubular spaces and capsules of the malpighian tufts much thickened by the presence within them of numerous small, round, finely granular cells $\frac{1}{2400}$ to $\frac{1}{3000}$ inch in diameter. These cells had every appearance of white blood corpuscles, and were so pronounced by Dr. Danforth and others. By way of explanation it was presumed that the retardation of the blood current, due to the causes previously mentioned, had afforded the colorless corpuscles an opportunity to exhibit their amœboid movements —and that the opportunity had been improved. That this was not an inflammatory process, was proved by the absence from the clinical history of all the recognized symptoms of renal inflammation, and by the absence from the urine of the

*Read before the National Microscopical Congress at Indianapolis, August 16th, 1878.

exudation cylinders or tube-casts. Nor were the microscopic appearances of the organ those of inflammation.

Within six weeks I had an opportunity of examining the kidneys of two other patients dead from pneumonia, without previous history of renal disease. In each case the urine contained a small quantity of albumen, but no casts, and in each instance colorless corpuscles were found in abundance in the intertubular tissue, and in the malpighian capsules. At a meeting of the West Chicago Medical Society, held June 10th, I exhibited a section from one of these kidneys, and another from a normal kidney, demonstrating to the satisfaction of those present the existence within the connective tissue of the former organ of the small round cells above described. At that time I had sought unsuccessfully for literature or a reference to literature on this subject. However, deeming the fact, if it were a fact, of the migration of leucocytes in passive hyperæmia a very important one pathologically, I determined to investigate the case, and for that purpose instituted the proceedings about to be narrated.

On June 19th, I curarized a frog, cut down on the femoral vein (which can readily be done without injuring the artery, as in this animal the vein and artery lie on opposite sides of the femur), made compression by means of a rubber band and a plug of cork, and stretched the web of the corresponding foot on the stage of the microscope. I employed a Hartnack No. 4 objective, and a Grundlach C periscopic eyepiece. By watching the blood movements I easily regulated the pressure so as to retard more or less completely the onward movement, avoiding complete stagnation. After considerable compression had been exerted, as was shown by accumulation of blood corpuscles, distension of the vein, and retardation of the current, the field was carefully watched for nine hours. During that time no leucocytes were actually observed to leave the vessels, yet several were seen just external to the walls, having apparently escaped unnoticed during the shifting of the stage. For the next ten hours the field was not observed with sufficient care and frequency to warrant any assertion of migration. At the end of this period, however, that is, nineteen hours after compression was made, an almost continuous observation of the field was begun. From the 19th to the 36th hour leucocytes were observed to leave the vessels in considerable num-

bers, the shortest time of exit observed being twenty minutes —the average one to two hours. The method of locomotion did not, of course, differ from that exhibited in inflammation, though at no time did I observe the excessive change of form and protrusion of long processes figured in the books. There was frequently a flattening of the leucocyte against the wall; then the appearance of a bud external to the wall; then the gradual enlargement of this bud and shrinkage of the intravascular portion, the part piercing the wall being apparently a tunnel through which the rest of its body passed. Often the locomotion was continued after the leucocyte had become wholly extra-vascular, so that it traveled several times its own diameter from the place of exit. It was noticed, too, that other corpuscles were prone to pass out at the particular point of previous migration, so that sometimes several would be crowded together along the vascular wall, and an hour later would be in close proximity, external to the vessel opposite the same point.

This phenomenon occurred usually not in the minutest capillaries but rather in the large capillaries and small veins, ranging from $\frac{1}{1500}$ to $\frac{1}{600}$ inch in diameter. Nor were the passages always made where the current was slowest, nor where the vessel gave evidence of greatest engorgement—by the crowding of the corpuscles—as emigration from a rapid current but sparsely supplied with corpuscles was not infrequent.

Before I had watched the process a great while I became aware that the colorless corpuscles were not the only bodies exhibiting amœboid movements. I observed that certain red ones without nuclei, of circular shape and small size ($\frac{1}{2500}$ inch in diameter), performed the same movements with as great celerity as did the white. (The listener is reminded that in the frog the perfect red corpuscle is of elliptical shape, is $\frac{1}{1200}$ inch in its longer diameter, and has a distinct nucleus; while the white globule is, when at rest, of circular shape, its diameter only about $\frac{1}{2500}$ inch.) There could be no possibility of confounding these small red ones with the white, for although in size, shape, and movements, they were identical, the red color of some was unmistakable. So extensive was the locomotion of the red ones that at the 36th hour of the experiment there were numerous red patches in the field, which looked almost like hemorrhages. That they were not hemorrhages I knew,

first, because there were no large oval corpuscles, the red globules proper, but only the small circular ones; second, because they were fixed in the tissue, not floating to and fro in blood serum; third, because I had seen many of them migrate.

These phenomena were witnessed not by myself alone. Dr. Bridge, Lecturer on Practice of Medicine, observed the emigration of several corpuscles; Dr. Danforth, Professor of Pathology, while unable to watch the process for a considerable time, was convinced that emigration actually occurred; Miss Mergler observed numerous red as well as white cells leave the vessels.

Having established the fact of the locomotion, therefore, it remains to prove the dependence of that locomotion upon mechanical congestion rather than upon active hyperæmia. That congestion existed was shown not only by the retardation of the blood-current, and dilation of the vessels, but also by œdema of the web, which became evident within twenty-four hours. That the congestion was not "active" was established by two facts; first, the absence of all the phenomena of inflammation, other than the amœboid movements—*i. e.* the primary acceleration of the blood-current, the subsequent retardation with irregular contractions of the vascular walls; second, that the discontinuance of the pressure on the vein was at once followed by complete restoration of the circulation in the web, whose irregularities, therefore, were dependent wholly on a mechanical impediment and not upon any "nutritive irritation," nor vascular spasm.

This experiment has been repeated twice since the above date. In both instances emigration occurred; in one it began within three hours after compression was made. In this case the pressure exerted exceeded somewhat that made in the first instance.

Now, the value of these facts depends upon one's ideas of pathogenesis. If he believes, with Billroth, that connective tissue is developed solely from migrated blood corpuscles, he has a key at once to the connective tissue hyperplasia of the skin and venous walls which accompanies a varicose condition of the veins. For the mechanical congestion necessarily present must result in the emigration of blood corpuscles into the surrounding tissues, and these are developed, says Billroth, first into spindle cells, and finally into complete connective

tissue corpuscles, causing the familiar thickening of the skin and vascular walls. In support of this view is the fact that the increase in thickness in the wall of a varicose vein is due to hyperplasia, not of the muscular elements, but of the connective tissue bundles interposed among those elements, and of the outer coat of the vessel which is composed wholly of connective tissue. So, too, the enlargement of the spleen which usually follows portal obstruction, as in cirrhosis of the liver, and the thickening of the superior hemorrhoidal veins—"hemorrhoids"—from the same and other conditions, are to be referred, in part at least, to the development of leucocytes which have wandered from the vessels during the mechanical congestion. Perhaps, too, the areolar hyperplasia so often found with displacements of the uterus is due to the venous congestion which usually exists in that condition.

Even the conservatives like Stricker and Rindfleisch, while insisting on proliferation of pre-existing cells as the more important source of connective-tissue hyperplasia, admit the strong probability that a considerable part of it is due to the development of the wandering cells or colorless corpuscles first into spindle cells, then into fibrillated tissue. Certain it is that, in the repair of wounds, at least, they play a prominent part in the formation of cicatricial tissue.

The fact of emigration without any evidence of that "nutritive irritation" of tissue, which Virchow presumes in active hyperæmia, would seem to favor Hering's view that the exit of corpuscles is a passive rather than an active movement, due to their glutinosity, to increased blood pressure and diminished blood velocity—in short, a simple filtration of colloid substances.

Then again the behavior of the small red corpuscles is interesting as exhibiting their close relation with the white, and as furnishing another link in the chain of circumstantial evidence that the red corpuscles are transformed white ones. Such has for some time been the prevalent opinion, though never completely demonstrated. The fact that these red ones were but little if any larger than the white, that they were of circular shape, were devoid of nuclei, and possessed the power of amœboid motion, proves their close connection with the colorless cells; while the presence of hæmoglobin, as indicated by their color, testifies to their ability to perform at least one im-

portant function of the fully-developed red ones, namely, the transportation of oxygen.

Upon further examination of the literature of this subject, I find in Wagner's Pathology (p. 186), Charlton Bastian cited as authority for the statement published in the *British Medical Journal* for 1868, that "red globules as well as white leave the vessels in venous stases, scorbutus, etc., by means of amœboid movements." Not having had access to the *Journal* I do not know upon what observations he based his statement, nor whether he had made investigations similar to my own.

## A NEW DEVICE FOR DARK-FIELD ILLUMINATION.

BY PROFESSOR WM. LIGHTON.

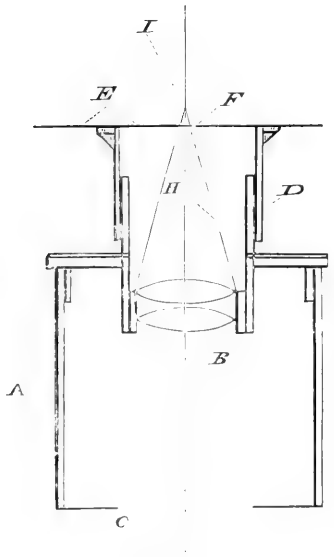


FIG. 1.

I HAVE been quite interested, lately, in some experiments connected with the subject of dark ground illumination, and have worked out a device which brings out new and most interesting results. The accompanying diagram will illustrate its working. Let A, Fig. 1, represent a sectional view of the tube of an eye-piece; B, a triple achromatic lens of one inch focus, and 30 degrees aperture; C, the diaphragm; D, cap of the eye-piece sliding over the tube of the achromatic lens; E, a thin brass plate sliding between grooves in the top of the cap, having at the point F a small hole of not more than $\frac{1}{20}$th of an inch in diameter; H, the cone of rays of the achromatic eye lens, meeting at I. Place the thin plate so that the hole F will be at the side, and as near the apex of the cone of rays as possible. It is quite evident that none of the light usually used by the eye will be allowed to pass to it, as it will be

interrupted by the brass plate. By placing the eye at the hole F, and looking at a suitable object upon the stage of the microscope, a most wonderful sight will be seen. The object will be brilliantly shown upon a dark field. I would suggest its trial upon the diatom *Heliopelta*. It is not necessary to explain the principle of the device, as it will be quite evident to those familiar with optical work. By revolving the eye piece in the body tube many curious changes in the appearance of the object will take place. In using oblique light it will be found best to place the hole on the opposite side of the cone of rays from the mirror. The arrangement can be used with the common eye piece, but with an inferior result. The value of the device can be tested by making a hole in cardboard with a small pin, and holding it at its proper place over the eye piece.

Ottumwa, Ia., Sept. 2, 1878.

[The principle involved in the above may not be seen at once by all our readers. A little thought will show that the object is not seen by transmitted light, but by that which it radiates itself; the direct light from the mirror being quite cut off.—Ed.]

## ON THE SPORE-FORMATION OF THE MESOCARPEÆ.

A paper on this subject was presented by Dr. Wittrock before the Swedish Academy of Science last December and published in the *Bihang till k. Svenska Vet. Akad. Handlingar, Band V.* The publication is not accessible, so we cannot refer to the original (which is printed in English), but as the views advanced by the writer are worthy of more than a passing notice we do not hesitate to reprint the following from *Nature*.

In one lovely group of green-colored algæ we find a number of very pretty species, many of which consist of one-celled forms, and others of which, obeying a law of cell growth, not only produce new cells but also cause these to adhere to one another and so, as this growth goes on, give a chain-like or filamentous appearance to the mass. These filamentous green freshwater algæ are very common. Dillwyn, in the beginning of this century, knew and described many of them, and he also seems to have well known that the contents of some of their cells formed oval bodies called resting spores. The merit of having worked out the history of these spores belongs to Prof. A. de Bary, from whose researches it was first made clear that in some of these forms (Zygnema) one of the chains of cells will come to lie alongside of another chain, and then the cell-wall of two opposite cells will grow out-

wards until they meet. On meeting, the tips of these outgrowths will be absorbed, and the two cells will thus communicate by means of this newly-formed canal, whereupon it will follow that the contents of both cells will each go half way to meet the other, and their conjoining will take place in the newly-formed canal, or sometimes in one of the cells; or that the whole of the contents of one of the cells will pass over and combine themselves with the contents of the other. In either case the result will be the formation of a new body—well known as the zygospore, but also known under many other denominations. But, again, in other forms (Mesocarpus), while the initial process will be the same, so far as the formation of the cross channel goes, the further steps differ much, it being only the green-colored portions of the protoplasm of both cells that move over into the canal, whereupon the central portion of this green mass, composed of about equal parts of the contents of the two cells becomes developed into a zygospore, leaving the rest of the cell-contents to fade away. The physiological import of these two quite different phenomena was therefore this: in Zygnema and its allies the total contents of two of the cells were required to form a zygospore—whereas in Mesocarpus this was formed out of only portions of the cell-contents. There is thus no strict analogy between these two forms of zygospores, and they probably should not both receive the same name. De Bary perceiving this, referred to the one as resting-spores formed by the partition of the zygospore (the parts destitute of green contents having been partitioned off), strangely applying this term to that stage when the two cells had combined to form one, and to the other as resting-spores without partition. De Bary's attempt at being logical has apparently been overlooked by many writers on this subject, notably by such eminent investigators as Max Cornu and Sachs, who still apply the term zygospore to both forms, but Pringsheim has grappled with the difficulty in his most thoughtful paper "On the Alternation of Generation in Thallophytes," and suggests that the first stage in the reproductive proscess in Mesocarpus is the "conjugation" stage—here the cells join and become, so far as their cell-walls are concerned, united into one. The next stage is the more important one, in which the cell-contents commingle, and the result is the production of the central cell —a carpospore—and of two or four cells which surround it, and form the equivalent of a fruit-like body, or sporocarp, and of course it would make no matter whether this sporocarp were formed in the connecting canal as in Mesocarpus, or whether it fills this and extends over into both the cells as in Staurospermum, or as in Plagiospermum is altogether formed in one of the cells; the essential feature being the differentiation into the carpospore and its investing covering the sporocarp.

Now Dr. Wittrock has made the rather startling observation that in

one and the same species (*Mougeotia calcarea*, Clev.), the formation of the spores may take place equally in the manner of the three above-mentioned genera; also that occasionally even the spores may be formed without any conjugation, and further that in a plant found growing last October in an aquatic stone house in the Upsala Botanical Gardens, and which is described as *Gonatonema ventricosum*, the spores are formed in a neutral way through the agency of cells never intended for and incapable of conjugation. Such spores the author calls agamospores, and he finds a second species of this new genus in Hassall's anomalous *Mesocarpus notabilis*.

If the interpretation placed on the phenomena to be witnessed in the Mesocarpeæ by Prof. Pringsheim be accepted, then this family can scarcely be left among the Conjugatæ, and this would hold true also of Wittrock's new genus, as indeed is so stated by himself. But may not the phenomena be interpreted in yet one other way? First, as to the agamospores in Gonatonema. Is it beyond the bounds of possibility that, despite their external likeness to zygospores, these are simply vegetative spores, to be compared to one of the so-called tetraspores in Florideæ? They surely cannot be compared to any form of organism itself the product of the commingling of the contents of two different cells! Another suggestion, to account for this agamospore, has been made to me by my friend William Archer. It is that there may have been a separation between the upper and lower portions of the protoplasmic contents of the same cell, and that these, without waiting for the formality of forming separate cells, may have then and there conjugated. This is certainly a most ingenious suggestion, and is stengthened by the well-known fact that, in some Desmids, after the single-celled frond has divided into two halves, and before the newer portions grow into anything like the similitude of the older portions, the two halves, which were only just parted, will conjugate and form an ordinary zygospore. De Bary gives some pretty figures of this strange phenomenon, which, according to Mr. Archer, might be carried one step further, and there be no parting at all. In favor of my own idea I can only add that the first origin of what, in some of the Florideæ, will form the tetraspores, and the origin of these agamospores, appear to me to be the same. Next as to the sporocarps in Mesocarpus. The differentiation into sexual entities of the protoplasmic contents of cells is confessedly, at first, scarcely perceptible. It would be impossible, in many cases, to say with any confidence, this one is the germ cell, and that one is the sperm cell. But gradually a differentiation appears in that the contents of the former exhibit themselves as passive, and of the latter as active; the contents of the one remain quiescent, those of the other pass over to conjugate with the former, but all through the contents that commingle are almost in every case alike in quantity. Carry the differentiation a step further on, and

we find that the contents that commingle may be at first somewhat, and then be strikingly unlike in quantity. The passive contents will be divided into a comparatively small number of portions (in Fucus eight), but these each can be fertilised by the very smallest portion of the active contents. Now may not the Mesocarpeæ be a link between these groups? The contents of each of the two cells divides into certain portions. The fertilising power of the active contents is not sufficient for the passive contents, and hence but one portion—that the most specialized—is fertilised; this forms the zygospore; the other portions remain sterile. Then this spore would differ from the zygospore of Zygnema just in the same proportion as it would differ from the oospore of Fucus, but the fructification would not at all be a representative carpospore, and the at first sight very anomalous case of *M. calcarea* may be explained by supposing that the number of partitions is a matter of but secondary importance, unless the fertilising power of the active contents were to increase. This field of research is an important one, and much as we are indebted for information on these points to the labors of the Swedish botanists, we must still continue to look for fresh facts and new explanations.

E. Perceval Wright.

## ON THE STRUCTURE OF BLOOD-CORPUSCLES.

At the "Physiological Laboratory," University of Michigan, Dr. C. H. Stowell has continued his study on the structure of the red blood-corpuscles.

The method employed is that given by Professor Bœttcher in the Archiv für. Mic. Anat. Bd. 4.

The corpuscles are "bleached" by means of a saturated solution of corrosive sublimate in 96 per cent. alcohol. Into fifty parts of this solution one of blood is rapidly diffused.

In twenty-four hours the super-incumbent fluid is poured off and alcohol added. In twenty-four hours more this is poured off and distilled water added.

The corpuscles are then subjected to staining agents, carmine being preferred.

Three classes of corpuscles are seen.

1st—Homogeneous and shiny.

2d—Those having a nucleus; and

3d—Those having a well-marked nucleus and nucleolus.

The July No. of *New Preparations* contains the following account of recent experiments. Dr. Stowell says:

"My experiments were performed on cats and rats, poison-

ing them with solutions of corrosive sublimate—in some cases bringing on death immediately, in others not until the lapse of several days. The blood was examined both before and after death, and no change was discerned in the appearance of the blood-corpuscles, except in a few instances, when there was noticed some change in their shape. This is not what one would anticipate from a perusal of Prof. Bœttcher's article.

"However, by following the method given in the last number of your journal, we have demonstrated this nucleus in the red corpuscle of man (as previously reported), the dog, cat and rat. The most satisfactory result was obtained from the blood of the rat; the most unsatisfactory from that of man. No value, however, is attached to this fact.

"By using higher powers than at first employed, we are positive there is a granular appearance to this nucleus, not present in other parts of the blood cell. In some cases this is quite marked, especially when the nucleus is large; and also in those corpuscles where we have seen a nucleolus, this granular structure is very evident. This is what we should expect when accepting Beal's theory of protoplasmic matter.

"In some specimens examined, the proportion of nucleated to non-nucleated cells was very small indeed, while in other specimens the proportion was much greater."

## A STANDARD MICROMETER.*

BY R. HITCHCOCK.

The subject that I wish now to bring before this convention is of such importance that it seems hardly necessary to say anything to call your attention to it.

The need of a definite and accurate standard for microscopic measurement has been recognized by some for many years. As an example of this, Prof. Lyons, in 1857, proposed to the British Association for the Advancement of Science that "some definite micrometric integer should be assumed, being a determinate part of unity." He suggested as a name for this integer, that it should be called a micro-line, and thought that a good provisional standard would be the 1-10000 of an English inch, but his preference was for a decimal scale.

* Abstract of a paper read at the National Microscopical Congress, Indianapolis, Aug. 16, 1878.

No action seems to have been taken in the matter at that time or since.

We are as far from a definite standard to-day as we ever were, and unless the question is taken up in good earnest by able and well-known men, representing in some way the microscopists of the country, either as delegates from societies to a convention like this or at a special meeting for the purpose, it will be as it is now for years to come.

If we pretend to scientific accuracy in our work we must have reliable micrometers; and, if we desire to avoid trouble in reading the results of the labor of others we must all use the same unit of measurement.

If well chosen, our standard will be adopted by other countries, and we have a good opportunity now to make this congress remembered in the history of our science.

To secure our standard, Prof. Rogers promises to place in the hands of a properly appointed committee, representing five of the leading microscopical societies of the country, six standards consisting of fifty spaces, covering exactly $\frac{1}{12}$ part of the standard British yard at Washington. Each of these spaces would be divided into 10 equal parts, thus giving 500 lines. These lines would be 1-1000th of an inch apart. Prof. Rogers then goes on to say as follows:

"This committee shall ascertain that these six micrometers are comparable within certain very narrow limits. I will then present one to the properly appointed custodian of each society, and retain one for myself. I can then at any time make duplicates of a common standard."

I should add that Prof. Rogers is now having a new machine made, which he has reason to believe will enable him to do better work than the one he is now using. Even with the one he now has, he can arrive very near the truth.

Some of his earlier micrometers are not reliable, and all made previous to May, 1877, belong to this class. The errors of these range from zero up to 1-7000 of an inch.

By perfecting his machinery in various ways, this error has gradually been made less, until it became about 1-40000 of an inch in maximum; but a few weeks ago even this residual error was accounted for, so that now, Prof. Rogers believes he can rule one hundred micrometers just alike.

We can all realize that it has required a great deal of patient observation and experimenting to arrive at this result.

We are accustomed in this country to employ the divisions of the inch. As a rule people are conservative. But, in a case like this, custom must not govern us. We decide this question, not for ouselves alone, but for future generations. The action of this congress will be known throughout the world, and its influence must be felt. It becomes us, then, to act carefully and with the best judgment.

We propose a standard for universal use; then let us select one that can and will be adopted, not alone by our own country, but by all civilized nations. We must not allow considerations of economy to actuate us, nor of mere convenience. Therefore, I say, let us select the French metric system as our basis of measurement.

It is not for me to indicate to this audience its advantages as a system of measurement for universal use. I do not even say that I believe it is the best. But I do say, that it is the only system that can be made universal in a micrometer for the microscope, and in this I expect the support of all who are familiar with scientific work throughout the world. To those who are in doubt as to this, it is sufficient to remind them that a nation like the French, which has used a decimal system so long, could not be expected to change it for one with divisions like our inch. We should be ready to sacrifice something ourselves (and it will be, at most, a sacrifice to us for a short space of time) for the sake of securing uniformity with the people of a whole country. Moreover, even in our own country the inch standard cannot be maintained, for scientific men are decided in their preference for the French system. When I say that this congress has the power to make a standard for the country, I mean on condition that it be made to suit the requirements of men of science. Practically, we are forced to the adoption of the French system, by the demands of our own workers. I have not been able to collect statistics as to how many of our educational institutions are now using the millimeter micrometers, but I know that many of them are, and I know, too, that a chemist can hardly be found who measures in quarts, and pints, and gills, or who weighs in grains. It is always centimeters and grammes, and

if this congress means to do a good work, it will do well to adopt the millimeter as its standard for subdivisions.

The time is ripe for it, and we must either assert ourselves as ready to meet the demands of the time in which we live, or be relegated to the age of conservatives.

It is wonderful how science is progressing, and still more wonderful it is when we think how few are doing the work.

In all this large assembly, how few are really scientific workers! And, yet, our science is advancing, and we, who, from our numbers, hold the balance of power, can do nothing better, it seems to me, than to meet or anticipate the wants of the few, who add the treasures to our storehouse of knowledge.

## ANGULAR APERTURE DEFINED.*

BY ROMYN HITCHCOCK.

Even among those engaged in scientific pursuits we frequently observe that there is a greater desire to come out best in an argument than to arrive at the truth. This has well been illustrated by the long-fought battle about angular aperture.

In order to avoid any quibbling in the future about the meaning of the term, I propose to this congress that it adopt a definition, which, right or wrong,—if the right or wrong can ever be determined,—shall be adopted and used throughout the country. I am fully aware that such action should be taken after mature deliberation, and, in advocating any such course, it is my duty to ask your careful attention to a number of points, as follows:

First.—What does angular aperture indicate? Our definition should be chosen to express some particular quality or qualities of an objective, or else it must be merely an arbitrary one, adopted to give a definite meaning to the term. The distinction between angular aperture and angle of field, made in my paper before the New York Microscopical Society, and recently published in the *American Journal of Microscopy*, June, 1878, governs my present use of the terms.

*Abstract of a paper read before the National Microscopical Congress, August 15th, 1878.

[The Editor deems it but right to say, that he is only led to devote so much space to this abstract because of a deliberate effort, that has already been made, to misrepresent his motives in presenting the resolutions which followed the reading of the paper. The subject cannot be of great interest to scientific men generally, hence this apology.]

The first question that arises is, can we, by adopting any definition for angular aperture, express the power of an objective to resolve bands of closely ruled lines? This, it occurs to me, is the only definite test that we have for an objective. The plain question is, can we adopt any definition for aperture, which will at once tell us the power of a lens to resolve tests? In other words, can we express, in these terms, just what is the lowest limit of aperture that will resolve the individual bands of Nobert's plate? If we can do this, by any definition, then by all means let it be adopted at once. If we cannot do this, then let us adopt the simplest one possible. My impression is, that we cannot, in any possible way, express, by any terms of aperture, the capabilities of a lens; and certainly not until some more definite figures are used than the + 180° with which we are now so familiar; for this angle is given to a class of objectives which have apertures ranging from a certain indeterminate point upwards. To my mind, it appears that it will never be possible to express resolving power, under ordinary conditions, in terms of aperture.

The appearance of an object depends upon two factors, viz.: the aperture of the objective (whatever this may mean), and the angle of the illuminating pencil.

Again, in the present state of our knowledge, we are not able to say how much the angle of field affects our resolutions. I am inclined to the opinion that it has no little influence; but, without having any well-formed opinion on the subject, I point out a single way in which the effect may be seen. When we increase the diameter of our field lens, and keep the angular aperture the same, the result is an increase of working distance, and, as a matter of course, our lens has a greater depth of focus. That this has some effect upon the performance of our lens cannot be questioned. How much, and just what, we cannot tell.

In selecting a definition we should first settle upon certain requirements, which it must fulfill, and these may be given as follows:

1. It must be concise, and must admit of no misunderstanding.

2. It must be one which can be practically applied in measuring aperture, without dispute as to the accuracy of the results obtained.

3. It must be applicable to all objectives, dry or immersion.

4. It must be an angle measured under such conditions as the objective will work in practice. That is to say, a dry objective must be measured dry, an immersion must be measured in its fluid.

It is claimed upon the other side, that all apertures should be given in air. That is, that in order to make the angular apertures comparable with each other, the air angle should be stated, whether the objective is dry or immersion.

This, it seems to me, is merely an arbitrary demand made by a few of the present day, but without the least pretense for a scientific basis. What is the air angle of a glass that does not work in air? Is it not purely hypothetical? What possible knowledge can it convey to us? I will grant that when the balsam angle, for example, is increased beyond a certain point, the *corresponding air angle*, if it were possible to have such,—which I *emphatically* deny,—would exceed 180°, or, in fact, would not enter the lens at all. It must follow that the expression 180° is a vagary, and we must discard it for scientific discussion. I base my argument on the *undeniable* fact that the aperture of an immersion objective is the angle which the light actually forms within the medium of immersion; this cannot be fairly denied. I claim, too, that any hypothetical angle, without the fluid intermedium, is one for which the objective is not adapted, an angle which it cannot possibly utilize, and that no angle can express anything as to the value of an objective unless it is an angle which can be put into actual use.

As regards the method to be employed in measuring aperture I do not hesitate to say, very frankly, that in my opinion no method has yet been devised free from objections, which attempts to measure the angle with a candle flame.

There is, however, a method which is simple, easily understood, and which can be practically carried out. It is the only one by which results can be obtained in any wise comparable. I propose to call it the "triangle method" to distinguish it in speaking from the others.

This method measures the angle formed by two lines drawn from a point in the centre of the field of view, and in the plane of the focus, to the extremeties of the available diameter of the field lens. In order to get this angle, we simply measure

the working distance and the available diameter of the lens, and calculate the angle. The method will be described in detail shortly.

First let us examine the advantages and disadvantages. The disadvantages lie merely in the necessity of having a means to measure working distance.

The advantages are that an angle thus obtained is clearly defined. The figures cannot be misconstrued, and scientific men need not hesitate to use them for fear of being misrepresented.

Without taking up your time with a greater enlargement upon the advantages that are to be secured in this way, I wish to base my argument in favor of its adoption upon the grounds first stated, viz : that we need a definition which shall admit of no misapprehension, and will summarize after describing the practical operation of measuring this angle.

TO MEASURE FOCAL OR WORKING DISTANCE IN AIR.

The best and simplest method is by means of a graduation upon the body of the microscope, and upon the fine adjustment screw head. When the face of the lens is flush with the mounting, simply bring it in contact with the surface of a slide, and measure the distance it has to be raised to bring particles of dust which may be upon the slide into view.

When the lens is not flush with the mounting another plan is necessary.

Place the object glass on the sub-stage as for use as a condenser, and arrange it so that it forms an image of distant objects at its focus. Then with another objective, say a ½-inch, focus upon the face of the former, and measure the distance through which the latter must be raised, in order to get a distinct view of the image. This will give the focal length in air.

TO MEASURE THE FOCAL DISTANCE IN FLUID, OR BALSAM.

When the nose of the objective can be placed in the fluid without injury, the slide may be marked with a diamond and a little finely levigated graphite rubbed into the mark to make it visible. Then interpose the fluid as usual, and measure as before.

In the case of balsam, if it is not advisable to soil the objective with this medium, we can proceed as Mr. Wenham

does, and I give this ingenious plan from a private letter which I received from him a long time since.

Harden a little balsam on a slide until it will retain any form given to it, and, at the same time, yield to moderate pressure. Place upon it a thin cover-glass. The total thickness of balsam and cover must be greater than the focal length of the objective. Lower the latter until the surface of the slide is visible through the balsam and cover. By means of a lever of contact, now measure the thickness of the balsam and cover, which will give the desired focal length.

With the cover-glass and face of the objective in contact, as in this method of Wenham, the glass acts practically as an immersion, and, *unless vision is distinct*, the angle so measured does not indicate any angle of aperture proper to the objective.

TO MEASURE THE AVAILABLE FACE OF THE LENS.

Place the objective on the table, face up. Put a drop of milk upon the front lens, and when dry place the objective in the sub-stage, as for a condenser; throw parallel rays up through it, and, by means of a low power objective and eye-piece micrometer, measure the diameter of the spot of light seen when the dried milk surface is in focus.

We have now simply to calculate the angle by any mathematical formula, the base and perpendicular of the triangle having been thus determined.

I propose now to enumerate the results we may expect from an universal adoption of this method. It would place within our hands a means of confining future discussion within legitimate bounds. The term angular aperture would mean something definite, and there would be no excuse for any misapprehension on any side.

Look, however, at the field of research which it points out—thus far practically disregarded. From its nature angular aperture will mean, for a dry objective, the angle measured in air; for an immersion, the angle measured in the fluid used. At once the question arises, what is the angle of light which comes from an object in balsam or other medium? The angle within the medium being different from the angle at which the light enters the objective, which of these angles has the most to do with the resolving power? What relation is there

between the value of these angles and the quality of the object glass ?

When we know what *angle* means, then we are prepared to study the subject of microscopic vision to advantage. The very definition I propose here makes evident the great distinction between the aperture and angle of field. We cannot ignore either of them, for the distinction so plainly visible forces itself upon us. I leave the subject here for your discussion. I hope for a careful and earnest consideration by this congress. It is full time that scientific men should take a firm stand in this matter.

I am fully aware of the responsibility which we take upon ourselves, but it is not for us to shirk it. There can be no better time for action than at this first convention, and no better one will ever come to show whether there is a determination to get rid of all future ambiguity in this matter, and the courage to do so.

# Editorial.

We have no reason to be discouraged with the reception which our journal has met thus far. The list of subscribers is small, but daily increasing, and no doubt will come up to our expectations. It is not, then, with a feeling of disappointment that we pen these lines, but rather with the hope of reminding those who do not subscribe and who are perfectly able, (a large class among those counted as amateurs in science), that they are responsible for the non-existence and financial failure of many a good and truly valuable journal.

We put it down as a rule, that even the oldest, and apparently best established, scientific periodicals of this country are not to-day self-sustaining.

Perhaps this statement will be a surprise to many. We hope it will serve to indicate one way in which those interested in the progress of science, even though not workers in any of its departments, can be of material benefit to its votaries.

Without a suitable journal in which discoveries can be announced, and important questions discussed in a public manner, there is little incentive to original work ; but such a journal must receive its financial support not from its con-

tributors, the men who do the work and benefit science by hard and exhaustive mental labor, but from the larger number of those who read and enjoy the results of this labor, and who have means to spare.

It would not be a pleasant task to recount the numerous ventures in the field of scientific literature in this country which have proved financial failures.

Many who read these lines will remember the *Lens*, published in Chicago by the State Microscopical Society of Illinois. One can scarcely speak to a microscopist, who was familiar with the *Lens*, about its sudden demise, without calling forth an eulogy of that journal, and regrets that it did not continue to be published. And yet the *Lens*, recognized so universally as a valuable and well conducted journal, failed. Why? Because it did not receive the financial support from some of the very ones who are now ready to speak so well of it. It does not cost such a very large sum to publish a journal as many seem to believe; a very moderate number of subscribers will make a really good one self-supporting, and we have made one more venture, not expecting a great financial success, but believing that there is a large field of usefulness for it, and that our humble efforts, if well directed, will enable us to do something to benefit science.

We make the venture in the face of the facts already stated, and trust that the time has come when there will be seen a change from the old fashion.

We point to our list of contributors with pride, but it should be remembered that, while a journal must have contributors it must also have subscribers.

It is a mistake to suppose that any number of the best men in the world, as contributors, will make a journal a success. A vast amount of original work is going on in this country, which has been laid aside for want of means on the part of the authors to publish or prepare suitable illustrations, and also for the lack of a suitable journal for the purpose.

We have asked just thirty-two prominent men, known to the world as original investigators in science, if they would contribute to our columns. Out of these only five have declined; one, without offering any reason whatever, another for lack of time, another from ill health, another because of

his connection with a journal, and the last merely could not "*promise* to contribute."

Taking another look at the letters we have received from these men, we observe that many of them write that they are glad to have such a journal established as this proposes to be; and the reasons given may all be expressed by the following quotation from one of the letters:

"I have had to send * * * some articles abroad for want of a really available means of publishing in this country." As another instance: a well-known writer told us that he had promised the results of a long course of study to an English journal, because there was no means of publishing it here, such as we now offer.

It is an unfortunate condition of affairs that American scientists have been obliged to rely upon foreign periodicals for information about the progress of science even in their own country.

We have started our QUARTERLY in the face of difficulties well known to us, have calculated the cost, and are determined to publish it if it merely pays expenses. We say this to assure our friends that our journal is founded upon a good basis, and that we are not deceiving ourselves with unfounded expectations.

Some of our plates for this number are not, in every respect, what we would wish; but for this we need hardly apologize, for we may justly claim that we offer our contributors better facilities for illustrating their work than they can find in any other scientific journal in the country.

Lest there be any misapprehension created by our first number, we deem it just to say that the quality of our work will be maintained unless we find, at the end of the first volume, that we thereby entail a real and considerable loss. We do not say that each number will contain a stated number of plates, nor that one shall be a steel-plate, as in this instance. Our steel engraving is merely introduced here because the admirable drawing of Prof. Smith could not be satisfactorily reproduced on stone. We will always furnish just the number of plates necessary to illustrate our articles.

If our enterprise does not meet with success, it will not be from want of energy and effort on our part.

## IS THERE A SCIENCE OF MICROSCOPY?

THE vast majority of those who own microscopes use them for purposes of amusement and pleasure. Men who make no pretenses to be "scientific" have their fine instruments and cabinets, with which they can entertain their friends; they join microscopical societies, assist at annual displays, and no doubt profit some in knowledge of the superficial characters of minute life. We do not look with regret upon this state of things. On the contrary, we are glad that it is so, and would encourage every one, no matter how ignorant of natural science, to secure and use a microscope in this way; for, if interest leads to no deeper study, it will surely open to the mind a wide field of beauty, and show a perfection of detail in even the smallest creatures, which must exert an influence for good.

To the student of natural science the microscope is, and always will be, a mere tool. Microscopy, as a special science, has very little claim for existence. In so far as a certain familiarity with the instrument, and training in the proper management of the light and accessories, is necessary to enable one to use the instrument, it may be called a science. We would detract nothing from the merits of those who are expert in securing the most perfect performance of an objective.

Still, as a matter of fact, and plain facts should not give offense to any one, we must admit that the great value of the microscope, as a means of investigation, lies in the aid it gives to almost every branch of science.

This leads us to a statement of what, in our opinion, a microscopical journal should be. Recognizing the value of microscopical study in the various branches of natural science, such a journal should aim to publish the results of research carried on with the microscope in every department.

This opens a wide field, and demands the attention of the naturalist, the physician, the lithologist and the botanist, of all, in fact, whose studies lead them to examine minute structure, and there are few indeed, at the present day, who find no use for a microscope. While we so plainly deny the claims of microscopy to the position of a science, at the present day, we as strongly urge its claims as an invaluable adjunct in many studies.

Surely it has revealed isolated facts in structure and growth,

it has created the sciences of biology and embryology, it has added much to our knowledge of morphology, and become of incalculable benefit to the physiologist and practicing physician ; and yet, of what real value would all its revelations be to us, without the systematic grouping of facts and knowledge, which comes with the development of these sciences ; some of which, indeed, the microscope has helped to create ?

A man may be a microscopist, but to be that he must be something more, to stand as a man of science. The man who testifies before a court of law as a microscopist, must have a fund of knowledge drawn from many sources, or perhaps we must write he *should* have, for the mere ability to handle his instrument does not constitute him an authority on the identity of a stain or the purity of an article of food.

At the risk of offending a few of the votaries of the microscope, we have spoken plainly our views, believing that they coincide with those of the great majority of working scientific men, and that they will serve in some measure to remove the prejudice which is so firmly rooted in the minds of honest workers, against those who call themselves special microscopists.

This journal is cosmopolitan in the widest sense.

It is established to occupy a high place among scientific periodicals, and it will either do this or cease to be.

For support it relies upon students in all branches of science.

## DREDGING IN THE GULF OF MEXICO.

The second letter of Prof. Alex. Agassiz to the Superintendent of the Coast Survey is published in the *Bulletin of the Museum of Comparative Zoölogy*, at Harvard College.

The dredgings carried on since the first letter were confined to a line running "in a general way, parallel to the 100-fathom curve of the western edge of the great Florida bank." It was extended as far north as the latitude of Tampa Bay, and from this point another line was run to the mouth of the Mississippi. Owing to rough weather it was not possible to do much more than determine the faunal characteristics of these lines. It was shown, however, that the deep water fauna on the western side of Florida, corresponds with that on the eastern bank of

Yucatan at the same depths, and that this fauna extends over the greater part of the Gulf of Mexico. The mud about the mouth of the Mississippi produces a decided change in the fauna: in the deep water off the mouth of the river nothing of importance was obtained by the dredge, but in depths of 118 to 500 fathoms a number of interesting specimens were secured.

The following extract from a letter of Capt. Sigsbee, commanding the S. S. Blake, is of considerable interest:

"On the first of April we put to sea again [from Havana]; we steamed about one and a half miles from the Morro (East), and at the third haul in 177 fathoms, from disintegrated coral rock bottom, up came six beautiful "sea lilies." Some of them came up on the tangles, some on the dredge. They were as brittle as glass. The heads soon curled over and showed a decided disposition to drop off. At a haul made soon after we got more, and being afraid to put so many of them in the tank together, I tried to delude the animals into the idea that they were in their native temperatures by putting them into ice-water. This worked well, although some of them became exasperated and shed some of their arms. They lived in the ice-water for two hours, until I transferred them to the tank. They moved their arms one at a time. Some of the lilies were white, some purple, some yellow; the latter was the color of the smaller and more delicate ones. All the sea lilies were obtained from the same place."

Some twenty perfect specimens of these beautiful Pentacrini were obtained, representing the two recognized species, but Prof. Agassiz is inclined to consider *P. Müllerí* as a younger stage of *P. Asterias.*

The work on the Blake has been of great value in determining the hydrography of the Gulf, as is well shown by a small map prepared at the Coast Survey office. This map is made up from the British Admiralty and U. S. surveys.

"The map speaks for itself, and I need only call attention in a general way to the principal features of the bottom. The most striking characteristics of the Gulf are the two great banks extending the one to the west of Florida peninsula and northward of the Florida Reef, the other northward of the peninsula of Yucatan, the 100-fathom line in both cases running in a general way parallel to the shore line and forming the edge of the steep slopes of the deeper parts of the central portion of the Gulf of Mexico. The rapidity with which the depth increases is very strikingly shown to the north of the Tortugas, and to the northward and westward of Alacran Reef, by the proximity of the 100 and 1,000 fathom curves, the eastern and southern edges of the

central basin of the Gulf of Mexico having thus very steep sides, while the western and northern slopes are far more gradual. The north slope off Cuba is also quite abrupt, while the southern slope of the Florida Reef into the trough of the Gulf Stream is comparatively gentle."

This letter is accompanied by a preliminary report on the Mollusca, obtained during the cruise of the Blake by Mr. W. H. Dall.

Some of the apparatus used on the Blake is described with the aid of illustrations. Capt. Sigsbee's water bottle for collecting samples of sea water at various depths, is a very ingenious arrangement, and it has worked well in practice. The improved forms of dredge and trawl are also described.

The wire rope used for dredging and other purposes has proved very satisfactory, and Prof. Agassiz now recommends it for all future work of this character.

## THE NATIONAL MICROSCOPICAL CONGRESS.

THE first Congress of microscopists ever held in this country met last August, at Indianapolis, Indiana, at which time there were over fifty delegates present. The comparatively small attendance was, in great part, owing to the slight reductions in fare offered by the railroad companies, and to the delay in issuing the final circular by the local committee. Forty-nine names were registered, however.

Much interest was manifested by all who attended, and many went with the understanding that there was to be a permanent organization effected. Accordingly, a committee of delegates was appointed to consider the proper course to pursue in this matter, and on the last day of the meeting a provisional constitution was adopted, and the "American Society of Microscopists" came into existence. How many members of the Congress joined this society we do not know. The meetings are to be held annually at such places as may be chosen each year; the next one is to be at Buffalo, during August, 1879.

The officers of the Society are the following:

Dr. R. H. Ward, president; Dr. S. W. Dennis and C. M. Vorce, vice-presidents; Dr. Henry Jameson, Indianapolis, Ind., secretary; and H. F. Atwood, treasurer. These officers,

together with Drs. Geo. E. Blackham, J. Edwards Smith and Wm. H. Atkinson, constitute for this year the committee on publications.

We wish the new society the best success, and trust that the Buffalo meeting will show that there is sufficient enterprise and enthusiasm to ensure its future well-being.

To return to the proceedings of the Congress we will give a brief account of each day's programme.

On Wednesday, Aug. 14th, the Congress assembled at the court house soon after ten o'clock. Rev. A. B. Hervey, of Troy, was made temporary chairman, and Mr. H. F. Atwood, of Chicago, secretary. Proceedings were then opened by a prayer, when Mayor Caven delivered an address of welcome on behalf of the city, and Dr. Orpheus Evarts followed with a similar one on the part of the scientists who had called the meeting. Dr. Evarts's address was in every way appropriate to the occasion.

The chairman responded briefly, and a committee was at once appointed to nominate permanent officers for the Congress. The officers thus nominated and elected were : Dr. R. H. Ward, president ; Prof. J. E. Smith, and Dr. W. W. Butterfield, vice-presidents ; H. F. Atwood, Chicago, secretary ; and Dr. J. B. Marvin, of Louisville, treasurer.

The reading of papers began at once after this election. The first one was read by the secretary, as the writer, Prof. W. A. Rogers, was not at the meeting. The subject of Prof. Rogers's paper was :

"THE LIMIT OF ACCURACY IN MEASUREMENT WITH THE MICROSCOPE."

This paper was quite elaborate, and embraced the results of experiments in measuring minute spaces in tabular form. For the most part the figures of Prof. Morley were compared with those obtained by the author, both measuring the same lines independently.

The results are summed up by Prof. Rogers, as follows :

"1. Two equally skillful observers can measure the same space within about one-300,000th of an inch if the space does not exceed one-500th of an inch. For a space of one-100th of an inch, the deviation will probably amount to one-80,000th of an inch in case the measurements are made with an eye-piece or a filar micrometer.

2. The average deviation for accumulated errors, under similar condi-

tions, is not far from one-50,000th of an inch for eleven intervals. For a large number of intervals the deviation will be somewhat larger, but it will not be proportional to the number of intervals.

3. A single observer can obtain an agreement with a normal equation representing all the observed values, as far as a solution by least squares can represent them, within somewhat smaller limits than those obtained by comparing the results obtained by two different observers.

A paper was then read from Mr. C. C. Merriman, of Rochester, entitled

"SOME NEW FORMS OF MOUNTING."

Shellac cement is the favorite with the author for making cells, either for dry objects or for such as are to be mounted in balsam in a cell. Anilin colors are used for ornamenting in preference to all others. One method of mounting, which gives fine results with certain objects, deserves notice, and we give it in the author's words.

"If the objects to be mounted will bear immersion in balsam, as shells, plant seeds, minerals, etc., I pursue the following plan: The thin glass covers are cemented to some old slips, which are kept for the purpose, by two or three touches of balsam applied at the edge of the cover. Care is taken in this, and in all cases, to accurately center all work on the slides by means of the self-centering turn-table. Then, on a light coating of balsam in the center of the cover, the objects, whatever they may be, are placed and arranged. When quite dry, and the objects are thus securely fastened, they may be completely covered by balsam and put into the dry-oven until thoroughly hardened. Then over the balsam Brunswick black, if the objects are white, or white zinc cement, if they are dark or high-colored, may be spread by thin layers at first, each being dried in the open air for a day before the next is applied, until there is no opaque covering to the objects. The thin glass cover is now thoroughly cleaned around the objects and then removed from the slips by a slight heating just sufficient to loosen it. It can then be turned over and mounted on the cell designed for it. The best preparation for fastening the cover to the cell is gelatine dissolved in water, with enough alcohol added to liquefy it from the jelly state. Just enough of the water cement seems to run in under the glass, and to dry just where it is placed. Afterward the cell may be finished with liquid balsam, carefully avoiding the little aperture, and the outer edge gathered up into a neat, trim little circle with the point of a knife on the turn-table."

This method of mounting in balsam on the cover, and backing up with black varnish, deserves to be better known. We have seen some of Mr. Merriman's slides made in this way,

and with certain objects such as the *Orbiculina* and *Orbitolites*, or *Peneropolis* from Bermuda sand, there is no method equal to it.

The afternoon session was given up to the exhibition of instruments and apparatus.

The subject discussed on Thursday was principally angular aperture. Mr. W. H. Bulloch, of Chicago, made some pointed remarks upon the

"FORMULAE OF OBJECTIVES."

He had some carefully-made drawings, showing the exact course of the rays through several objectives which have occasioned some discussion in the English journals.

Dr. Geo. E. Blackham followed with a long, but interesting paper on

"ANGULAR APERTURE,"

which, owing to the nature of the subject, is too lengthy for our columns.

Mr. C. M. Vorce took up the remaining time in the forenoon with a paper on

"MECHANICAL FINGERS."

In the afternoon Mr. R. Hitchcock read a paper on

"ANGULAR APERTURE DEFINED,"

an abstract of which appears in another place.

After the reading of this paper, Dr. R. H. Ward gave an account of his study of the ashes of leaves. This subject has already attracted considerable attention, and we may expect to hear more from it. Dr. Ward considers it to be of no little importance in vegetable histology.

Rev. A. B. Hervey then spoke for a few minutes about the

"CLASSIFICATION OF ALGAE."

Our next number will contain a more complete paper on this subject.

As all the papers of the day were read, debate was in order.

Mr. Hitchcock then introduced the following resolutions :

WHEREAS, the subject of the angular aperture of objectives has been discussed for many years without great benefit to science, or showing even now a fair prospect of satisfactory solution;

WHEREAS, we believe that much of this discussion has sprung from the undefined meaning of the term ; and

WHEREAS, we, representing in this National Microscopical Congress the various societies and classes of microscopists in the United States,

believe that by recommending and adopting a definite meaning for the term we can advance the interests of true science; and

WHEREAS, in the present state of our knowledge of objectives, we see no indication that the capacity of an objective to resolve lined tests depends upon its angular aperture alone, as distinguished from other optical qualities apart from workmanship—

We therefore adopt the following resolutions:

*Resolved*, that we adopt the following definition of angular aperture as applied to the objectives used with the microscope:

The angular aperture of a microscope objective is the angle at the apex of a triangle, having a base equal to the available diameter of the front lens, and a height equal to the actual focal length (working distance), measured in air for a dry lens, and in the fluid employed for an immersion, the collar being adjusted for the most perfect definition in every case.

*Resolved*, that we request all makers to mark their objectives in future to correspond with the definition above adopted.

*Resolved*, that this preamble and resolutions be distributed in circular from among the various societies and makers of objectives, with the request that they give it their formal approval, and communicate whatever action they may take to such body as the Congress may appoint.

*Resolved*, that we recognize that the interposition of cover-glass, balsam, or any other medium of a different refractive power from the one for which the aperture is given, has more or less effect upon the aperture and image, and we recommend this as as a subject for investigation.

These called forth some remarks from several members, among them, his most prominent opponent, Prof. J. E. Smith. Prof. Smith, however, undertook to argue that the author was not debating the subject of aperture, as pretended, but was merely arguing in favor of low angled glasses as against high angled. This was so obviously wrong that it was flatly denied, and, in order to bring the matter to a focus, and to induce the supporters of the terms 180° and + 180°, to come fairly before the Congress, Mr. Hitchcock read the following challenge:

It will be admitted by all in this audience that no ray of light can take any course that cannot be shown by a diagram, and calculated mathematically.

The opposition which meets this paper is not unexpected. In order that my opponents may show themselves in the right, if possible, I offer the following:

I challenge any man who is ready to champion the side which claims the angular apertures of 180° and+180° as possible apertures, to step be-

fore this audience and demonstrate by diagrams the following propositions:

1. That light at an angle of 180° can enter an objective.

2. That a balsam angle of over 82° can be employed with any objective, without special arrangements for illumination. Unless this can be demonstrated, I maintain that the high balsam angles do not depend upon the aperture of the objective but upon the sub-stage accessories.*

3. That an objective can take in light, theoretically or practically, infinitely near 180° either dry or immersion.

4. That the terms 180° and — 180°, have any definite scientific meaning or rest upon any basis of scientific accuracy. Unless they do, I maintain that they should be thrown out of scientific literature.

5. Whoever may accept this challenge must agree to reply to such questions as may be asked, and the whole of his argument must be reported by a stenographer for the Congress.

If this challenge is not accepted I shall feel at liberty to ignore the claims of my opponents in future.

This provoked some discussion, but of a rather general character, and, in order to confine it, Mr. Hitchcock asked if any one would accept the challenge. He was asked to read it again, which was done. Dr. Geo. E. Blackham then took the floor and showed on what grounds the figures 180°, and + 180° were upheld, and touched upon some other points. Dr. Blackham's statement of the case was, so far as it related to the actual course of the rays of light, perfectly fair.

Prof. J. E. Smith then arose and made a protest against challenges. He considered them undignified.

The challenge was not accepted by any one, and it should be noted that there were present the most noted supporters of these extreme angles.

Dr. Ward made a few remarks upon the subject, in which he opposed the passage of the resolutions, on the ground that the Congress should not take hasty action in a matter about which there was so much difference of opinion. Mr. Hitchcock stated that his object in offering the resolutions was merely to confine future discussion, by limiting the meaning of the term "angular aperture." He then withdrew them as advised by his friends.

On Friday the principal subject was micrometry, and as this is a matter which is of considerable importance, and one which will engage the attention of microscopists for some time to

*See paper in Am. Journ. Mic., June, 1878, p. 182.

come, the action of the Congress will be of considerable interest.

Dr. W. T. Belfield read the first paper, which is published on page 37.

Mr. C. M. Vorce described a method of measuring which he had found convenient. It consisted of a series of scales properly divided, one for each objective, for use with the camera.

Mr. Hitchcock read a paper entitled

"A STANDARD MICROMETER."

An abstract of this is found on page 47.

Dr. R. H. Ward then followed with some extempore remarks of great value, relating to the ruling of plates and the accuracy attainable in our standard divisions. These were of a most interesting character, but unfortunately were not written out.

Prof. J. D. Hyatt then made a few remarks embracing an account of his work on bee stings.

The afternoon was occupied with an excursion on the "belt line" railroad by invitation, and in the evening an exhibition of instruments and objects was held which was well attended by the citizens.

On Saturday the business relating to permanent organization was first attended to, with the results already stated.

Prof. J. Edwards Smith spoke for a few minutes on

"THE PROGRESS OF MICROSCOPIC RULING."

He stated that Prof. Rogers had ruled 120,000 lines to the inch, which he (Prof. Smith) had succeeded in resolving by reflected light. In reply to a question he answered, that by transmitted light he was not able to resolve these lines. Prof. Rogers believes he can make a band with 240,000 lines to the inch. Remarks are superfluous on this. The band may be made, but we much doubt if it will ever be seen.

The following papers were read by title:

"ON THE CONSTRUCTION OF OCULARS," by W. H. Seaman.

"A NEW ANALYZING EYE-PIECE," by Prof. Wm. Lighton.

"A NEW ARRANGEMENT FOR DARK FIELD ILLUMINATION," by Prof. Wm. Lighton.

"A NEW SECTION CUTTER," by Dr. Carl Seiler.

Mr. John Sidle described a new and ingenious self-centering turn-table, devised by himself.

Dr. Ward described Biscols' section cutter, which he praised as being convenient, and made on a correct plan for such instruments.

The last paper was by Dr. Wm. H. Atkinson, of New York,

"ON EPITHELIUM."

Mr. Hitchcock then introduced the following resolutions which were carried unanimously :

*Resolved,* that this Congress, representing the various microscopical societies and microscopists of the country, recommend and adopt for universal use, from this time forth, the 1-100 of a millimetre as our unit of micrometry.

*Resolved,* that we request each society of microscopists to formally approve of our action in this matter, and that they also ask authors of papers to conform to these resolutions whenever practicable, and that they communicate whatever action they may take to the New York Microscopical Society.

*Resolved,* that we request microscopical organizations of all countries to formally adopt the same unit, and communicate their action to the same body.

*Resolved,* that we recommend the plan of Prof. W. A. Rogers for deciding upon a standard micrometric division to the favorable consideration of the societies.

After all further business had been disposed of, Dr. Atkinson arose to ask if any person present desired "to know what Epithelism is?" As there was no immediate response the Congress adjourned at about 5 o'clock.

A report of this Congress would not be complete without some notice of the instruments and accessories exhibited. We can only notice a few. Dr. R. H. Ward had one of Prof. Rogers's micrometers, the divisions of which were true fractions of an inch, and offered it to all who wished to compare their micrometers with it. He had also some of Mr. Fasault's fine ruled plates.

Mr. W. H. Walmsley, of Philadelphia, exhibited the largest stock of any dealer. A fine lot of Beck's instruments, objectives and accessories, Dr. Seiler's very admirable section cutter, and also Rivet's wooden microtome, which is so highly spoken of for cutting sections of vegetable tissues. Mr. Walmsley deserves much credit for his enterprise and energy in transporting so much expensive and delicate apparatus to such a distance for this meeting.

Mr.W. H. Bulloch, of Chicago, exhibited several of his stands, which are fast becoming better known and appreciated. Among the rest was his largest stand which is a model of completeness.

Mr. Joseph Zentmayer was unfortunately not able to attend, and his son, who expected to be present, was also detained at home. Some of their fine stands were shown by Mr. John Sidle, who also represented J. W. Queen & Co., and as usual their beauty in design, and the wonderful mechanical skill, shown by their smooth movements in every part, made them universally admired.

Mr. Ed. Bausch, of the Bausch & Lomb Optical Company, had a series of objectives made by them. Several objectives, provided with the new cover adjustment, lately patented by Mr. Grundlach, and, we believe, now belonging solely to this company, were also exhibited for the first time.

There was much more that deserves mention, but our limited space makes it advisable to close here.

## NOTES.

—Dr. Thudicum, whose name has long been connected with some valuable chemical studies on the brain matter, has succeeded in obtaining a peculiar coloring matter from egg shells, the absorption spectrum of which is identical with cruentin.

—In Germany there has been invented an apparatus which permits sixty microscopic objects to be examined, in succession, without changing slides or readjustment of objective. It is made on the plan of the revolving stereoscopes, and is called a "poly-microscope."

We know of an English gentleman who has his polariscope so arranged that he can reproduce any effect at pleasure. If we could only observe by machinery, how convenient it would be.

—H. N. Mosely has lately described his method of imbedding soft tissues for cutting sections. His process is a slight modification of one devised by Mihakowics. Equal parts, by weight, of gelatin and glycerin are heated together, until the former is dissolved. Mosely finds a little excess of glycerin an advantage. The tissues, hardened and stained if necessary, are soaked in glycerin and transferred to the warm mixture until thoroughly penetrated by it. They are then placed in blocks of liver hardened in common alcohol, with sufficient of the imbedding material, properly arranged for cutting, and the whole placed in absolute alcohol. The liver contracts and holds the tissue

firmly in place, while the jelly soon hardens, becoming white and opaque. Sections are then cut and treated with glycerin. This is highly recommended for use, in preparing sections of calcareous structures, which are liable to collapse upon removal of the lime. The author has made successful use of it in preparing sections of coral. One great advantage is that there is no imbedding material requiring to be dissolved away by a special solvent.

—By means of his new immersion paraboloid, Dr. James Edmunds has demonstrated a fine beading in the membranous part of this scale. It is best seen by so arranging the light that the featherlets become invisible. The scale of the speckled podura shows it with least difficulty.

—Mr. H. T. Johnston-Lavis has been examining some old pieces of glass which contained " certain irregular worm-eaten-looking holes of some depth," and communicates his results to *Science-Gossip*. By microscopical examination he concludes that the cavities are produced by the growth of a lichen.

—Prof. Aug. Weismann, Zeitsch. f. wiss. Zool., finds that in a few of the Daphnoidae, and also in some of the Phyllopoda, bright patches of color are to be found, blue and scarlet. These colors, he concludes, are the result of sexual selection, at first being developed in the male only, and by transmission are now found in the females. Different colonies of the same species have not the same colors and the difference is constant. In *Latona* the colors of both male and female are most brilliant. These observations seem to confirm Mr. Darwin's theory of the coloring of butterflies' wings.

—It is said that the common Dill, owing to its peculiar smell, will protect cabbages from the ravages of the caterpillar, when grown in the beds. Broad beans, planted by gooseberry bushes, are said to protect those bushes from the gooseberry worm, and *Pyrenthrum* protects vines from Phylloxera.

—We have received a "Catalogue of Mounting Apparatus and Material, and of Microscopic Objects," made and for sale by Jesse S. Cheyney, 308 Walnut St., Philadelphia, 1878. Mr. Cheney is well known among dealers in such materials. His catalogue is quite complete and embraces many things which are needed by the microscopist, and, what is more to the point, the prices charged are not unreasonable.

—In Section A., of the British Association, Prof. W. Stanley Jevons read a note on the "*Pedetic action of Soap*," which is of interest to microscopists. He finds that soap added to water increases greatly the Brownian motion, and this fact he considers to oppose the idea that these motions are due to surface tension. He attributes this motion to " chemical and electromotive actions." China clay diffused in wa-

ter soon settles to the bottom, but in a one-per-cent. solution of soap they remain suspended much longer. The author believes that the detergent power of soap is caused by this pedetic action, and this explains why soap is a better detergent than the free alkali from which it is made.

—The origin of the minute spherules of metallic iron and nickel found in the fine red clay forming over the bottom of the deep sea has not yet been determined. By some they are thought to be of cosmic origin—minute meteorites; by others, and among them Sir Wm. Thomson, they are thought to come from the disintegration of igneous rocks and products from submarine volcanoes.

—M. Pasteur has promised to repeat the experiments of the late Claude Bernard which M. Berthelot has recently published. M. Bernard reached conclusions opposed to those of M. Pasteur in regard to the phenomena of alcoholic fermentation, but the latter believes that the experiments can be repeated by himself and that they will support his views.

## LABORATORY NOTES AND QUERIES.

*Dear Editor:*—IT seems to me that a column of this kind in the *American Quarterly Microscopical Journal* will be very fruitful in good results; for it will approximately take the place of personal intercourse, which is mostly impossible for the comparatively few microscopists in our great country. It will serve as a friendly middle-man, telling of the little things that are hit upon to lessen labor, and so render possible to all what might otherwise be possible only to the few. It will be also a repository in which may be stored up these valuable little things that go so far towards ensuring success and lessening drudgery. And finally, in its answers, it will give invaluable information to hundreds who are denied the privilege of access to elaborate books and monographs.

It would properly contain: 1. Short notes on original observations and methods of work, or improvements on old methods. 2. The best and most available sources of working material. 3. Practical questions and answers.

S. H. GAGE.

[We heartily approve of the suggestions of this letter, and will devote sufficient space in every issue to such a column. Subscribers and others are requested to contribute freely to these notes which may be made very useful. We are indebted to Mr. Gage for many valuable services. The following are from Mr. Gage, of Cornell University Anatomical Laboratory.—ED.]

1. THE microscopical study of live aquatic animals is often very tedious and unsatisfactory on account of their almost constant motion. This may be very effectually overcome by adding a small quantity of

sulphuric ether to the water in which they are kept. Ether is a very excellent quieting agent, as it mixes quite readily with water, it does not sensibly affect the circulation, and the animals are as lively as ever soon after being put back into fresh water.

As was pointed out to me by my friend, L. O. Howard, a student in natural history, the common caddis-worm, (one of the *Phryganeidæ*), shows the progressive contraction of the insect's heart most admirably. If its continual up and down wave-like motion be overcome by putting two or three drops of ether into the watch-glass of water containing it, it forms a most excellent subject for class demonstration. Larval amphibians, quieted in the same way, show very well indeed the action of the heart and the circulation in or through the gills. Doubtless, every microscopist will think of many other applications to make of this valuable agent.

2. Probably every teacher has experienced some disappointment in attempting to show cilia and their motion to a class untrained in microscopical observation. The demonstration may be made much more striking and successful if a small quantity of blood is put upon the slide with the epithelium. From seeing the large red corpuscles whirled round and round the student is, naturally and easily, led to see the cause. This is the same, in principle, as putting grains of carmine upon the slide with the cilia, but is more striking and the blood is always at hand.

3. On page 261, of Huxley and Martin's Elementary Biology, in treating of the skin, it is stated that the mouths of the cutaneous glands are seen as clear round spots, although their openings are really tri-radiate. No directions are given for demonstrating that appearance, but it may be done very nicely by putting a piece of skin from a frog's back or side into Müller's fluid one part, water, four parts, (any weak solution of a chromium compound would do very well), for two or three days. The layers of the epidermis come apart, and the external layer shows perfectly the tri-radiate openings of the glands. If this layer be colored in carmine or picro-carmine, it makes a very pretty and instructive object; for it not only shows the mouths of the glands, but the large flat nucleated epidermal cells. Prof. H. H. Straight, of the Oswego Normal School, says, "If a live frog be wiped dry with a cloth, and then put into water over night, the external layer of epidermis comes off very readily," that is, the frog has been made to cast its skin. By making use of this process the points mentioned above might be demonstrated without hurting the frog.

4. A very easy way to keep dust, etc., out of watch-glasses, while tissues are staining, or being otherwise prepared, is to cover them with square pieces of glass. If it is desired to keep alcohol in watch-glasses, with sections for several hours, evaporation may be prevented by smearing the glass cover with glycerin.

5. This, and the following are inserted, knowing from experience that the aspirations of microscopists are, too often, beyond their exchequer. A very good substitute for the expensive glass slides may be made by any one at a cost of ten cents or less per hundred, as follows: A steel glass-cutter may be bought for twenty-five cents, and strips of thin, clear glass may be obtained at any drug store for almost nothing. The slides can be cut with the steel cutter, and the best ones ground on any ordinary grind-stone, or the sharp edges may be removed with a fine file or coarse whet-stone.

6. A very cheap and excellent section-lifter may be made by hammering out flat the end of a copper wire, 3 mm. ($\frac{1}{8}$ in.) in diameter, 10 cm. (4 in.) long. The hammering should be done on a smooth iron, like an anvil, and when it is as thin and wide as desired (about 1 cm. wide and long will do for nearly everything) it should be trimmed evenly with scissors, and smoothed on a fine whet-stone. The thin part should then be bent to an angle of about 85 degrees with the unhammered part, which serves as a handle.

QUERY.—What are the highest magnifying powers now used in practical work, and how are they obtained?

## DIGEST OF CURRENT LITERATURE.

IT is intended to make this a valuable record of the work going on throughout the world. As may be readily understood, it is impossible to make the record complete in our first one or two numbers.

This department is considered a very important one, and for the accuracy of these abstracts, which, too often, are carelessly prepared for journals, the Editor holds himself personally responsible.

Only such articles as are communicated to the journals by the authors will be abstracted here. Reprints will be noticed only by title as a rule.

### THE JOURNAL OF THE QUEKETT CLUB.

*July*, 1878.

ON GLYCIPHAGUS PALMIFER.—A. D. Michan, F. R. M. S.—A specimen of this mite, not previously noticed in England, was found by the author in Warwickshire. It was not unlikely carried there with casks of wine, and can not be said to be indigenous. A description and drawing of the insect is given.

The most exhaustive account of this species is given by Robin and Furmose in *Robin's Journal pour l' Anatomie et Physiologie*, 1868.

A FEW REMARKS ON INSECT DISSECTION.—T. Charters White, M. R. C. S., F. R. M. S., etc.—The instruments used are very simple, and a few good suggestions are made; but as a rule every one will work in his own way in such matters as this.

ON SOME MICROSCOPIC TRACINGS OF LISSAJOUS' CURVES.—Robert G. West.—In this paper is found a brief review of the subject of

fine ruling. Perhaps there is nothing more wonderful as an instance of fine mechanical work than the delicacy and accuracy with which fine lines are now drawn upon glass. The delicate curves here described are attracting considerable attention, and by some are considered superior to Nobert's plates as test objects, from the mere fact that the lines are not parallel, but cross or gradually approach each other. The cuts are apparently V shaped grooves, and, if desired, a "vertically waved line" can doubtless be made. Although the lines are all practically in the same plane, an alteration of focus is required to bring out the transverse lines.

On a New Micrometer.—George J. Burch.—This is illustrated by a plate, but the principle can readily be grasped without a figure.

About ten inches from the body of the microscope a scale, drawn on ivory or card, is supported, level with the eye-piece. An arm reaching from the eye-piece acts as this support. A Beale's neutral tint camera lucida is placed above the eye-piece so as to throw an image of this scale, properly illuminated, into the eye. At the same time, any object upon the stage is seen through the camera. The object and scale being thus seen together, measures can be at once read off. Other cameras than Beale's can of course be substituted. Many advantages are claimed for this instrument. It is certainly capable of many applications apart from measuring with the microscope, as, *e. g.* the internal diameter of the mouth of a bottle can be measured by simply using a tube ten inches long in place of the microscope.

On a Method of Mounting Whole Insects, without pressure, for the Binocular Microscope.—Staniforth Green.—The smaller insects should be killed by placing them in turpentine. They thus die usually with wings and legs outspread. After a few days soaking in turpentine they are ready to mount in balsam. With horny kinds turpentine cannot be so used, as these curl up in dying. Such must be placed alive on glass, and while walking a cover glass placed upon them, and strong alcohol then introduced to kill them in position. Mount in balsam as usual.

Moderate sized Diptera must be held by the wings and dipped in turpentine, and allowed to remain in this for five minutes. Then hold them by the wings, spread out the legs with needles on glass, replace in turpentine for a few minutes, and then heat them in turpentine until boiling begins. When heated enough tongues and ovipositors will be found protruded. Place then in cold turpentine until ready for mounting.

Spiders are killed in alcohol, placed between pieces of glass, arranged with needles, and soaked in turpentine.

On Variation in Spongilla fluviatilis.—J. G. Waller.—This is a thoroughly good article, and we want more such. It is a plain-spoken protest against giving specific names to mere varieties. There

seems to be a sort of mania on the part of many naturalists to propose specific names on the least provocation.

*Spongilla fluviatilis* is found in very many forms in different localities which, by careful comparison, show such gradual gradations that they are undoubtedly merely varieties of one species. A plate showing the forms of spicules is given.

## JOURNAL DE MICROGRAPHIE.

This Journal, edited by Dr. J. Pelletan of Paris, although only in its second year, is undoubtedly one of the most valuable journals published in the special line of microscopy. In plan it is quite different from any other, and the "Review" with which each number opens, from the pen of the editor, is always full of interest.

We briefly abstract from the numbers at hand as follows:

*May*, 1878.

LYMPHATIC HEARTS.—Prof. Ranvier.—A continuation of a lecture at the College of France. It begins in this number with a study of the nerve of the posterior hearts, and then follow a few words on the lymphatic hearts of serpents.

The last division here given relates to the structure of these organs in Batrachians.

OBSERVATIONS ON THE TERMINATION OF THE MOTOR NERVES IN THE STRIATED MUSCLES OF THE TORPEDO AND THE RAYS, AND ON THE RESEMBLANCE BETWEEN THE ELECTRIC AND MOTOR PLATE OF THE TORPEDO.—Prof. C. V. Ciaccio.—Continuation.

NEW RESEARCHES ON THE INTIMATE STRUCTURE OF THE RETINA IN BIRDS.—Dr. Al. Tafani.—Continued.

STUDY UPON FOREIGN MICROSCOPES.—Dr. Pelletan.—This is one of a series of articles on the subject. A full and good description of Mr. Zentmayer's "Centennial" stand is given. Dr. Pelletan is not sparing in his praise of this specimen of American workmanship.

Following this is quite as long an account of Mr. R. B. Tolles's new large stand, which also receives a due portion of praise.

THE VERNIER APPLIED TO THE BODY-TUBE OF THE MICROSCOPE.—L. M. Bawens.—The author states that about ten years ago he applied a vernier to his microscope (Jackson model), for the purpose of measuring the thickness of cover glasses and other work.

*June*, 1878.

LYMPHATIC HEARTS.—Prof. Ranvier.—Continued.

OBSERVATIONS ON THE TERMINATION OF THE MOTOR NERVES, ETC.—Prof. C. V. Ciaccio.—Continued.

THE MICROSCOPES AT THE PARIS EXPOSITION.—Dr. Pelletan.—This is the first of a series of articles, and is a general view of the microscopes of the whole exhibition.

It embraces much that is interesting, and some things are said about the conservative French and German makers which they would do well to think about. We have not room to devote to this subject, but must notice a few points.

The exhibition of microscopes is a very large one, but they are much scattered about among the "exhibits" of different nations. Among others on the Continent, were exhibited instruments by Nachet, Verick, Hartnack & Prazmowski, Chevalier, Culot, Mirand, Bardou, Lebrun, Seguy, Jaubert.

Ross & Co. had some splendid stands of large and medium size, some modeled upon the Ross, and others upon the Jackson style. "Among the latter, I remark six models which are copies, pure and simple, of the "Centennial" of Mr. J. Zentmayer; the sub-stage and mirror, connected, revolve about the focal point, and the slow movement acts upon the entire tube." Mr. J. H. Dallmeyer, of London, exhibited some stands on the Ross model, and Mr. Crouch was also represented. The display of Mr. Swift is highly spoken of.

From the United States only four makers are represented, but these are of much importance.

The Bausch & Lomb Company have a full set of their instruments from the large "professional" down, and a series of objectives, from a 2 inch to the $\frac{1}{8}$ immersion.

Mr. Zentmayer only sent a single stand, and this was his "Centennial." Beside this is a box containing "26 magnificent preparations," by Mr. Charles Zentmayer, mostly double stained.

Chas. A. Spencer, and Sons of Geneva, have a number of objectives on exhibition, among which is a $\frac{1}{20}$ duplex immersion. These will be examined in future.

"S. Plössel, Vienna, * * * exhibits no micrscopes; it appears that this is for prudential reasons."

Mr. J. Rosenthal, Vienna, shows some precisely like Hartnack's.

There are many other exhibitors, but we must pass them by,—all but the last one. There is a small stand in the Japanese department which might be English, or it might be American, but it has an inscription which, being translated by the polite native exhibitor, who "speaks French better than an Englishman, and English better than a Frenchman," evidently referred to the name of the maker in Tokio.

On the Gold Method, and the Termination of the Nerves in the "Muscles Lisses' —L. Ranvier.—From *Comptes Rendus.*

Cryptogamic Botany.—Programme of the course of M. Leon Marchand, at l' Ecole Superieur de Pharmacie de Paris.

A New Field of Study for the Microscopist.—W. Saville Kent.—From the *Popular Science Review*, April, 1878.—To be continued.

On the Measurement of the Angles of Microscopic Crys-

TALS.—Em. Bertrand.—*Comptes Rendus*, December 17th, 1877. This is really an ingenious arrangement, and appears to be quite practicable and accurate. Want of space only prevents us from translating it entire.

In the eye-piece is placed a cylinder of glass of higher refractive power than balsam. This cylinder is split lengthwise, the surfaces polished and again cemented together with balsam.

With direct illumination, the field is illuminated equally and a line crosses it. When a crystal, the surface of which is large enough to change the direction of the rays of light, is placed upon the stage, these rays suffer total reflection in the eye-piece cylinder, owing to the film of balsam.

One can readily understand what the effect would be in this case, and how the instrument is used. It makes a revolving concentric stage unnecessary.

TRANSPORTING LIVING SPECIMENS FOR THE MICROSCOPE.—Dr. Pelletan.—A notice of the enterprise of Mr. T. Bolton, of Birmingham, who, being an industrious collector of objects, has for some time been selling them, and sending them by mail in little glass tubes. A long list of objects, which he supplies, is given. This is certainly of great value to microscopists, but in this country we cannot enjoy such benefits.

NEW MODEL MICROSCOPE, OF MR. R. B. TOLLES, BOSTON.—Geo. E. Blackham, M. D., Dunkirk, N. Y.—A detailed description of a stand recently made for the author.

THE "TRANSPORTER" OF PROF. MONNIER.—This is a mounting instrument for placing the cover glass in position. Its use is described.

*July*, 1878.

LYMPHATIC HEARTS.—Prof. Ranvier.—Continued.

OBSERVATIONS ON THE TERMINATION OF MOTOR NERVES IN THE STRIATED MUSCLES OF THE TORPEDO FISH, ETC.—Continued.

PRELIMINARY NOTE ON THE DEVELOPMENT OF BLOOD AND VESSELS.—Drs. V. Brigidi and Al. Tafani.

These studies, which appear to have been carefully conducted, were made in great part upon the embryo of *Cyprinus auratus* while living, and this subject the authors consider peculiarly adapted to the work. The germ, freed from the testaceous membrane, may be placed in a cell with a drop of water, covered, and can be long examined without the use of an anæsthetic. We can barely indicate the results of these studies. It is affirmed, and will be more fully shown, in a forthcoming memoir, entitled the "Embryology of *Cyprinus auratus*," that the blood and vessels have their origin in a special "feuillet" which appears about the second day after fecundation. This the authors designate as the "vascular feuillet," and they thus verify the observations of former students.

They feel fully justified in saying that the white corpuscles are formed

at a later period than the red. They reject the doctrine that the heart and vessels are formed before the blood, but they appear contemporaneously. To be continued in the next number.

MICROSCOPY AT THE UNIVERSAL EXPOSITION OF PARIS.—Dr. Pelletan.

NOTE ON THE APPLICATION OF AMMONIUM PICROCARMINATE TO THE ANATOMICAL STUDY OF INTESTINAL WORMS.—Dr. G. Duchamp. —Owing to the difficulty in making out the structure of these worms after death, which produces almost immediate alteration, this coloring solution was tried with apparently perfect success, and the preparations can be preserved. The worm is merely placed, while living, in the ordinary picrocarminate for about thirty minutes.

CRYPTOGAMIC BOTANY.—Continued.

ON THE GUM DISEASE OF CITRON TREES, (*Fusisporium limoni*, Briosi).—C. Briosi.—This is only an introduction to what promises to be an interesting account of the author's investigations. A review of the history of the disease is given, and the questions he proposed to solve in beginning the work himself.

RESEARCHES ON THE COMPARATIVE ANATOMY AND THE DEVELOPMENT OF TISSUES IN THE STEM OF MONOCOTYLEDONS.—E. Dubreuil. —This is a review of a thesis by Dr. A. Guillaud, and it is of such a nature that we must give it some space here.

The thesis is divided into two parts. The first is purely anatomical. Plants are divided into six distinct types, and by further study this number may be increased. Each of these types shows some peculiarity of organization and they do not pass gradually into each other.

Type I. This is characterized by the absence of special tissues; the fundamental cortical tissue passes without the least modification into the medullary parenchyma. Example, *Polygonatum vulgare*.

Type II. This type is distinguished by the presence of a more or less complex band of special tissues, developed about the external ring of bundles. This band constitutes an intermediate zone between the pith and bark, isolating the parenchyma of the two regions. Examples, *Iris florentina*, L., *Chamoedorea elatior*, Mart. *Acorus calamus*, L., *Scirpus lacustris*, L. These examples constitute different sub-types which may be distinguished.

Type III. In this type the rhizomes are long and slender. The bundles, less numerous than usual, do not describe a central curvature, are not decussate, and are ranged in a circle or in a definite ring as in ordinary Dicotyledons. Example, *Luzula campestris*, D. C.

Type IV. This, like the last, is founded on the arrangement of the bundles, which form two groups isolated in the inter-nodes and only reuniting as they enter the leaves; the one includes those in which the bundles, curved towards the centre, occupy the interior of the pith; the other, those with straight bundles which form the ordinary circle and the limit of the bark. Example, *Tradescantia*.

Type V. This is characterized by the formation of a secondary mass of prosenchymatous tissue, hard, forming from one end to the other of the rhizome, of *Triglochin maritimum*, for example, a solid triangle of pseudo liber-like tissue; and similarly situated in other plants, as *Schoenus nigricans, Marsilea* and *Posidonia Caulini.*

Type VI. In this type the bundles in the branches, and also sometimes the rhizomes are provided with two tissues isolated and distinct. One develops behind and near the air vessels, the other in front. A. times there are many liber fibers as in certain *Dioscorea.* Example, *Tamus communis*, L.

In these two latter types there is usually an intermediate zone more or less developed.

The second part is a long exposition of the general anatomy of these types of monocotyledons, of which not sufficient is given to furnish material for a good résumé.

On the Application of the Microscope to the Study of Mineralogy.—Em. Bertrand.—This paper first describes how the apparatus for measuring the angles of crystals, aleady noticed on page 76, can be practically applied to the microscope, and also an improvement upon its former construction. Then follow a few words about the study of the optical properties of double refracting crystals by the microscope. To determine the position of the axis of a crystal, four sectors of quartz are mounted in the eye-piece with optical rotation alternately to the right and left, and these, by their color, indicate the position of the prisms. This has already been described in another journal.

An arrangement is also described for using converging light with the polariscope.

A New Field of Study for the Microscopist.—Continued.

*August* 1878.

Lymphatic Hearts.—Continued.

Observations on the Termination of Motor Nerves, etc.—Concluded.

Preliminary Note on the Development of Blood and Vessels.—Continued.

The blood when it first appears is in vessels in no wise different in structure from those of the adult; the blood of the embryo and of the perfect animal has precisely the same properties. Authors consider that the first rudiments of the heart or vessels cannot be distinguished until they present endothelial elements, and that a collection of elements of indefinite character, having no other importance than that they occupy the position of the heart, should not be regarded as a stage in its development.

In this paper the development of the heart is described until the contraction begins and circulation is established.

On the Isogenic Groups of the Cellular Elements of Cartilage.—J. Renaut.—Comptes Rendus, July, 1878.

On the Gum Disease of Citrons.—Continued.

This article is somewhat long, although the experiments are incomplete, and are only published because the author, having left Sicily, does not expect to find opportunity to conduct them further.

The disease appears to be caused by, or, at least, accompanied by, a new cryptogam excessively minute and very prolific, which is named *Fussisporium limoni*, Briosi. The description given of this fungus is entirely too long to quote in this place. Unfortunately its characters are not given in technical language.

A New Field of Study for the Microscopist.—Continued.

Dunkirk Microscopical Society.—Report of meeting of July 16, from Dr. C. P. Alling, Secretary.

Dr. Edmund's Paraboloid.—A short description.

Microscopical Technic.—Extract from Dr. Pelletan's Manuel of Histology.

## THE AMERICAN JOURNAL OF MICROSCOPY.

*August*, 1878. Extra number.

On the Life-History of a Minute Septic Organism, with an Account of Experiments made to Determine its Thermal Death Point.—Rev. W. H. Dallinger.—From the Proceedings of the Royal Society, No. 187, 1878. To Mr. Dallinger we are indebted for a great deal of patient and careful work, and our knowledge of the life-history of the minute monads we owe almost entirely to him and his co-worker, Dr. Drysdale.

No one who has studied the results of this labor can overlook the evident similarity in the methods of development and multiplication shown by all these organisms, and still less can we fail to admire the true spirit of investigation shown by the gentlemen who have done this work, the skill they have shown in conducting it, and the fertility of invention which has enabled them to overcome the difficulties involved.

In this last paper Dr. Dallinger describes the organisms with his accustomed care, and then watches them until the process of self division is fully made out. This process is the same for the most part as he has noticed in other forms, the body and nucleus divide longitudinally, the division continuing until the two new forms are separated by the finest shred of sarcode, which soon breaks about the middle, and thus becomes a flagellum for each of them.

As was anticipated from previous experiments on other forms, he finally succeeded in obtaining cysts, as the result of conjugation, from which spores were finally discharged, and these latter develop into the original form.

This paper is illustrated with two well-executed plates, and takes up the greater part of the journal.

MICROSCOPICAL RESEARCH.—From "Scientific Opinion," June, 1869.

NOTES ON CENTURY III. OF THE "SPECIES TYPICÆ DIATOMACEARUM."—Prof. H. L. Smith.

A MICROSCOPICAL CABINET.—A description of a cabinet devised by Dr. Mouser and exhibited before the San Francisco Microscopical Society.

BALSAM MOUNTS.—Dr. F. M. Hamlin.—Recommending a ring of gold size around balsam mounts to protect them.

COLLECTION OF CANADA BALSAM.—From the *Transactions Am. Pharmaceutical Association.*

## BOOK NOTICES.

MICROSCOPIC ORGANISMS IN COCHITUATE WATER. By ROBERT WHITE, JR., M. D. Reprinted from *The Boston Medical and Surgical Journal.* Riverside Press, Cambridge, 1878. This is a neat pamphlet of ten pages, and a plate fairly illustrating the more common forms of plant and animal life found in drinking water. After describing his method of examination, the author recounts briefly the characters of the various genera represented, touching upon their habitat and methods of growth and multiplication. The living forms in the Cochituate water he considers to be harmless, and the only objectionable feature of the water lies in the amount of "organic matter" which it contains, which "indicates the necessity of carefully protecting it from all sources of pollution."

ISTHMIA NERVOSA. A study of its modes of growth and reproduction. By J. D. COX, A. M., LL.D. Reprinted from the *American Journal of Microscopy.* Many of our readers have already seen the contents of this pamphlet. It embraces the results of a careful study of the silicious frustules as they were found upon sea-weed, and shows well that there is much to be learned about methods of growth, and even multiplication, by the examination of dead specimens. Commencing with a short description of the appearance of the frustule, a general account of the phenomena of subdivision follows, after which the so-called "hoops" are considered. While agreeing with Dr. Wallich as to the presence of two or more hoops, sliding one over the other like telescope tubes, Mr. Cox differs from him as to their manner of growth. According to Mr. Cox the hoops are made up of a membrane upon, or in which, the silex is deposited after the manner of plant growth. The outer hoop frequently shows one or more sutures at which the edges of the two parts are slightly separated so as to show the inner tube, and there is always a line of suture at each end of the hoop. The hoop and valve never sever their connection during life. When the frustule has reached the proper stage, subdivision begins within, and as the young cells grow, they force the old valves apart, and thus cause the telescope tubes to slide over each other.

The most important part of Mr. Cox's pamphlet relates to his observations on the sporangial frustule, and they will no doubt require verification from the study of living forms before receiving general support from diatomists. He considers that his observations prove that the sporangial frustules propagate by division in

the same manner as others. We cannot deny that the figures given indicate that his conclusions appear legitimate, and yet, we may well question the propriety of assuming quite so much from the study of dead remains. It does not appear that the real office of the sporangial frustule of Isthmia has been as yet made out, and an attractive field for study is here opened up for those who have the material at hand.

## PUBLICATIONS RECEIVED.

MINING AND SCIENTIFIC PRESS. San Francisco, August 24.

THE PROCEEDINGS OF THE MEDICAL SOCIETY OF THE COUNTY OF KINGS. September.

THE KANSAS CITY REVIEW OF SCIENCE AND INDUSTRY. September.

THE MEDICAL RECORD. September 14th, 21st, and 28th.

THE CINCINNATI MEDICAL NEWS. September.

JOURNAL DE MICROGRAPHIE. Paris. May, June, July, August.

MICROSCOPIC ORGANISMS IN COCHITUATE WATER. By ROBERT WHITE, Jr., M. D. Cambridge. Riverside Press. 1878.

ISTHMIA NERVOSA. By J. D. COX, A. M., LL.D. From American Journal of Microscopy.

SMITHSONIAN REPORTS. 1874, 1875, 1876.

SCIENCE OBSERVER. September, 1878.

THE KIROGRAFER AND STENOGRAFER. July, 1878. Quarterly.

When we decided to publish the Quarterly it was not intended to make it so large as the present number, but the abundance of matter at our disposal has greatly exceeded our expectations. We do not now promise to give over 350 pages in each volume.

The few typographical errors that may be noticed are not so much the result of carelessness on our part as of inexperience in proof reading. We hope they may be overlooked in this our first number.—Ed.

THE

# TRANSACTIONS

OF THE

# NEW YORK MICROSCOPICAL SOCIETY,

No. 1267 BROADWAY,

NEW YORK.

---

Committee on Papers and Publications:

D. BRYCE SCOTT, CHAS. H. HASWELL, R. HITCHCOCK.

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VOLUME I.

*PUBLISHED FOR THE SOCIETY.*

# TRANSACTIONS

OF

# THE NEW YORK MICROSCOPICAL SOCIETY.

## OCTOBER, 1878.

## INTRODUCTORY.

### HISTORY OF THE SOCIETY UP TO THE PRESENT DATE.

On the 12th of November, 1877, a letter was written calling a meeting at the residence of Mr. W. C. Hubbard, No. 109 West 13th street, on the evening of the 14th, for the purpose of forming a microscopical society in the city of New York, provided sufficient interest was manifested in the project. This letter was signed by Messrs. J. D. Hyatt, J. L. Wall, W. C. Hubbard, and R. Hitchcock. A copy of the letter was sent to twenty gentlemen, nearly all of whom were strangers to the writers, and promptly at the appointed time twelve of them responded to the call. The names of these are here given : Messrs. T. F. Hance, Chas. H. Haswell, R. Hitchcock, J. A. Hoyt, W. C. Hubbard, Rev. W. Huckel, J. D. Hyatt, A. A. Julien, John Phin, A. J. Swan, J. L. Wall, G. I. Whitehead.

The first few meetings were entirely occupied with the business of organization. On December 11, 1877, the first election of officers was held, which resulted as follows :

### OFFICERS FOR 1878.

President, J. D. Hyatt ; Vice President, G. I. Whitehead ; Corresponding Secretary, A. J. Swan ; Recording Secretary, R. Hitchcock ; Treasurer, W. C. Hubbard ; Librarian, D. Bryce Scott (acting curator) ; Auditors, J. L. Wall, C. H. Haswell, J. Michels.

The following Permanent Committees were then appointed :

### ON ADMISSIONS,

Messrs. Scott, Swan, Whitehead, Hubbard, and Phin.

ON PAPERS AND PUBLICATIONS,

Messrs. Scott, Haswell, and Hitchcock.

On the 21st of December, the Constitution and By-Laws were adopted as reported by the Special Committee.

Articles of incorporation had been drawn up, and were this evening signed by those present.

Mr. J. L. Wall offered the society the use of his parlors for meetings, until a permanent room should be engaged.

This offer was accepted with thanks, and for a considerable time meetings were held at his residence, No. 64 West 21st street.

Without detailing the interesting occurrences at many meetings, the following brief résumé of what has been done during the few months of its existence, indicates good prospects for a future.

Beginning with twelve members, the society now numbers twenty-nine, and has secured a room for its exclusive use for the coming winter, which has been furnished in a substantial and appropriate manner by subscriptions from the members.

The average attendance of members at all regular meetings since the beginning, including the meeting on Sept. 6th, has been 12.2.

Since March 1st the average has been about 14 (13.6). In proportion to membership this is a record of which we may be proud.

No great efforts have been made to increase the number of members, not because of a feeling of exclusiveness, but because there is no desire to secure such as will not attend meetings or take interest in the work of the society. No doubt there are many in the city we would be glad to number as members, but unless such persons send their names to some officer or member of the society, they will only become known to us by accident.

We would desire to count as members all who are truly interested in any branch of microscopy, whether as professionals or amateurs, or only beginners in the study, and who will attend to the work of the society faithfully.

The following papers have been read before the society.

Dec. 21st, 1877.—A new Rhizopod, *Lobularia marina*, by R. Hitchcock. Published in the *Am. Journ. Microscopy*, Jan. 1878, p. 3.

Jan. 4, 1878.—The examination of Drinking Water, by R. Hitchcock.

Jan. 18.—Angular Aperture, by R. Hitchcock.

A Private Letter from Rev. W. H. Dallinger, read by John Phin. *Am. Journ. Mic.*, July, 1878, p. 154.

Feb. 1.—The use of Salicylic Acid in Mounting, by R. Hitchcock.

Feb. 15.—The Combination Whirling Table of W. H. Bulloch, described by the Secretary. *Am. Journ. Mic.*, March, 1878, p. 60.

March 1.—A new Mounting Bottle for Canada Balsam, by A. A. Julien. *Am. Journ. Mic.*, April, 1878.

March 15.—A Cheap Collecting Outfit, by R. Hitchcock.

April 5.—Stings of the Hymenoptera, by J. D. Hyatt. Preliminary note.

May 3.—Society Work, by the Secretary.

May 17.—Stings of the Hymenoptera, by J. D. Hyatt. Additional note.

May 17.—Angular Aperture, by R. Hitchcock. *Am. Journ. Mic.*, June, 1878, p. 130.

June 17.—Recent Observations in Microscopical Lithology, by A. A. Julien.

The following donations and exchanges have been received :

SLIDES.

R. Hitchcock.
Santonine. Polariscope object.
Salicine. " "
J. D. Hyatt.
Marine alga, *Ptilota*. Cape Ann, Mass.
Palate of Snail. *Buccinium obsoletum*. Harlem River.
John L. Wall.
*Passiflora cœrulea*. Portion of leaf stained.
*Zea mays*. " " "
*Deutzia scabra*. " " "
*Salisburia adiantifolia*. " " "
*Deutzia gracilis*. " " "
*Eucalyptus globulus*. " " "
R. Hitchcock.
Foraminifera from Bermuda. Opaque.
D. Bryce Scott.
Foraminifera from chalk.
" " " opaque.

Potato starch. Opaque.
Spicules of Gorgonia.
" *Plexora plexurosa.*
Spicules of Gorgonia, various, opaque.
Polycystina from Barbadoes, "
" " " " calcined.
" " " " arranged.
" " " " "

J. D. Hyatt.
Section of Precious serpentine. Polariscope object.
Chas. S. Shultz.
Bott's eggs on Horse-hair, with larvæ.
J. D. Hyatt.
Echinus spine. Section.
F. H. Engels.
Fossil Diatoms. Virginia, Nev.
Transverse section of Yerba Santa.
" " Mountain mahogany.
" " Sage bush.
G. I. Whitehead.
Gizzard of Cricket.
Dr. C. Seiler.
Kidney of Cat. Stained and injected.
" " " " "
" " " " "
Stomach of Cat. Injected.
" " "
" " "
C. L. Peticolas.
Fossil Diatoms. Richmond, Va.
" " " "
" " " "
" " Nottingham, Md.
" " California.
" " Petersburg, Va.
" " Calvert Co., Md.
Diatoms. Hanover, Va.
" Holland Cliff, Md.
" Lake Superior.
" Drakesville, N. J.
" Toom Bridge.
" St. John's River, Jacksonville, Florida.
Dr. C. Seiler.
Section of Lung. Tuberculosis.
" Kidney. Normal.

Section of Tongue. Injected.
" Liver. Cirrhosis.
" Stomach. Normal.
" Intestine. Tubercular.

Allen Y. Moore.
Diatoms from Coldwater, Mich., *Encyonema cæspitosum*.

MATERIAL.

Prof. John Phin and D. Bryce Scott.
Foraminifera from Chalk.
" " "
" " "
Polycystina from Barbadoes.
" " "
Spicules of Gorgonia. Florida.
" " "

Eugene Mauler.
Diatomaceous deposit. Lake Majeur, Switzerland.

R. Hitchcock.
Diatomaceous Deposit.
Diatoms Kieselguhr de Soos pres Eger. Bohemia.
" de Franzensbad. Bohemia.
" d' Oran, Algeria.
" Kieselguhr de Franzensbad.
" Santa Fiora. Italy.
" du Phosphate de Fer de Vivianite. Bohemia.
New Zealand Guano.
Chincha Island Guano.

D. Bryce Scott.
Diatomaceous deposit. Port Hope, Canada.
Tous les Mois starch.
Calabar bean starch. (*Physostigma.*)

R. Hitchcock.
Diatomaceous deposits.
Diatoms de Berlin de museum.
" d' Unterluss. Germany.
" de l'ile de Mors. Jutland.
" Ciment de l'ile de Fur, dans le Limpjard. Jutland.
" Moleur. Mors, Jutland.

C. S. Shultz.
Six brass cells.
One glass slide, with brass cell and cover attached.

Rev. W. Huckel.
Sea weed, *Microcladia Coulteri*, from Santa Cruz, Cal. Diatoms attached.

J. D. Hyatt.

One blackboard on tripod stand.

D. Bryce Scott.

Echinus spines.

Prof. W. H. Seaman.

Fungus, *Didymium cinereum.*

" *Arcyria punicea.*

Diatomaceous earth. Richmond, Va.

" Farmingham, Mass.

Seeds of *Pinckneya pubescens.*

Portion of root of *Ipomœa pandurata.*

R. Hitchcock and John L. Wall.

Diatomaceous deposits, taken from Prof. Bailey's collection, West Point.

R. Hitchcock.

| | | |
|---|---|---|
| Diatomaceous deposit. | | Monterey, Cal. |
| " | " | Santa Barbara, Cal. |
| " | " | Virginia, Nev. |
| " | " | San Gregorio, Cal. |

Eugene Mauler.

Diatoms. Island of Fur, Jutland. Recently discovered.

Dr. F. H. Engels.

Diatoms. Virginia, Va.

G. I. Whitehead.

Leaves of Silver tree. Cape of Good Hope.

R. Hitchcock.

Diatomaceous earth from Sierra San Fernandez, Ventura County, Cal.

Diatomaceous earth from Lower California, 40 miles south of San Diego.

DONATIONS TO THE LIBRARY.

1. Article by Dr. R. U. Piper, *Chicago Times*, of December 15th, 1877. From R. Hitchcock.

2. Paper on a new *Rhizopod.* (Read before the Society.)

3. File of the *American Journal of Microscopy.* From Prof. John Phin.

4. Paper on "Angular Aperture." (Read before the Society.)

5. Paper on salicylic acid in mounting. (Read before the Society.)

6 and 7. Two Photomicrographs.

8. Paper on "a new mounting bottle for Canada Balsam." (Read before the Society by A. A. Julien.)

9. Ossification process in birds, pamphlet by Dr. L. Schoeney. Presented by J. D. Hyatt.

10. Ninth annual report of the Microscopical Society of Liverpool. From the Hon. Secretary.

11. Dr. C. Seiler's catalogue of anatomical preparations.

12. Four numbers of the *Bulletin of the Museum of Comparative Zoology*, Cambridge, Mass. Exchange.

For the benefit of the country at large, the Society undertook to secure such legislation by Congress as would alter the regulations which exclude slides from the mails. The result has been quite to the satisfaction of microscopists, so far, but it is still uncertain as to the final result, which now depends upon the action of Congress.

On April 19th, 1878, the Society passed a resolution advising the adoption of the metric system as our standard of microscopic measurement.

For the summer vacation a series of excursions were marked out, but this year they were not well attended owing to several causes.

At a special meeting called for the purpose, and held July 16th, it was decided to publish the *Transactions* of the Society in the Am. Quart. Mic. Journ. The advantages of such an arrangement for the Society are great, for not only will the papers read by members and others be given to the world, either in full or condensed, as may seem advisable to the Committee, but the Society will thus become known to other scientific bodies throughout the world, and a system of exchanges can be made of great benefit to all.

Besides the active members there are six associate and three honorary members.

## MICROMETRY.

BY ROMYN HITCHCOCK.

(*Read Sept. 20th.*)

The action of the "National Microscopical Congress," which met at Indianapolis during the month of August, in making the 1-100 mm. our standard division for micrometry, was a great step towards uniformity in this regard.

The resolutions there adopted make this society, in a measure, responsible for the final success of the movement, and I have a few suggestions to make as to a proper course for us to pursue.

The first thing for us to do is to show our concurrence in the action there taken by a resolution, and I offer one as follows :

*Resolved*, that the N. Y. M. S. approve of the resolutions adopted by the National Microscopical Congress, at Indianapolis, August 17th, 1878, making the 1-100 mm. the standard for micrometry in the U. S., and recommend the same unit for universal use.

The next thing for us to do is to make proper arrangements for receiving the reports upon this subject from other societies, and filing them ready for publication or preservation in proper form.

There is, however, more that we can accomplish in this matter that will be of the greatest benefit to science for years to come.

I make the following suggestions:

The New York Microscopical Society should first endeavor to secure the immediate co-operation of four other societies, each one of which should appoint a competent man to represent it at some designated place, for the purpose of obtaining our standard centimeter and its divisions.

Prof. W. A. Rogers will be ready before long to furnish six micrometers to five regularly appointed representatives, for careful measurement. These micrometers, if found sufficiently exact to meet the requirements demanded by the Congress, shall then be accepted as our standard, and one will go to each of the societies represented, and the sixth to Prof. Rogers himself, to serve as his standard to work from.

When this has been accomplished, and we have our standard, we must have some distinguishing mark for every true standard sold, and it must be copyrighted to prevent its use upon all others. At present Prof. W. A. Rogers alone can make the true standard, for he alone has the means for obtaining a true inch, or centimeter. Still, in future, others will doubtless copy from our standard. Therefore, the copyright mark should not be in the possession of an individual, but rather of a chartered society like our own.

I propose that a committee be appointed to prepare designs for such a label, and also to communicate with other societies to obtain their sanction for our action in this matter.

This label should be in charge of a special committee of the society, and this committee must allow no one to use it until fully satisfied as to the accuracy of the micrometers for which it is intended and after formal action by the society.

We can thus secure the accuracy so much desired.

As soon as our standard is obtained we should take steps to have it deposited with the bureau of weights and measures at Washington, for preservation and reference.

In order to avoid the annoyance of converting fractions of an inch or line into the new scale by calculations, the society should publish a table of such reductions, compiled with the utmost care, together with such rules as may seem useful in practical work.

I believe it is not necessary for me to enlarge upon the real benefits to be thus secured. Every man who has had occasion to determine for himself the accuracy of his micrometer, by the tedious process of comparing it with many others of different makers, will at once appreciate the value of this work.

For a more detailed account of what was said at the Congress at Indianapolis, upon this subject, I must refer the members to the pages of the forthcoming quarterly journal.

## OBLIQUE ILLUMINATION AND MEANS OF OBTAINING IT.

BY R. HITCHCOCK.

(*Read September 20th*, 1878.)

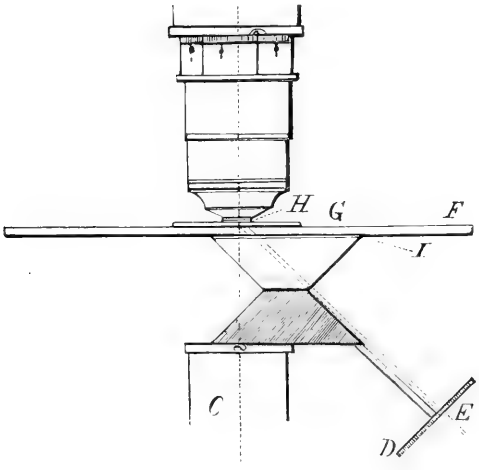


FIG. 1.

It is generally understood that the appearance of an object under the microscope depends as much upon the character of the illumination as upon the objective. Therefore, any improved method of controlling the light demands attention, and I have chosen two recent accessories for consideration in this

place; one devised by Dr. J. J. Woodward, which recommends itself from its simplicity and cheapness; the other by Dr. James Edmunds, described last year before the Royal Society, which, from the accounts we hear of it, is destined to become a valuable accessory.

Dr. Woodward's apparatus is figured on page 11 (Fig. 1, reduced from the M. M. J.), and may be thus briefly described: Just beneath the slide F, and connected with it by oil of cloves or other highly refractive medium, is a truncated right-angled glass prism, resting upon a similar brass prism supported on the sub-stage. D is a shutter, parallel to the side of the prism as shown, with a small hole E about like a large pin hole. This side of the prism is covered with black paper with a corresponding pin hole.

A balsam-mounted object, viewed with an immersion lens of sufficient angular aperture, can thus be seen with sunlight from the plane mirror at an angle of 45° from the axis. It is only by some such plan as this that we are able to obtain light of this obliquity in examining balsam-mounted objects.

We now pass to the more costly appliance of Mr. Edmunds. This consists of a paraboloid lens, with the front cut off flat and polished. The extent to which the apex is cut off depends upon the conditions of use, and may be one-twelfth of an inch below its internal focus, or barely one-fiftieth of an inch below.

This lens is used beneath the slide, in fluid contact with it, and the thickness of the slide determines the place of cutting; the object being to secure a lens which shall have its focus for parallel rays just at the upper surface of the slide when in fluid contact. Diaphrams and shutters of any kind may be arranged beneath the lens, and any rays can thus be selected for use at pleasure. Such a lens has peculiar properties, which we should observe in order to understand its action and advantages. Excluding the more central rays, light entering from below will not pass out again into air above, but suffer total internal reflection. This is not true of the Wenham paraboloid in common use, and this very fact makes the new lens the more valuable for use with high powers for resolutions.

Place a slide upon the stage and interpose a drop of gly-

cerin. The light now passes up through glycerin and slide, and can be focussed on the upper surface.

Any object placed upon the slide is well lighted, and with rays of great obliquity only. Obviously this paraboloid gives us a perfect dark ground effect, the rays being so very oblique that no immersion objective can take them up, and with a dry one the only rays that pass to the objective must be radiated from the object itself.

It certainly appears, then, that this new "immersion paraboloid" possesses certain points of superiority over any other yet devised, and this seems to be borne out by the results of experience. The fact should not be overlooked, however, that Mr. Wenham claims to have made a similar instrument as early as the year 1856.* Although Mr. Edmunds denies this claim, it is not easy to understand the distinction he would make between the two instruments, which in principle are surely identical.† We would not detract from the merit due Mr. Edmunds for making the new lens of great practical value at the present day.

My purpose in describing these instruments is to open a question which seems pertinent at this time, and which has been too much ignored by microscopists as a rule: what kind of illumination is the best—that from below the stage or that from above?

Perhaps it is too early to settle the question now, but it certainly is time to consider it carefully.

First, let us ask, are these, and the many other sub-stage accessories, of sterling value to the observer?

There are those who would discard everything beneath the stage but the mirror, and among these are men of no mean authority in such matters. As for them the reason lies in this, that they believe it possible to resolve any test without any other accessory. Well, we must admit that this is true. No test has yet been proposed that cannot be resolved in this way and, by an expert workman, without great difficulty. Nevertheless, while admitting the fact, is it enough to lead one to discard all other devices? Knowing, as we do, the great difficulties that often arise in making out the exact meaning of

*Mr. Wenham also placed a hemispherical lens in the cavity of a common paraboloid, and thus made a substitute for the solid lens.

†Since this was written Mr. Edmunds has given full credit to Mr. Wenham for this instrument.

the appearances of minute structure under the microscope, should we not always be glad to accept every means in our power to modify and improve our illumination? It does not follow that because a *test* is resolved that we have the best results our lens is capable of giving. It certainly appears from the discussion before the Quekett Club, where this new condenser was exhibited, that the appearance of these very tests was somewhat novel. Another point made by Mr. Edmunds tends to confirm an opinion of long standing. He suggested that "if we could, by new means of illumination, increase the resolving power of low angled lenses, a vast gain would be made," and it seems already that he has done this to a certain extent by this very paraboloid.

Admitting the value of these accessories as aids to investigation, we return to our original question, what is the best kind of illumination? Taking a difficult frustule of a diatom let us observe the effect of various methods with the mirror. With direct light we can see the outline, with oblique light the fine markings, and as less and less light passes through the object in a line with the optical axis, the more distinct become the markings. We might justly conclude from this, that the proper method of illumination would not be by transmitted light.

In practice we only secure the best resolutions of lines or series of dots, when the line is of the utmost possible obliquity. Now, the ordinary way of looking at objects in every-day life is by reflected light. We are easily deceived as to a transparent object when seen by transmitted light. Naturally this is also the case when using the microscope, and I would speak in favor of reflected light for this purpose. In fact, I am strongly inclined to the opinion that the most appropriate and best light for microscopical work is what comes from above the stage. What we want is a positive image of the object, and this cannot be obtained by the ordinary methods of working. One of the greatest obstacles to this kind of illumination has heretofore been the difficulty of throwing sufficient light upon the object with high powers. A $\frac{1}{10}$ can now be used very successfully in this way with simply the mirror above the stage.

Practically, a positive image is also obtained, when the object is transparent, by means of very oblique light from such

an instrument as we have described.* It will be a difficult matter to show any difference, in effect, between a transparent body thus made self-radiant, and an opaque one illuminated from above.

Moreover, it may be that the effect of very oblique light, giving a dark field, is really something more than we have suggested. Long ago, Mr. Wenham devised various means of obtaining oblique light for balsam or fluid mounts, and he considered that in many cases the light suffered total reflection from the surface of the cover-glass and was thrown down upon the object, thus in fact giving the effect of illumination from above: only, however, with dry objectives.

It is often difficult, if not impossible, to say whether an image we see is truly positive or not. It seems not unlikely that sometimes the object seen by such oblique light, really shows by the reflected light from the cover. These are old ideas but they should not be forgotten entirely.

There is one remark I wish to add here for the mere purpose of putting myself on record in this matter. I wish to say distinctly that I do not admit, and never have intentionally said, that high angled glasses of the finest quality are always the best for the most delicate work. I do say that as a rule they are the best, and particularly for the resolution of fine lines or dots in series.

## PROCEEDINGS.

Regular meeting, Sept. 20th, 1878. The minutes of the preceding meeting were read and approved.

After several reports from special committees relating to matters of business, two new members were elected—Mr. Benjamin Braman as an associate, and Rev. Dr. W. Underwood, as an active member. The Secretary read a paper on "Micrometry."

The following resolution, proposed in this paper, was carried:

"*Resolved*, that the New York Microscopical Society approve of the resolutions adopted by the National Microscopical Congress, at Indianapolis, August 17th, 1878, making the 1-100 mm. the standard for micrometry in the U. S., and recommend the same unit for universal use."

The Corresponding Secretary was directed to communicate with the various societies, informing them of this action, and requesting their sanction for the efforts of this society to secure an universal standard of micrometry.

Mr. Whitehead opposed the plan suggested in the paper of having five standard micrometers throughout the country. He maintained that only a single true

*All observers do not admit this.

standard was possible, by which all micrometers that are to be recognized as correct must be verified. Prof. Phin discussed the subject of fine ruling, and stated that the difficulty in making micrometers was not in securing accuracy of spacing, but in determining the true value of the divisions of the unit. He opposed the acceptation, on the part of the society, of any standard until it had been properly verified by a proper body appointed by the society for that purpose, and said that at present we have only the statement of one man—Prof. Rogers, the maker, that the divisions of the proposed standard were true fractions of the unit. He maintained that the society should not sanction any standard until its accuracy had been verified by members from independent observations from the U. S. standards.

The Secretary maintained that while the gentleman was entirely right in saying that the society should not adopt a standard without assuring itself as to its accuracy, the proposed method of doing so was quite impracticable. He thought there was no member of the society sufficiently experienced in making minute measurements, or familiar with the means of dividing up a given space, to justify any such attempt on our part. Prof. Rogers had worked for years before he succeeded in accomplishing the result, and as he is a recognized authority in this matter, and a thoroughly scientific man, his results are entitled to our consideration.

Nevertheless it becomes us to verify his results by the examination of his methods and instruments, as suggested by Mr. Whitehead, and this would properly be the duty of the delegates from the five societies. After all it is not so much the exact 1-1000 of an inch or 1-100 of a mm. that we need, as it is a certain value of the divisions which we can adopt as our standard, and which shall be so nearly the exact division of our assumed unit as to be practically true. The resolutions of the Congress allowed a variation of 1-75000 of an inch in the standard measures.

Mr. Phin replied that this course would be establishing a new value for the millimeter or unit.

Mr. C F. Cox said that he could not agree with Mr. Whitehead that only one standard micrometer should be recognized, because absolute accuracy was impossible, and five or more could be made practically alike.

The five micrometers might be compared, and the average value of the divisions taken as the standard. The variation of each one from this average could then be stated. He thought the 1-100 mm. unit was too small.

Mr. Haswell drew attention to the new standard measure of Capt. Clark, which he thought would be adopted universally before long.

After some further discussion, the Board of Managers was instructed to report a plan for action as soon as it could be matured.

The difficulties in the way of carrying out the resolutions of the Congress are foreseen, but the members are in favor of giving careful attention to the subject, and will not shirk the responsibilities involved.

The Secretary then read a paper on "Oblique Illumination."

The President announced that Mr. Scott would be at the room on Monday and Wednesday evenings, to meet such members as desired instruction in mounting and preparing objects

A letter was read, addressed to the President, asking him to attend a meeting to be held in this City, October 9th, to discuss needed alterations in the postal laws.

The President was made a delegate from the Society, to attend this meeting, and the Secretary a substitute in case he could not attend.

After adjournment, the Secretary exhibited a specimen of the alga *Merismopedia convulvata*, found at Port Morris, N. Y.

THE

AMERICAN QUARTERLY

# MICROSCOPICAL JOURNAL.

Edited by ROMYN HITCHCOCK.

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Devoted to the Interests of Microscopical Study in all Branches of Science.

WITH WHICH IS ALSO PUBLISHED

THE TRANSACTIONS OF THE NEW YORK MICROSCOPICAL SOCIETY.

VOLUME I.

PUBLISHED BY
HITCHCOCK & WALL,
150 NASSAU STREET,
NEW YORK.

# The American Quarterly Microscopical Journal.

"Go forth, under the open sky, and list
To Nature's teachings."—*Bryant.*

VOL. I. NEW YORK, JANUARY, 1879. NO. 2.


## NEW RHIZOPODS.


BY PROF. WILLIAM S. BARNARD, B. S., PH. D.



(*Received Nov. 4th, 1878.*)


In studying American Rhizopods representatives of most European genera are found, and it is seldom, indeed, that a new species is discovered. This wonderfully broad distribution is probably due to their being so exceedingly small that they may be carried from place to place by moving water or air, or in the moisture on the surfaces of aquatic animals, as well as to the fact that the numerous germs, and even adult forms of many, are capable of being dried and wafted, like particles of dust, from one part of the earth to another. Wherever they chance to fall into the water, under favorable conditions, they may revive, live, and multiply.

Most Rhizopods are extremely interesting and curious, but the following genus is very remarkable.

*Echinopyxis*, Clap. et Lachm. (*Centropyxis*, Stein). Claparède and Lachmam characterize it as having "a shell furnished not only with a round opening, giving passage to locomotor pseudopods, but also with tubular prolongations open at their extremities. Through each of these prolongations can pass out a slender pseudopod, which does not seem to be of any value for locomotion." They describe the only species known as *E. aculeata* (Syn. *Arcella aculeata*, Ehr., *Difflugia aculeata*, Perty). "Diagnosis: Shell oblong, opening eccentric, like the mouth of a *Spatangus*." This genus and species, described a few years since in Europe, also exists in America, where I have observed it several times. Externally, the shell (Plate VIII., Fig. 3, *a. b.*) seems to consist entirely of agglutinated

sand-grains, and bears several (4-6) tubules near its larger end. These minute tubes have the shape of horns, but by strong magnifying power are seen to be open at (what with lower power seem to be) their points, from which very slender pseudopods are occasionally projected. Their substance appears like diatomin, and is an outward continuation of an inner lining, upon which the sand-grains are incrusted, as may be best observed on the margins of broken shells. The question arises, for what purpose are these small, spiny tubes? They probably serve as spines or bayonets for weapons of defence, as do the diatom shells I have observed fixed erect upon the shell of another species of rhizopod, probably *Difflugia bacillariarum*, Perty, but it is likely that they also serve some other purpose not now understood. Besides this, I have studied, in this country, several specimens representing two well-marked new species as follows : *Echinopyxis tentorium*, nov. sp. (Plate VIII., Fig. 1, *a. b.*). The test conical with a concave base, and bearing one tubule on its apex ; opening subcentral. Its only decidedly specific characters belong to the shell, which presents the general form of a tent, or inverted funnel, and is so opaque that nothing can be seen of the amœboid animal within, except its pseudopods, which are sometimes, though seldom, extended from beneath, serving especially for locomotion and prehension. Also, a delicate plasmic point is occasionally projected from the single tube above. Specimens of this species are found on the muddy and sandy bottoms of creeks and ponds in New York. *Echinopyxis hemispherica*, nov. sp. (Plate VIII., Fig. 2). Test hemispherical, depressed ; tubules several (3-7), more or less elongated and crooked, with large distal openings ; the main aperture subcentral. This form is found also on the muddy and sandy bottoms of ponds and creeks in the same locality. The

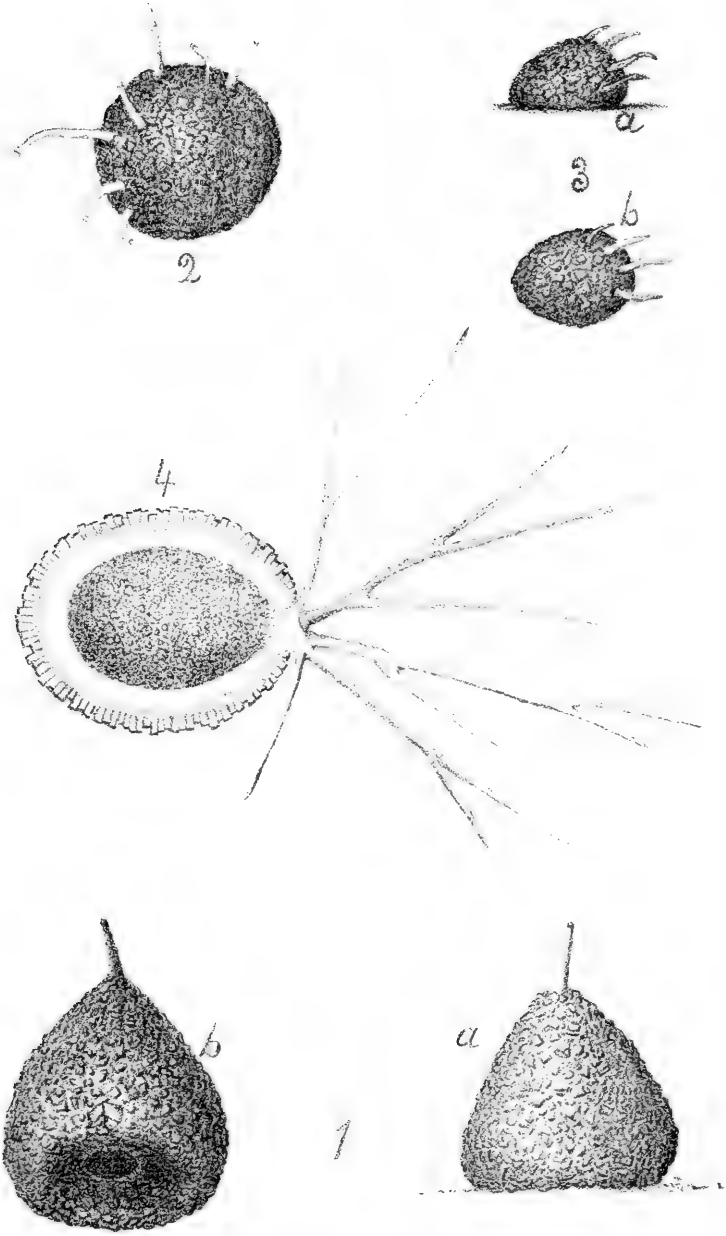
DESCRIPTION OF PLATE VIII.

Fig. 1. Test of *Echinopyxis tentorium; a*, elevation view, *b*, showing pseudopodal orifice in concave base × 450.

Fig. 2. Test of *E. hemispherica* as seen from above, showing seven hollow tubules, one with pseudopodi projecting × 450.

Fig. 3. Test of *E. aculeata ; a*, lateral, *b*, dorsal view, showing four hollow horns × 200.

Fig. 4. Sectional view of *Euglypha tegulifera*, with its protoplasm, pseudopods, nucleus, and nucleolus, granulus, etc.


2
a
3
b
4
b
1
a

irregular or variable number of tubules is probably due to the fact that sometimes one or more become accidently broken off. If we admire the instincts of birds and bees, and wonder that such low animals as tubiculous worms can construct for their protection encasements of united particles of sand, how much more marvelous is it that we find organisms so low as the amœba, almost structureless masses of living protoplasm, endowed with this wonderful, inherited habit of constructing artificial houses for themselves!

Another admirable exhibition of Rhizopod architecture is shown in the genus *Euglypha*, to which I shall add one new form.

*Euglypha tegulifera*, nov. sp. (Plate VIII., Fig. 4). This is a beautiful little Rhizopod, and is characterized by a peculiar and interesting shell. It occurs among fresh-water Algæ, as I have seen it in New York, with an ovoid test, glistening in strong light from the effect of a layer of crystalline blocks of unequal height, which pave the external surface. The inner homogeneous capsule upon which the pavement lies, is quite thick, exhibiting the color of diatomin, and forming a smooth (not dentate) margin about the pseudopodal orifice. Protected within this hard, rough case lies the delicate, granular, plasmic, amœboid body, which does not entirely fill the shell, but presents a large nucleus and several small vacuoles, at times extending itself outwards by long, usually branching, sometimes anastamosing, pseudopods.

From among the great number of our fresh-water Rhizopods which I have studied, and which are mostly varieties of known species, only the few above mentioned are presented because they are new.

Oskaloosa College, Iowa.

## A STUDY OF ONE OF THE DISTOMES.

BY C. H. STOWELL, M. D.

(*Received October 17th*, 1878.)

VAN BENEDEN says: "The parasite is he whose profession it is to live at the expense of his neighbor, and whose only employment consists in taking advantage of him, but prudently, so as not to endanger his life. He is a pauper who

needs help, lest he should die on the public highway, but who practices the precept not to kill the fowl in order to get the eggs. It is at once seen that he is essentially different from the messmate who is simply a companion at table. The beast of prey kills its victim in order to feed upon its flesh: the parasite does not kill; on the contrary, he profits by all the advantages enjoyed by the host on whom he thrusts his presence." Again: "Every animal has its own parasites, which always come from without. With some few exceptions, they are introduced by means of food or drink."

This gives us a better idea of a parasite than any single definition that could possibly be given.

They are animals:—

1. Entirely dependent on other animals for support.

2. They do not usually reproduce themselves in the animal which they inhabit.

3. They may locate themselves in any organ of the body, having been found in the brain, spinal cord, eye, ear, heart, blood, &c.

4. They vary in size; some requiring the microscope to reveal their presence, while one has been reported to have a length of three thousand feet.*

5. They may exist in great numbers in one individual. Prof. Berthold, of the University of Göttingen, in a memoir on the abode of parasites in man, says that a case was reported in 1699 where a boy twelve years of age voided 164 millipedes, 4 scolopendræ, 2 living butterflies, 2 worm-like ants, and 32 brown caterpillars. Two months later he voided 4 frogs, several toads, 21 lizards, and sometimes a live serpent was seen for a moment at the bottom of his mouth. Van Beneden remarks: "Happily for science, we do not see such things seriously related in books at the present day." He says that sixty millions of eggs have been counted in a single nematode, and in a single tape-worm, or rather in a colony, even a thousand millions of eggs.

6. They inhabit every part of the globe.

7. As a rule, they are not hurtful; an excess *is* hurtful.

It is said that the Abyssinians never take medicine when they have Tæniæ, being in a better state of health at that time.

---

**Tænia solium.* Reported at the Academy of Copenhagen.

Yet in Iceland, a cestode causes the death of the third part of the population, and we are all aware of the excitement Trichinæ have produced.

8. They are not easily killed. Some can be dried completely and returned to life by moistening. Eggs preserved for years in alcohol, chromic acid, and other destroying agents bring forth embryos when placed in proper surroundings, such as water or damp earth.

9. They have a great tendency to roam; "Migration is the very soul of their prosperity."

The parasite under consideration is found in the bladder of the frog; and in order that we may understand the position he holds among the Helmintha, we append the following standard classification:

| | | | | |
|---|---|---|---|---|
| Helmintha | Sterelmintha (*Sub-Class I.*) | Turbellaria (*Order I.*) | Entozoa. |
| | | Trematoda (*Order II.*) | |
| | Cœlemintha (*Sub-Class II.*) | Nematoda (*Order III.*) | |
| | Anenterelmintha (*Sub-Class III.*) | Acanthocepala (*Order IV.*) | |
| | | Cestoda (*Order V.*) | |

The first sub-class is characterized by having solid or hard bodies; the second, by having hollow or cavitary bodies; and the third, by not being provided with an intestinal canal.

The Sterelmintha, we see, are divided into two orders:

1. Turbellaria, having ciliated epithelium covering the entire body, and receiving their name because of the peculiar rotatory motion communicated to the water as they swim through it.

2. Trematoda, which, as their name suggests, are characterized by certain holes or pores.

It is to the latter order that we must give our especial attention. They are, as a rule, visible to the naked eye, ranging from .25 mm. to 6 and 8 centimeters in length. Thus viewed, there is nothing about them to attract attention; but upon closer examination, bringing the microscope to our aid, we are astonished at their beauty and the complexity of their organization. They are not parasitic during their whole lives, for we find them at certain periods of their existence inhabiting low, moist grounds, and open waters. There are about 400 species, yet rarely are they found in man or monkeys. None have

been discovered in the lion or tiger, and only two in the cat: one for the domesticated, and one for the wild state. They exist quite abundantly in bats, reptiles, and fishes, and display great partiality for frogs and toads.

The order is easily classified, as follows :

| | | |
|---|---|---|
| Trematoda | Monostomidæ, | Family I. |
| | Distomidæ, | " II. |
| | Tristomidæ, | " III. |
| | Polystomidæ, | " IV. |
| | Gyrodactylidæ, | " V. |

The first three families are so named because they have respectively one, two, and three suckers ; or, as was formerly supposed, "perforated mouths."

In the fourth family a particular number of suckers need not be insisted on, while the fifth family are characterized by having peculiar hooks around the posterior disk.

Plate IX., Fig. 1, represents a distome from the bladder of a frog. This animal, visible to the naked eye, can be readily obtained, and but few frogs will be sacrificed in vain.

The first thing noticed is its smooth integument, composed of muscular substances, always of the non-striated or smooth variety.

At the anterior extremity is the anterior or cephalic sucker (*A*), perforated at the bottom (*C*), which represents the oral cavity. A little posterior to this is a larger sucker called the posterior sucker, or acetabulum (*B*). This is not perforated, being used as an organ of locomotion, or as an anchor.

The oral cavity (*C*) enlarges to form the pharynx (*D*), to be continued into the œsophagus (*E*), which divides into two long blind tubes (*F*) extending nearly the whole length of the body. At *G* are seen little granular masses, doubtless food.

In order to study our distome in its native element, it was examined while resting on the exposed inner surface of the bladder of the frog. While thus situated, a blood-corpuscle (*H*) was seen to pass into the oral cavity, and by watching its course, the blind stomachs were traced quite satisfactorily. When the body was active, it would be driven toward the blind end of these tubes ; but as soon as motion ceased, and the body was comparatively quiet, then the corpuscle would invariably be driven to the pharynx and there remain till

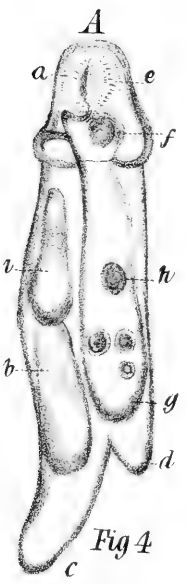



Fig 4

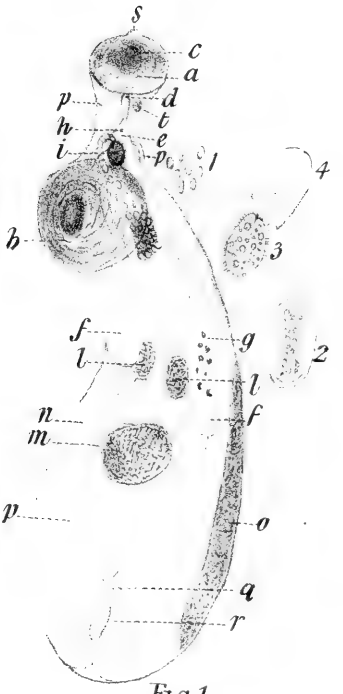



Fig 1

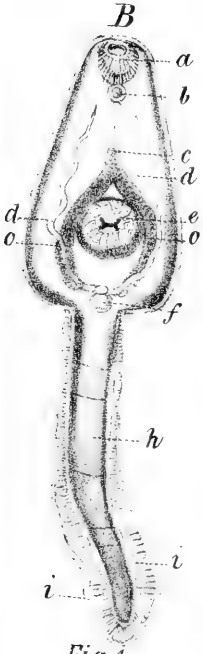



Fig 4

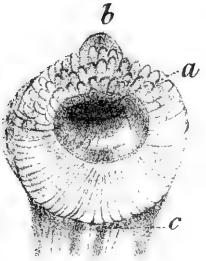



Fig 3

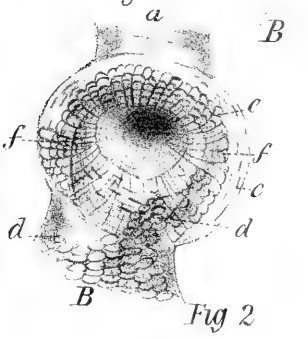



Fig 2

pushed down again. Although watched for some hours it did not get past the pharynx, neither did it appear to suffer any change.

The small body (*I*) situated immediately in front of the posterior sucker is the opening of the reproductive organs. It communicates with a long, tortuous tube (*K*), strongly colored and filled with ova. This is the greatly elongated uterus. The whole of the body posterior to the acetabulum is occupied by this long uterus, which is filled with thousands of ova in various stages of development, purposely omitted in the drawing that other parts may appear the more distinct. With this exception, the drawings represent the object as actually seen.

Our investigations lead us to conclude that the uterus is lined with epithelium of the ciliated variety.

Directly behind the acetabulum are two bodies, the testes (*L*). Still more posteriorly, on the median line, is a large, irregular body—the ovary (*M*)—and passing off from either side a narrow, slender tube, seen in this case only at the left side (*N*). These tubes connect the ovary with a long, glandular mass, situated at either side of the body. These are the yolk-forming glands (*O*), seen well in this specimen.

Owing to the great number of ova, the one on the opposite side was hidden from view. Lastly we have the true excretory and water-vascular system (*P*). This is composed of two long, slender tubes, which coalesce in the median line to form the sigmoidal duct (*Q*), which suddenly enlarges to form the contractile vesicle (*R*). We see that one of these tubes crossing the acetabulum turns back upon itself just behind the anterior sucker and terminates in a small indefinite point.

The little projection (*S*) from the cephalic sucker has all the appearance of being an organ of prehension, serving the same purpose to this animal that the tongue does to the frog. Such, however, is not the case, for it is used as a lancet to pierce the parenchyma of the animal it infests, and thus open a passage for the whole body to enter. If our distome is slightly compressed, or in any way made uncomfortable, this organ is thrust out suddenly at about the distance represented in the cut, to be as suddenly withdrawn, over and over again. A careful examination reveals the fact that this lance does not come from the mouth, but from the dorsal surface

at a point nearly opposite. Examined after death it is nearly always found protruding. It is easily seen with a 1-in. objective, and studied profitably with a $\frac{1}{5}$-inch.

Has our distome a nervous system—any special sense? The demonstration of anything like a nervous system has entirely failed in our hands. It was supposed that the pigmentary spots just below the cephalic sucker represented at *T* were eyes, but most authorities hold to the opinion that they are simply an aggregation of pigment cells.

The digestive apparatus is exceedingly simple. The food enters the mouth at the base of the cephalic sucker, and, passing through the pharynx and œsophagus, enters the blind intestinal tubes.

The circulation of a colorless fluid containing granules, appears to be due to the general contractions of the body and walls of the vessels, yet one is surprised at the regularity of the oscillations. A complete oscillation occupied seven seconds. This was true at one examination for eleven consecutive oscillations. The oscillations were not so regular in all cases. Some specimens did not present them at all, while the time in others varied for each oscillation from four to thirteen seconds.

Fig. 2 represents the posterior sucker magnified 1000 diameters and reduced. We see two sets of fibers covering the body, the one longitudinal and the other circular. These are very intimately blended in some parts of the body ; when not so, the circular fibers constitute the outer layer. Around the border we notice the longitudinal fibers, showing their nuclei very distinctly (*C*).

Toward the bottom of the sucker the circular fibers are greatly in excess (*E*). The center looks perforated, but the dark color is due to the close and compact fibers stained here with carmine. This center is never seen to open and close as does a similar point in the cephalic sucker. Neither are foreign bodies ever seen to enter it. At this point it is imperforate, and owes its appearance to the mechanism of its fibers. The peculiar arrangement of fibers at *F* is very strange and difficult to describe. At the right is a diagrammatic section of these fibers. They are bundles of smooth muscle-fibers with one end (*B*) attached at the bottom of the sucker, while the other terminates in a free, rounded, blunt point. They appear to lie beneath the two sets of fibers composing

the general covering of the body. A multitude of these bundles united surround the sucker, and when the animal is active they extend out, at nearly a right angle with the long axis of the body, and thus come very much nearer the center of the sucker than here shown. In fact, in some cases they appear to meet completely, and the whole sucker seems made up completely of these bundles. The cut shows these fibers relaxed and flattened, a result of death and manipulation. The fibers of this sucker are so arranged that when applied to any soft surface they must, during their full action, tend to create a vacuum in the center, thus serving as a hold-fast or anchor to the body.

The cephalic sucker (Fig. 3) is similar to its fellows in construction, only it is perforated, and has the addition of the lance (*B*). We recognize the well developed fibers forming the walls of the pharynx at *C*. When our distome desires to move from place to place, the acetabulum becomes fixed, and by the contraction of the circular fibers between it and the anterior sucker, the distance between them is increased, this part of the body being reduced to one-half its former transverse diameter and increased accordingly in length; thus the cephalic sucker is pushed ahead. Now it, in turn, becomes fixed by a mechanism precisely like that of its fellow. The acetabulum and the fibers relax their hold and the body is drawn up a distance of nearly one-fifth the length of the animal. While the acetabulum is fixed that part of the body in front of it will swing from side to side, showing the greatest degree of contractility.

One will very rarely fail to see the distome casting its eggs. It is a most beautiful and instructive sight. It can be seen sufficiently well with a ¼-inch objective, with the process of segmentation going on.

Fig. 1,[1] represents these eggs as they appear when first cast off. By the general contractions of the body, aided by the cilia at the upper part of the uterine tube, these eggs are thrown off, usually three or four at a time, to be followed in a few seconds by as many more. At a single examination over two hundred were cast off, yet to all appearances as many were in the body as before. Some of these eggs should be removed to a very shallow cell, normal saline solution added, and high powers employed, and the process of

segmentation carefully studied. The ova vary in size, but are quite uniformly oval in shape. At the right of Fig. 1 are some of these ova magnified 1000 diameters and reduced. One is undergoing segmentation (Fig. 1, [2]). This will keep contracting and expanding rapidly, each contraction making the center narrower and narrower, until separated completely into two parts, each part whirling about at a terrible rate. The embryo ([3]) has just left its covering ([4]), an appearance obtained by pressing gently on the cover-glass, causing the rupture seen here and the escape of the embryo. The embryo at [3] was from the distome at its left, and in shape is not unlike a jug. It is covered completely with ciliated epithelium. These cilia are very active, and, as a result, the body revolves on its axis at a high rate of speed. Their motion is so rapid that with high powers it is exceedingly difficult to keep them in the field. Evidently they have no idea where they are going, for they will strike some obstruction with force sufficient to give them a considerable rebound, when for a moment they will remain perfectly quiet, only again the next moment to go whirling about. Examined closely we see the commencement of a cephalic sucker.

After a time this embryo develops in its interior another organism, a sporocyst (Fig. 4, upper figure, after Cobbold). At first the appearance of this sporocyst is very simple, having a faint semblance of a head, body, and a short, straight tube for a digestive canal. The figure represents the sporocyst in an advanced condition. There is a well-developed head and body, with a very prominent tail (*c*). We see an oral sucker in front (*e*), communicating with the bulb of the œsophagus (*f*), which passes directly into the blind digestive tube, or stomach (*g*), which contains here particles of food (*h*). At *b* and *i* are irregular bodies which will develop into organisms called cercariæ. After their more complete development and escape from the sporocyst, we have the appearance given in Fig. 4 (lower figure). Here we have no difficulty in recognizing the several parts. The cephalic sucker (*a*) is plainly seen with the pharynx (*b*) communicating with the œsophagus (*c*). The digestive tubes or stomachs (*o*) are seen, also the posterior sucker, or acetabulum (*e*). The water-vascular and excretory system (*d* and *f*) are here shown. The tail (*h*) is prominent, and has a marginal fringe (*i*).

The cercaria now loses its tail and becomes encysted,* either on or within the body of some mollusk or aquatic animal. This is known as the pupa condition. In this state it passes into the stomach of some higher animal, where it loses its covering and acquires all those organs which entitle it to be called a sexually mature distome.

Thus we see the embryos, as they escape from the eggs, are not at once transformed into individuals like their parents, but they in turn produce other larva-like forms, capable in their turn of producing still other larvæ, which alone resemble the parents. This form of development is called "Alternate Generation." As we have seen, the embryos are sometimes developed before the eggs are cast, and, indeed, may escape from the eggs while they are still within the uterus.

Physiological Laboratory,
University of Michigan.

## ON THE PROBABLE ERROR OF MICROMETRIC MEASUREMENTS.

BY EDW. W. MORLEY, M. D., PH. D.

(*Received Nov. 29th, 1878.*)

To some of the readers of the QUARTERLY MICROSCOPICAL JOURNAL it may be interesting, or possibly useful, to have an estimate of the degree of accuracy attainable in those micrometric measurements demanding the highest precision. The statements in this article apply directly only to measurements of objects fulfilling certain conditions; they would not apply rigorously to the measurement of anything but fine, straight lines ruled on a transparent medium, and viewed by transmitted light.

Professor William A. Rogers and the writer have made numerous measurements of the intervals between lines ruled on glass plates; the object being to see how near the professedly equal spaces were to actual equality. Care was taken to make our results absolutely independent of each other's work, by keeping ourselves in absolute ignorance of each other's results. Professor Rogers has examined the question pro-

*It is supposed these cysts are formed by means of a special, secreting organ, with the help of the epidermis.

posed for this paper by comparing the results of two independent observers. The writer made many measurements in duplicate, in order to examine the same question by comparing the independent results of the same observer.

The measurements made for this purpose are one hundred and twenty-three in number. Twenty-three were made with a glass of one inch nominal focal length, whose real focal length is eighty hundredths of an inch. The other measurements were made with a glass called a quarter-inch, whose real focal length is twenty hundredths of an inch. The micrometer used was a cobweb micrometer, by Troughton & Simms. It has two movable wires; the heads of the screws are divided into one hundred parts, and were commonly read to the fourth part of a division. The screws have threads of about one hundred and three to the inch.

Care was taken to keep the distance between the objective and micrometer constant, by not moving the fine adjustment of the microscope. Before noting measurements, preliminary measurements were made until it was thought that parts of the instrument, warmed by the approach of the observer's person, had assumed a new equilibrium. Great care was taken that the second of two measurements of the same space should be free from any influence of bias in favor of the value found by the first. When the two measurements were made with no other measurements intervening, the heads of the micrometer screws were disturbed at random, and were not seen again until the contact between the wires and the images of the lines had been finally established; and the result was, in all cases but one, set down with no correction or modification whatever, either of the second or of the first result. Since there is scarcely any room for supposing that any bias would affect the reading of the screw heads to the fourth part of a division, it is difficult to see why two results thus obtained are not, substantially, as independent as would be the results of two observers, sitting in succession at the same instrument, and possessed of the same habits of observation, but ignorant of each other's results.

When the lines measured were such as to give a sharply defined margin with the power used, the wires of the micrometer were brought gradually nearer the right-hand margin of the two lines, until the bands of light, left intervening be-

tween the wires and the images of the lines, were reduced to the least distinguishable quantity, and were as nearly as possible equal. With some of the sets of lines, contacts made in this way could be reproduced almost identically. But the margins of some lines, especially with the higher power, appeared of a character which did not permit the same degree of accuracy to be obtained in this way.

In most cases, therefore, especially with the higher power, another method was employed for making contact between the wires and the images of the lines. The image of a furrow cut in a glass plate shows two dark bands with a lighter intermediate band. These bands present various appearances according to the depth of the furrow in the glass, and according to the different optical circumstances under which they are examined. The wires of the micrometer were placed on the lighter central bands of the two lines in hand, and then brought nearer to the left-hand darker bands until the least visible strip of light remained between the wires and the dark bands.

In case of the intervals measured with the inch object-glass, the micrometer screw-heads were, in all cases, read to the fourth part of a division. Each interval was measured twice. The following table gives, in the first column, the difference between the two readings of each pair in ten-millionths of an inch; and in the second, the number of cases in which each value of column first occurred:

| | |
|---|---|
| 0 | 0 |
| 17 | 7 |
| 34 | 4 |
| 52 | 3 |
| 69 | 3 |
| 86 | 4 |
| 103 | 2 |

Taking the square root of the mean square of these differences, and multiplying by the proper factor, we obtain the probable difference of a pair of measurements, which is thirty-nine ten-millionths of an inch. It may be said that these were the first measurements of precisely this kind made by the writer, and that this probable difference of two measurements of the same interval was larger for him then than now.

In case of the measurements with the quarter-inch object-glass, twenty measurements were made for a purpose which

did not demand the reading of a quantity so minute as the fourth part of a division. The remaining eighty measurements were read to this quantity. The following table gives, in the first column, the values of the differences between each pair of measurements in ten-millionths of an inch. The second column gives the number of times each difference occurred among the eighty specified measurements, and the third column the number among the twenty. Computation will show that the probable difference of a pair of measurements among the eighty, is twenty-nine ten-millionths of an inch; and for the whole hundred measurements, thirty ten-millionths :

| | | | | | |
|---|---|---|---|---|---|
| 0 | 4 | 1 | 55 | 4 | |
| 4 | 7 | | 59 | 5 | |
| 8 | 7 | | 62 | 3 | 5 |
| 12 | 7 | | 66 | 1 | |
| 16 | 6 | 5 | 74 | 2 | |
| 23 | 3 | | 78 | 1 | 2 |
| 27 | 7 | | 86 | 1 | |
| 31 | 4 | 2 | 90 | 1 | |
| 35 | 8 | | 94 | 1 | 2 |
| 39 | 3 | | 98 | 1 | |
| 47 | 2 | 3 | 101 | 1 | |
| 51 | 1 | | 105 | 1 | |

Whether the smaller probable difference, obtained with the object-glass of shorter focus, shows that the greater amplification is better suited to accurate measurement, is a point on which the writer has not formed a decided opinion. Two or three years ago he obtained smaller probable errors with the inch object-glass than with the quarter; but the experiments made to determine which should then be used for a given purpose were few in number. He has inclined to the belief that the greater accuracy of the later series was, more probably, not due to instrumental causes.

From the probable difference of a pair of measures the probable error of a single measure may be deduced by multiplying the former quantity by the square root of one half. The propriety of this may be seen by observing that, since the spaces measured in each series were professedly equal, the differences in each column may be considered to be the differences between two measurements selected from a number of measurements of the same space in pairs, one as much greater as the other is less than the mean of this number of measurements. Half of each difference would be the difference of a

single measurement from the mean of the whole; from which it will be seen that the probable error of a single measurement would have to the probable difference of a pair the ratio of unity to the square root of two. The probable error, therefore, of a measurement made with the inch object-glass, of a space easily contained in its field, is twenty-eight ten-millionths of an inch; and the probable error of a measurement made with the quarter-inch object-glass is twenty-two ten-millionths of an inch.

HUDSON, OHIO.

## STANDARD MEASURES OF LENGTH.

BY PROF. W. A. ROGERS.

(*Received December 10th, 1878.*)

THE statement on page 10 of the last number of the Journal (*Transactions*) gives me a larger share of credit in the production of a standard micrometer than is my due. It may be true that I have attacked the problem of a standard inch and a standard centimeter in a way somewhat different from that usually pursued, but others have precisely the same means of solving the problem as I have. First of all, Dr. Edward Clark, of the U. S. Coast Survey, has access to the originals from which my yard and meter-bars were constructed; he has had long experience in measures of precision, and has abundant facilities for executing the work.

What is needed in the determination of an aliquot part of a true standard, is a good comparator, suitable both for long and for short measures of length. Instruments of this character are to be found at Johns Hopkins University, at the University of Pennsylvania, at Princeton College, at Stevens Institute, Hoboken, and Mr. Chapman of New York has recently constructed one to facilitate the pendulum researches of Mr. C. S. Pierce, of the U. S. Coast Survey. There is also a well-mounted instrument at West Point, by Grunow, but it is for end measures only.

It may be that others besides myself have given attention to the important problem of obtaining a centimeter which is exactly one one-hundreth part of a true meter at a given temperature. It would certainly be very desirable if several investigators could take up this problem independently. But

however different the methods of investigation employed, all must ultimately reach precisely the same results, and the several centimeters obtained must necessarily be comparable at the same temperature within certain very narrow limits, for there is but one particular meter-bar recognized as a standard through the world; viz., the platinum bar in the archives of Paris.

It has been suggested, that since the more recent investigations of Clark and Schubert have shown that the meter of the archives falls short of its definition by one fifty-four-hundredth part of its definition, it is probable that the new value thus found will come into extensive use, but the attempt to make the meter correspond to a natural unit has been deliberately abandoned, and the International Metric Commission, the only authority having the sanction of international law, has resolved that the particular platinum bar in the archives of Paris, at 32° Fahrenheit, shall be perpetuated forever as the original unit of length, without regard to the doubtful questions which have been raised concerning its correspondence with the natural unit from which it was first constructed.

Our problem then becomes a very direct one. First, we must obtain a copy of the entire length of the meter of the archives. If the comparison is made at a temperature differing from 32°, we must know the law of expansion of the particular meter-bar on which the graduations are made. Having the entire meter, the problem of its subdivision into equal parts is one in which different investigators would follow different methods, but, as I have already said, all must ultimately reach practically the same results.

The method which the writer has pursued is described in the article on two forms of comparators for measures of length.*

As there seems to be considerable confusion as to what properly constitutes a standard, it may be well to say that every measure of length, claiming to be a standard, must conform to the following conditions:

(*a*) If the unit chosen is a centimeter, then the distance between the end lines must be exactly one one-hundredth part of the meter of the archives at 32°, and for any other temperature it must be exactly one one-hundredth part of the meter of the

* To appear in the April number of this Journal.

archives reduced to that temperature by the known coefficient of expansion. (*b*) The subdivisions of the centimeter must be sensibly equal.

As a perfect test of the homogeneous character of the subdivisions, I offer the following scheme as a check :

| The distance from | | | The distance from |
|---|---|---|---|
| line 1 to line | 2 | = | line 101 to line 100 |
| line 1 to line | 3 | " | line 101 to line 99 |
| line 1 to line | 4 | " | line 101 to line 98 |
| ..... | ..... | | ..... ..... |
| line 1 to line | 101 | | line 101 to line 1 |

It will be seen that this test, with the exception of one particular curve, completely covers the case of periodic or accumulated errors, and it is precisely this class of errors which require the most careful investigation.

The problem of the subdivision of a given unit into exactly equal parts, is an extremely difficult one, as the many failures the writer has made will abundantly testify.

With the experience which I have had, I can hardly agree with the remark of Mr. Beck on page 310 of the *Proceedings of the Royal Microscopical Society*, that there would be no difficulty whatever in obtaining scales ruled according to a uniform standard. I have a large collection of micrometers by different makers, both at home and abroad; I have standards by Froment and Brunner, of Paris, and Merz, of Munich ; I have transfers from every well-known precision-screw in this country, including such makers as Buff & Berger, of Boston ; Clark, of Cambridge ; Brown & Sharpe, of Providence ; Rutherford, of New York ; Clement, of London ; Salleron, Bianchi, Froment, and Perreaux, of Paris. The investigation of these transfers is not yet quite completed, but I feel safe in saying that no two of them agree at a given temperature, and the errors of subdivision are, in many cases, very large, and in all cases easily measurable. Of the micrometers made abroad, the best I have seen are by Powell and Leland. They are superbly ruled, and the errors of subdivision are much less than usual, but in the two plates measured the unit was found to be nearly 1½ *per cent.* too long.

By the kindness of Professor J. E. Hilgard, Assistant in Charge of the U. S. Coast Survey, I obtained the opportunity of comparing the unit of my own screw with the Brunner

standard centimeter, which has, for some years, been adopted as a standard, solely upon the reputation of the maker. Since I found the two centimeters almost identical in their entire length, I too hastily adopted the conclusion that my own screw must be nearly correct. It turns out that neither is correct at 69° Fahrenheit. They are both too long at the temperature at which the U. S. Coast Survey meter is standard. The Brunner plate is nearly free from periodic errors, but the accidental errors of subdivision are large. In another standard by Brunner, I found the first mm. to differ from the last mm. by one twelve-hundredth of a centimeter.

Of the transfers from precision screws, of course the magnificent graduations of Rutherford stand easily first. It is utterly impossible to detect any errors in the single spaces of his diffraction gratings, but it is not difficult to measure the residual accumulative errors from his screws. After him, and since early in 1878, far ahead of all others, stand Brown & Sharpe, of Providence, in point of accuracy in subdivision. Of foreign standards, the disagreement between the standards of Brunner and Froment is very marked. The value of the centimeter which I have obtained, corresponds more nearly with that by Froment. I ought to say, however, in justice to these makers, that the temperature at which the plates are standard is not given, at least I have been unable to obtain it. It may be useful to illustrate the degree of accuracy attainable abroad in the subdivision of the entire meter.

In the following table are given the errors of the standard meter of the Central Physical Observatory of St. Petersburg as determined by the Director, Professor Wild, with a vertical comparator of his construction. The quotations were made by Herman and Pfister, of Berne. A positive correction indicates that the space measured is too short, a negative that it is too long :

DECIMETER DIVISIONS.

| SPACE. | CORRECTION. | SPACE. | CORRECTION. |
|---|---|---|---|
| 1 | +.0179 mm. | 6 | +.0156 mm. |
| 2 | +.0106 | 7 | −.0011 |
| 3 | −.0091 | 8 | −.0187 |
| 4 | −.0041 | 9 | +.0223 |
| 5 | −.0177 | 10 | −.0097 |

CENTIMETER DIVISIONS.

| FIRST CENTIMETER. | | LAST CENTIMETER. | |
|---|---|---|---|
| SPACE. | CORRECTION. | SPACE. | CORRECTION. |
| 1 | +.0024 mm. | 1 | −.0109 mm. |
| 2 | +.0042 | 2 | −.0057 |
| 3 | +.0006 | 3 | +.0069 |
| 4 | −.0053 | 4 | +.0017 |
| 5 | +.0011 | 5 | +.0017 |
| 6 | −.0008 | 6 | +.0013 |
| 7 | −.0053 | 7 | −.0069 |
| 8 | +.0107 | 8 | +.0061 |
| 9 | −.0010 | 9 | −.0046 |
| 10 | +.0115 | 10 | +.0017 |

MILLIMETER DIVISIONS.

| | | | |
|---|---|---|---|
| 1 | +.0023 mm. | 6 | −.0010 mm. |
| 2 | +.0010 | 7 | −.0056 |
| 3 | +.0013 | 8 | +.0072 |
| 4 | +.0075 | 9 | +.0035 |
| 5 | −.0069 | 10 | −.0048 |

It will be seen, from this brief account, that the construction of a true centimeter at a given temperature is by no means an idle or a useless problem. In fact, it has become a necessity.

It will also be seen from what has been said, that even *an absolutely perfect screw cannot be taken as a standard.* Hence, the proposition of our friends abroad to depend upon a Whitworth screw, carefully kept in the custody of the Royal Microscopical Society, is hardly feasible. A screw is not in itself, a standard, and it cannot be so taken. It is simply a tool to facilitate the subdivision of a given unit. Even if there were no other reasons, the changes effected through temperature would be fatal to its use as a standard, for there are no means of measuring these changes with sufficient precision. But there are other conclusive reasons, which forbid the use of a screw for a standard. In a paper on the sources of errors in micrometer screws, which I hope to publish presently, I expect to show:

(1) That the errors which belong to a given screw, reside, for the most part, in the mounting of the screw, rather than in the screw itself. Hence, if a screw is dismounted, or if any change is made in the adjustment of the mounting, either arbitrarily or by the action of temperature, the screw practically undergoes a change of pitch.

(2) That the periodic errors of a screw, especially those which are a function of an entire revolution, vary with the temperature.

(3) That every screw which acts against springs, in which oil is used as a lubricant, has a variable pitch.

The first named of these conclusions has been variously criticised, notably, and I may add, somewhat ungraciously, by Mr. Webb of London, but it is true, nevertheless. I have no taste for the style of discussion in which Mr. Webb indulged, otherwise, I should have made some reply to his criticisms. Instead, I began anew the experiments on which the conclusion was founded, thinking I might, after all, have been mistaken. This is not the place for a discussion of this point, but I will give one illustration. In seeking for the errors of the screw of my comparator for short lengths, Mr. George Clark, the maker, dismounted and remounted it nine times. In every case, different values were obtained in measuring the same space, which in this instance was one-fourth of an inch. The difference between the greatest and the least values amounted to over one two-thousand of an inch.

This communication is already so long that I have room only to add a word in reference to the unit recommended by the late Congress at Indianapolis. The real unit must of necessity be the meter. Granting this, it is simply a matter of taste whether one shall say 1 mm., .1 cm., or .01 dm. It is, however, desirable to be uniform in our practice. I am decidedly in favor of one centimeter as the unit, thus following more closely the analogy of the English custom with respect to the inch, but it will probably be better to adhere to the continental practice if that can be ascertained.

HARVARD COLLEGE OBSERVATORY, December, 1878.

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TRICHINÆ IN PORK. Messrs, Belfield and Atwood, of Chicago, have been engaged in making some examinations of the pork found in the Chicago markets. The samples were furnished by the health officers, and a report of their results was lately published in the local papers. In the examination of one hundred specimens, eight were found more or less infested with the parasite. These gentlemen have also experimented with various agents with a view to destroying the vitality of the worm during the process of packing the meat. Sulphurous acid appears to be very efficacious in killing the worms, and may be found applicable for this purpose.

# ON THE FISSURE-INCLUSIONS IN THE FIBROLITIC GNEISS OF NEW ROCHELLE, N. Y.*

BY ALEXIS A. JULIEN.

(*Received December 14, 1878.*)

It may be well to precede a discussion of so special a subject, by a brief review of the phenomena ordinarily presented

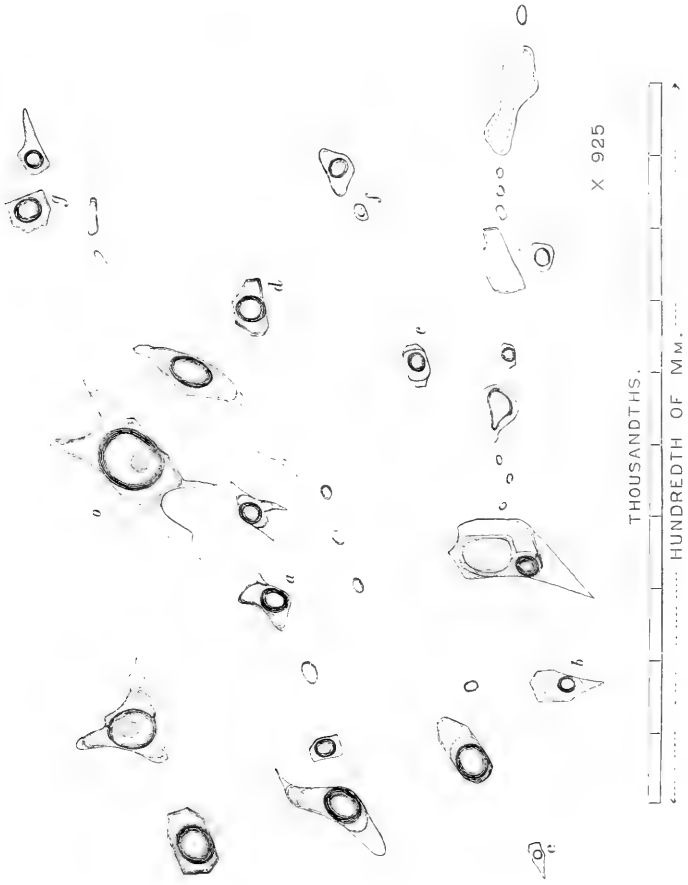


FIG. 2.

*Read in substance before the New York Microscopical Society, June 11, 1878.

by fluid cavities, as well as of certain conclusions accepted by lithological authorities, which seem to require some modification in view of the facts presented by a study of this gneiss.

The term "inclusion" is applied by micro-lithologists to the minute and merely accessory bodies which are enclosed in the mass of an otherwise pure, crystallized mineral or homogeneous rock, and which seem, in most cases, to have been caught within its material during the process of crystallization.

Macroscopically (*i. e.* in a form sufficiently large to be visible without the aid of the microscope), many of these bodies are very familiar to every mineralogist as granules, films, and tiny crystals (*e. g.* the magnetite and ochre in the interstices of hornblende, the acicular needles of rutile in quartz, the scales of specular iron in aventurine feld-spar, etc.,) and as large cavities (*e. g.* those holding water in the crystals of quartz, calcite, etc.); to every geologist in the globules and veins of glass or obsidian enclosed in many lavas; and to every chemist in the mother-liquor caught up during the crystallization of salts. But it is only beneath the microscope that the extreme abundance of these bodies in all crystallized substances can be recognized, and their identity, characteristics, and significance satisfactorily determined.

In thin sections of all minerals sufficiently translucent to admit of this kind of investigation, whether in isolated crystals or in those irregular and generally crystalline aggregates that we call rocks, these inclusions are constantly found, and account in part for the perplexing inaccuracy and variation of many skillfully made chemical analyses, and in part for certain physical characteristics, such as decrepitation, opacity, color, variations in specific gravity, etc.

The one class which will be discussed in this paper, fluid-inclusions, often abound in gems, such as beryl, topaz, sapphire, ruby, etc., and even affect their translucency; and the charm of their study in this delightful material, by such investigators as David Brewster, Sir Humphrey Davy, H. C. Sorby, and in this country Isaac Lea, has exerted considerable influence on the careful attention which has since been given to their occurrence in all mineral forms, by investigators like Vogelsang, Zirkel, Rosenbusch, and others. Four common varieties of these inclusions may be often seen, sometimes in the same field of view: (1) Cavities enclosing air, or a gas, distinguished by a dark but

narrow rim, and so differing from the well-known appearance of air bubbles in balsam or other liquids. (2) Cavities completely filled by a colorless liquid, or by more than one, of different refractive powers, however, than the enveloping matrix, and with sharply defined outline. (3) Cavities only partially occupied by a liquid which is associated with a bubble of gas; and (4) cavities of either of the preceding varieties enclosing crystals or particles of some solid substance (*e. g.* common salt, needles of hornblende, or tourmaline, etc.). The cavities themselves are always very minute, rarely exceeding 0.06 mm. in diameter.

They may be occasionally distinguished, at least in groups, under very low powers, but the smaller ones (in which alone the bubbles with spontaneous motion are found) can only rarely be identified under a $\frac{4}{10}$ inch objective, or, when previously selected, sometimes under a ⅔ inch ; ordinarily a ¼ or ⅛ inch objective is required for satisfactory definition. Their forms vary widely, the smaller being generally rounded—spherical, elliptical, oval, etc.—or larger and coalescing, and then far more irregular, or even angular, presenting crystalline forms.

The fluids which occupy them are confined to a small class, the liquid being generally water, or some saline solution, sometimes a bituminous liquid, and sometimes liquid carbonic acid or its solution in water. In the rocks of the Eastern U. S. this last interesting substance may be of rare occurrence, having been thus far reported only in two syenytes from New Hampshire,* but it occurs abundantly in the granites of the western territories.† The gas may be air, watery vapor, carbonic acid, or other gas.

The size of the bubble varies greatly, sometimes predominating over that of the liquid, though generally amounting to not over $\frac{1}{10}$ of its volume. When large, the bubbles may cling to one or opposite walls of a cavity, or may be compressed and flattened between them, and are generally fixed ; but even these often change their place on heating, or rotation of the stage, following the apparent lower side of the cavity. However, they often show a slow and continuous rocking or pendulous motion from side to side, as if fixed on a pivot. This

*Geol. of N. H., Vol. III., Part IV., 207. G. W. Hawes.
†U. S. Geol. Expl. of the 40th Parallel, VI., 20, 33, 44. F. Zirkel.

motion is spontaneous and exhibits itself in the most interesting and mysterious form in the more minute bubbles. Many of these appear to be in exceedingly rapid motion, dancing from side to side with an apparent velocity which often renders it difficult to follow them, and with a restless irregularity against different sides of the cavity, which has suggested a comparison with the movements of animalculæ seeking escape from a crystal prison. This rapidity is, of course, magnified in proportion to the power used, and the motion of all these bubbles is, in fact, very slow. Various explanations have been offered to account for this motion—the vibration of the microscope stand and table, the influence of heat rays or light from the mirror (as in Crooke's radiometer), the capillary attraction of the sides of the cavity, etc.; but like the molecular motion which is styled the "Brownian movement," and which in some forms it greatly resembles, it is a subject which still requires more careful study than it has yet received. In the examination of this phenomenon, skillful manipulation will be required from the observer in order to bring about the best effect, as the least change in the fine adjustment affects materially not only the sharpness of outline and apparent motion in the bubble, but the cross-section of the cavity at any moment in the focal plane of the objective.

Fluid-inclusions of all these varieties occur in many rocks; *e. g.* in the quartz-porphyries and granites, but in remarkable number in some twenty-one transparent mineral constituents of rocks, and particularly quartz. And yet the opaque minerals may also abound with them. It is an interesting fact, that the theory which ascribes the fluidity of melted lava in part to the presence of water, has been confirmed by the discovery, in thin sections under the microscope, of these liquid-inclusions in the olivine and leucite, which are found to be common, and often essential constituents of the cooled rock. In some coarse granites the quartz is so richly saturated with these cavities, lying at intervals of not over one-thousandth of an inch, that Sorby estimates their number at a thousand millions to the cubic inch (250 to a square milimeter, by Zirkel's estimate), and in some cases more than ten times as many: the cavities may thus amount to 5 *per cent.*, and their liquid contents to 1 or 2 *per cent.* of the volume of the quartz in granites according to Sorby, and to 1.8 *per cent.* in mica

schist, by the experiments of Pfaff. One of the most careful authorities, Ferdinand Zirkel, states that "there can be no doubt, that, as in the prepared thin sections, so also within mountain-masses, the same movements are going on: any block of granite contains in its quartz-grains millions of fluid-inclusions, and in numbers of these —perhaps during millions of years—the restless bubbles have been vibrating."

The position and distribution of the liquid-inclusions may vary greatly within each mineral-grain. Occasionally they are found in a crystal in parallel encircling rows, in the planes of crystalline envelopment, *e. g.* parallel to the prismatic faces of a quartz-crystal. But their ordinary arrangement and number is very irregular. Sometimes they are rare and isolated, so that but one or two may be detected in the same field. More commonly, however, they occur in cloudy masses, or in planes, which appear as rows or narrow bands, either radiating from a little central cloud, intersecting, or parallel.

The views of one of the earliest investigators, H. Vogelsang, may be understood from the following quotations,* in reference mainly to the fluid-inclusions in the quartz of the porphyries: "The water-pores for the most part are so grouped together that they appear spread out upon plane surfaces; nevertheless, the clefts really connected with them are not always distinguishable.....I consider them as cavities which in most cases have been not quite filled up with fluid by secondary injection. ....The question presented is this: if a fluid rises up or circulates through a capillary cleft by capillary force, and this cleavage-plane at the same time breaks through larger cavities, must these cavities be then completely filled with fluid by capillary force?....It ought not to be said of this explanation that it answers for all cases; especially is there probably presented in this connection....a distinction full of significance between the rocks of the porphyry group and of the granitic forms (pp. 155—156). So far as my observations go, the fluid-inclusions lie in great predominance upon cleavage-planes and are always very much smaller than the solid inclosures already considered. On the other hand, in their turn, ....the decidedly solid inclosures occur in quite the same form, distribution, and size as the fluid, and, indeed, there may perhaps be this general distinction, that the minute inclusions

*Philosophie der Geologie. Bonn, 1867.

in one and the same rock are either all glassy or all fluid. It therefore seems likely to me that in the porphyroidal rocks, the fluid-inclusions are nothing else but original glass-inclusions, out of which the glass-substance has been entirely decomposed and removed by aqueous solutions (p. 196)."

On the other hand, Zirkel* maintains that "these forms certainly do not occur, as Vogelsang considers, 'in great predominance on cleavage-planes.' It may now and then be the case that planes of the inclusions present themselves on the upper surface of the thin section as extraordinarily fine cracks; in such cases, nevertheless, the latter are certainly only secondary; the mineral bearing the inclusions is liable to fracture most easily in that direction in which its continuity is most interrupted, that in which the arrangement of its inclusions occurs;" and again he states: "In all cases we must conclude that the microscopic fluid-particles in different minerals, as well as those included in the constituents of rocks, were enclosed originally with their formation in a mechanical way."

In opposition to the theory of Vogelsang that these liquid-inclusions are cavities which have been filled by secondary injection, Zirkel further calls attention to the absence of communicating fissures, none being detected under the highest powers; the presence of bubbles in every (?) cavity of a group; the hermetical sealing up of the cavities, so that in experiment a strong heat is required to produce the expulsion of the liquid, with decrepitation; and the chemical nature of the liquids. Therefore, according to the generally accepted opinion on the subject, in all cases rocks have been formed in presence of, or under saturation by, these substances in liquid or gaseous form.

The character and identity of the liquid and gases which occupy these cavities are determined by certain chemical experiments, founded substantially upon their expulsion by ignition in a miniature glass retort, and their subsequent behavior, on introduction into a solution of some proper reagent (*e.g.* Baryta-water, for the determination of carbonic acid) or into a Geissler-tube for Spectroscopic indications.

Another simple, but important method is commonly employed for the same purpose. It is found that on warming a thin section of rock or mineral containing

*Mikr. Beschaff d. Min. u. Gesteine, p. 47, note.

these fluid inclusions, upon the stage of the microscope, changes invariably occur in the form, size, position, or velocity of motion of any bubble under observation, and in the volume of the liquid in which it floats. In fact, the relative changes in size of this drop at different temperatures, and the complete occupation of the cavity by expansion of the liquid, with a disappearance of the bubble at an observed temperature, sometimes afford an accurate and ready standard for the determination of the coefficient of expansion, etc., of certain liquids found in these cavities, and thus of their identity. For example, the temperature at which liquid carbonic acid assumes this condition, reaches its "critical point" and fills the cavity, is about 30–32° C., while with inclusions of water, or of saline solutions, which are by far more common, the section may be heated up to the point (about 150° C.) at which the hardened balsam, in which it is mounted, begins to soften, without any material change being produced in the relative sizes of the bubble and liquid. Sorby, in his well-known paper,* and after him, J. Clifton Ward, † have not only deduced from the presence or absence of cavities, and from the character of their contents—fluid, glass, or stone—whether the crystals or rocks in which they occur have been formed from aqueous solution, igneous fusion, or both conjoined; but they have availed themselves of the relative volumes of the liquid and bubble in carefully selected cavities to determine approximately the genetic conditions of their formation, temperature, pressure, and rapidity of cooling. This relationship has depended both on the temperature and on the pressure, usually enormous, under which the rocks became solidified. The coefficient of expansion of the liquid being known, and a certain probable temperature being assumed, at which the rocks in question, granites and elvan, were plastic, the amount of pressure was calculated with its equivalent in feet of superincumbent rock. This last amount was always found to be greater by 15,000 to 20,000 feet, than that indicated by the stratigraphical examination of the region, but this excess was attributed to the lateral pressure produced in the folding and crushing of the mass during its upheaval into mountain ranges.

The only purpose in the cursory review just presented has

*Quart. Journ. of Geol. Soc., 1858, XIV., 453.
†*Idem*, 1875, XXXI., 568, and 1876, XXXII., 1.

been to indicate the main facts of a field of investigation rarely familiar to microscopists, as well as the particular views of certain writers which do not seem to present a wholly satisfactory explanation of some of the following facts.

In the counties of New York and Westchester, in this state, a somewhat micaceous and fine-grained, blackish-gray gneiss occurs in considerable abundance, which possesses no physical characteristics of special importance, except the frequent concentration of quartzose aggregates of fibrolite, iron-garnet, and black tourmaline in thin lenticular seams. I have given particular study thus far to the microscopic character of this gneiss only in specimens collected from the vicinity of the town of New Rochelle, in Westchester county. Its thin section here reveals the following constituents :

Quartz predominates in colorless and angular granules of rather uniform size. Its clear material is sometimes traversed by irregular fissures and generally slightly clouded by long, straight and linear groups of inclusions (× 170); under higher power (×500) these are clearly resolved, mostly into cavities of lenticular, angular, elliptical, and circular forms filled with liquid gas, or liquid with a bubble ; the bubble in some groups is stationary, in others exhibits a greater or less mobility, from a tremulous vibration to a lively dance in every direction, many liquid inclusions with bubbles in motion being visible at one time.

On focussing at greater depths, the inclusions are found to lie mostly in planes, of which those of neighboring groups are nearly parallel, with shorter branches either connecting neighboring groups, or bifurcating, and often thinning out completely but indistinctly within a quartz field. There is the greatest variety in the numbers and distribution of the cavities within each plane. In size, they may, perhaps, average about 0.00014 mm., but they vary from minute specks, too small for measurement, up to 0.0054 mm., or larger. Their forms show a wide variation, as already described; but, although generally rounded, most of the cavities present one or more plane-faces, a straight side in cross-section, or even a distinct and sharp outline like that of a quartz-crystal, produced by negative or inverted crystallization—a form often observed by Vogelsang and others. Many of these forms, focussed at different depths, are exhibited in the drawing of a single group (Fig. 2)

near the crossing of two planes. In this, some are completely filled with liquid, many contain bubbles, and in the larger cavities which present projecting prongs, the extremities of the latter *seem* to be occupied by a second liquid. However, on the examination of several liquid-inclusions in this and other groups, by heating upon the stage to a temperature above 40° C., they were found to be little affected and to consist probably of water.

The letters, *a*, *b*, *c*, etc., are attached in the figure to those cavities in which the bubble exhibited spontaneous motion, the most rapid in the smaller cavities; in all other cavities the bubble was quiet. The motion of these bubbles was found to be entirely unaffected when the beam of light from the mirror, either by daylight or from a lamp, was strained from heat-rays by transmission through an alum-cell. In one instance, and only one, a bubble in rapid spontaneous motion was observed to suddenly stop and remain perfectly quiet, but the cause of the stop (possibly some obstacle projecting from the side of the cavity) could not be determined nor could the operation be confirmed by repetition. The longer and more irregular forms of these cavities presented their greater dimensions generally in the plane of the group.

The remaining constituents of the rock consist of a plagioclase-feldspar, in rather rare and small striated grains; light-brown hornblende, in straight blades with fine cleavages, but irregularly-rounded terminations, which pass through lighter shades of color, into the next mineral; fibrolite, occurring not only in the colorless needles but in blades and in beautiful wisps, knots, and bundles of parallel fibers, often macroscopic, seamed with cross-fractures. Under a higher power (×500) the delicate needles are also found to be sharply defined blades of the same form, with pointed terminations, which, however, are often rounded, or end abruptly in a transverse fracture, penetrating the quartz mostly in parallel bundles, but with many lying obliquely in a very irregular mesh. Many are also dislocated into a series of joints, nearly in position, like those so frequently seen in quartz-enveloped crystals of tourmaline or beryl; and there are also a large number of angular fragments and scales.

The accessory minerals observed are the greenish-brown biotite, whose transverse sections are striated and brownish-

yellow; associated and often contiguous scales of colorless muscovite; pinkish grains of garnet, dotted with colorless spherules of quartz; opaque and black granules of magnetite, and brownish-red films of iron-ochre. It was further observed in every thin section (most satisfactorily under a $\frac{1}{8}$ inch objective) that the rock is traversed by very numerous and exceedingly minute fissures, partly in planes which are approximately parallel, at least within the area of the thin section, and partly as branching cracks in an irregular network. The courses wind slightly, but irregularly, showing little or no relationship to the cleavage-planes of the minerals which they may traverse. In crossing the bundles of fibrolite needles, such a fissure is represented by a minute dark line, by interruption of the continuity of that material, with a somewhat jagged border, the fibers or blades of fibrolite being continued on either side, with splintered ends but generally without dislocation or fault. The fissures sometimes appear to be empty in places, or occupied and darkened by minute ochreous particles. More commonly, however, it appears as a vein of laminated structure, consisting of a finely granulated ($\times 925$), yellowish material (crushed fibrolite) on each side, next the walls, but in the center of a delicately laminated and colorless substance, apparently quartz, with a very thin and perhaps empty middle suture. The fluid-inclusions or cavities are extremely rare in the vein within a fibrolite-field, and always exactly along the central suture; they occur only close to the entrance to a quartz-field, or enclosed in the occasional quartz-granules within the interstices of the fibers. Some of these veins thin out and disappear within the fibrolite-fields, and near their terminations are crossed by short blades, with fractured ends. The width of the central laminated band—the true width of the original fissure—varies from 0.00007 to 0.00014 mm., and that of the entire vein, including the fragmentary bands, up to about 0.00135 mm.

Within a quartz-field, on the other hand, where the same fissure crosses that material within the interstices of the fibrolite-network, or, more distinctly, where it crosses an adjacent grain of quartz, its width is confined to that of the central band above described, sometimes still continued in the same capillary crevice, or represented interruptedly by short sections of crevice with clear quartz between, or very often by a line of

fluid-inclusions, until another bundle of fibrolite is reached on the further side of the grain, and the rock-fissure re-appears as a minute dark crevice cutting across the needles as before.

All these occurrences are illustrated in the drawing made under a 4-10 inch objective, by a Camera Lucida, presented in Plate X. The quartz-field in the center, shot through with but a few blades of fibrolite, is traversed by several anastomosing fissures, as lines of inclusions, which at one end are cut off by a composite scale of muscovite and opaque biotite, and at the other are transformed into the veins of fibrolite-material. The occurrence of the fluid-inclusions in planes, which in most cases lie obliquely to that of the thin section, is easily studied by deeper focussing, but could not of course be represented in the drawing; to this fact is due the occasional appearance in the latter of superposition of the inclusions upon a fibrolite needle, or the slight projection of a needle across the fissure within the quartz-field.

All these phenomena are interesting evidences of the microscopic results of the internal and gradual movements within the mother-rock in the course of folding. The mass has been repeatedly seamed by minute fissures, yielding the plasticity long-recognized in rock-masses of apparently the greatest rigidity, and repeatedly re-cemented by siliceous films deposited out of the concentrated and heated solutions which saturated the rock. The process was closely akin to that of the repeated fissuring and re-cementation in the ice-grains of a glacier. The huge veins, selvage, and slicken sides which are the familiar macroscopic results attendant upon such movements, here show in some respects their microscopic counterparts. By the slow grinding action, the greatest width of the fissure was attained and a fragmentary vein produced, where the softer material (fibrolite) occurred along its course : some needles being simply torn out or pulled apart, but not broken, where the rending force diminished, near the thinning out of the fissure.

By the fortunate co-incidence of such fissures of sufficient length, passing across both quartz and a fibrous mineral like fibrolite, with their subsequent partial occupation by dissolved silica (a common cementing material in many rocks), the rock under investigation apparently presents clear evidence that, in

this case at least, the extension of the fluid-inclusions in planes indicates for them a fissure-origin, secondary to, and *it may be* far later than, the genesis of the rock. It is also easy to understand how readily, as such a capillary fissure is gradually filled up, portions of its area may be entirely occupied by gas, steam, or a liquid, and resist and prevent the deposition of silica, until a barrier had been formed. The constant tendency to crystallization within this siliceous deposit produced the abundant cavities of crystalline form, frequently modified by partial re-solution and erosion of angles. The accidental enclosure in each case of gas or vapor or liquid under heavy pressure, with an additional introduction or escape of any one of these before the barrier became complete and the cavity hermetically sealed, and with the subsequent contraction on cooling, afforded all the conditions apparently necessary for the plane arrangement of the inclusions as now found. Thus, too, they occur completely or partially filled with either gas or liquid, but with a general correspondence in regard to contents, in contiguous groups of inclusions.

It may be further stated that just such parallel lines of fluid inclusions cross the quartz-grains in many other gneisses and granites of this country.

From these facts we may conclude that in many rocks those groups of fluid-inclusions, which are marked by a plane arrangement, are of secondary origin, resulting from a late injection, as suggested by Vogelsang—not exactly of cleavage cracks, however, but of rock fissures. In such cases they can throw light only on the conditions of metamorphism in a rock, rather than on those of its origin. Doubtless in the same rock, or even in the same quartz-grain, fluid-inclusions of both kinds may co-exist, and a careful distinction between them, whenever possible, is requisite in investigations like those of Sorby already alluded to.

The great variations in relative volumes of bubble and liquid and fluid contents in general, in closely contiguous cavities, often remarked by many observers, may be in part due to this difference in their origin, and may yet serve as a means of distinction in certain cases: *e. g.* where fissure or secondary inclusions may be distinguished from the primary by the co-incidence of certain characteristics (the same contents, or the same volume-relationship of bubble and liquid) along cer-

tain otherwise invisible planes. Evidently, that careful observer, Sorby, was on his guard in this respect, as he makes the following statement concerning the fluid cavities in the quartz of quartz-veins :

"Sometimes we may distinctly see that the quartz has been cracked, and the cracks afterwards filled up with quartz. This . . . . appears in some cases to have taken place at a low temperature and explains why bands of cavities occasionally occur with vacuities relatively less than those in the fluid cavities of the general mass." I believe, however, that in some instances, as in this very rock, fissure-inclusions of this class are quite difficult to identify, from either their sparseness or their great number and irregularity. It may be further suggested that since such inclusions appear to have been formed during the folding or extrusion of a mass, they present the exact conditions for the excess of pressure indicated in the calculations of Sorby and Ward, and by them attributed to the same cause

Again, the distinctions between rocks founded upon the presence or abundance of fluid-inclusions in certain groups, such as that proposed by Zirkel* between the metamorphic and younger eruptive granites of the West, on account of the frequent poverty of the former in liquid-inclusions, may, although local, yet meet with striking exceptions and need careful reconsideration. In the case of this metamorphic gneiss of Westchester and New York counties, which is certainly a member of the Montalban group, such a scheme, if pressed to a conclusion, would conflict with the idea of Archean age, and rather tend to corroborate the current suspicion, on other grounds, of its Silurian origin.

Finally, it may be briefly stated that the same fissure-inclusions in planes have been commonly observed in the quartz-grains of American sandstones, terminating abruptly at the outlines of the grains. They occur also in the quartz-grains of many metamorphic or conglomeritic gneisses of Wisconsin, North Carolina, Colorado,† etc., and with the same abrupt terminations at the limits of the grains, which, as Zirkel observes of the last locality, "makes them appear like worn elastic fragments."

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*Zirkel, loc. cit., 55.

†Expl. of 40th Par. VI., 36, 58.

# THE CLASSIFICATION OF THE ALGÆ.

BY A. B. HERVEY, A. M.

(*Received December 19th*, 1878.)

I shall attempt, in this paper, to give the most important results of the latest published studies of the Algæ, in so far as these bear upon the question of classification.

In no department of Botany has the application of the principles of the "natural" as distinguished from the "artificial" systems of classification, produced more important results than in that of the Algæ. The life-history of the plant is now made the principal basis of classification. The affinities of form, structure, and color, are subordinated to that. The *Colochæte*, for example, though a green, fresh-water Alga, and formerly classed with those of like habitat, color, and appearance, is now removed on account of its known reproductive process, quite away from the green, and even above the olive-green marine Algæ, and placed along-side of the red marine Algæ in the highest group of the series. Further, the biological basis of classification arranges the Algæ and the Fungi in two parallel series, and puts the Lichens in the upper groups of the Fungi, among the Ascomycetæ. The only characteristic difference recognized between the Algæ and the Fungi, is a difference in cell-contents; the Algæ containing chlorophyll, and the Fungi having none. This must be reckoned more of an "artificial" than a "natural" element of classification, as it does not seem to influence, in the slightest degree, the reproductive processes of the plants, these processes being quite alike in the various corresponding groups in the two parallel series. There is, indeed, an element of some importance in the life of the plant depending upon the presence or absence of chlorophyll in the cell; viz., the ability of the plant to live on organic or inorganic food. An Alga is able to subsist on elemental food; but the lack of chlorophyll in the Fungus, compels it to seek its nourishment from living plants, or from the decaying matter of organic substances, vegetable or animal. The following is the scheme of classification as proposed and worked out by Sachs (Lehrb. d. Bot. Vierte Auf., p. 248).

THALLOPHYTES.

FIRST CLASS.

*Protophytes.*

| Chlorophyll in plant cells. | Plant cells without Chlorophyll. |
|---|---|
| Cyanophyceæ. | Schizomyceteæ. |
| Palmellaceæ. | Saccharomyceæ. |

SECOND CLASS.

*Zygosporeæ.*

Conjugation of moving cells.

Volvocineæ, (Hydrodictyeæ). — Myxomyceteæ.

Conjugation of resting cells.

Conjugateæ, (including Diatomaceæ). — Zygomyceteæ.

THIRD CLASS.

*Oösporeæ.*

| | |
|---|---|
| Sphæropleæ. | |
| Vaucheriaeæ. | Saprolegnieæ. |
| Œdogonieæ. | Peronosporeæ. |
| Fucaceæ. | |

FOURTH CLASS.

*Carposporeæ.*

| | |
|---|---|
| Colochæteæ. | Ascomyceteæ. (including Lichens). |
| Floridieæ. (red marine Algæ). | Æcidiomyceteæ. |
| Characeæ. | Basidiomyceteæ. |

## THE PROTOPHYTES.

These are the simplest plants known. They consist of single, separated cells (*Glœocapsa*, *Protococcus*), or cells arranged in a series like a string of beads (*Nostoc*), or cells which have subdivided in both directions in one plane (*Merismopedia*). They are divided into two groups: those whose chlorophyll is pure green (*Palmella Protococcus*), and those with chlorophyll tinged blue or yellow (*Nostoc*, *Rivularia*, *Oscillaria*, etc.).

In this class true reproductive organs have not been observed. The increase of individuals takes place commonly by the self-division of the vegetable cell, not by the production of cells especially designed for that office. Vegetative and reproductive organs are not as yet differentiated, and only in the most highly developed species are there cells which seem to be

formed with some view to reproductive function, as in the *Rivularia*. In the second class, the

**ZYGOSPORACEÆ,**

the reproductive act is clearly made out. The changes which take place in the vegetative cell to transform it into the reproductive cell, and all the steps of the subsequent processes have been carefully studied and described in a considerable number of species. The reproductive act is called "conjugation." It produces a true spore, named the Zygospore. "Conjugation" is the uniting and commingling of the contents of two like cells. The Zygospore, which results from this act, produces by germination and growth, directly or indirectly, the new plant; *i. e.*, either with or without an intervening "resting" period. There are two distinct methods in this process of conjugation which divide the class into two unequal groups; viz., the conjugation of "swarm-cells," and the conjugation of unmoving or vegetative cells. Cohn has shown, some years ago, how the first process proceeds in the genus *Volvox*. Areschoug has made some recent studies in the history of certain marine Confervæ which illustrate this point very well. Areschoug has found that many of that group of related plants like *Hormiscia*, *Cladophora*, *Enteromorpha*, etc., produce, by the segmentation of the vegetative cell, two kinds of swarm-cells, distinguished chiefly by marked differences of size, and sometimes also by the larger swarm-cells having four, and the smaller two, cilia. The one he called a "Megazoöspore," and the other a "Microzoöspore."

Plate XI., Fig. 1, *a*, represents the Megazoöspore, and *b* the Microzoöspore of the *Enteromorpha compressa*, a plant growing common on our New England coast. These spores are produced by changes in the cell-contents of some of the vegetable cells of the plant—the two kinds being always produced in different cells of the plant. They are filled with green protoplasm, clear at the apex and granulous at the base, with a distinct dark-red granule on the side. Plate XI., Fig. 1, *c*, *d*, *e*, *f*, shows the different stages in the process of conjugation, with the fully formed Zygospore at *f*. At *g*, we see the same already germinated, and beginning its growth as a new plant without a resting period. The objects in these figures are magnified 1,000 diameters, and are from Observationes Phycologicae.—J. E. Areschoug. Particula Secunda, 1874.

In several genera of this class of Algæ, swarm-cells have not been observed. The conjugation of these plants must take place, therefore, by means of still or vegetative cells. Among the Confervæ or thread-like plants, as well as among the Desmids, and with certain modifications, also among the Diatoms, conjugation happens, in general, in the following manner: two threads, or more exactly two fronds, place themselves side by side, the cell-walls of each touching those of the other externally. Soon, at the point of contact, the cell-wall is absorbed, and a passage between the two vegetative cells is produced. Through this passage the contents of one of the cells pass over into and mingle with that of the other. This new mass seems to acquire a power not possessed by either of its constituent elements, and immediately proceeds to clothe itself with a thick cell-wall, and rounds out into an oblong or egg-shaped, dense mass of green protoplasm, forming thereby the Zygospore.

This, immediately, or after resting a longer or shorter time according to the habits of the genus, grows into a new plant, or else segregates itself into smaller spores sometimes into swarm-spores, which in their turn produce the new plant.

The illustrations of this process, drawn from life from the Confervæ, especially the genus *Spirogyra*, and from the Desmids, are so common in works of botany and books on the microscope, that it is not deemed necessary to reproduce them here.

The characteristic fact of this reproductive process is the conjugation of two cells of like and undistinguishable nature, whether they be swarm-cells or vegetative cells.

### OÖSPOREÆ.

The next higher step in the reproductive process of the Algæ is characterized by the conjugation of two cells of unlike size and distinquishable qualities, and also by the fact that the larger—oftentimes a thousand fold larger egg cell—is always fixed upon some part of the plant, and is fructified by the pressing upon and into it, of the spermatozoids, or very minute swarm-cells, which go swimming by.

On the plants of the genus *Vaucheria*, numbers of short one or two celled branches grow out near each other. Some of these always remain slender, and have in their contents but little chlorophyll, being filled mostly with colorless protoplasm. These branches are the antheridia, and produce from their cell-

contents the spermatozoids, which escape in great numbers into the surrounding water on the rupturing of the cell-wall.

The others of these reproductive branches differ materially in form and history from those just described. They have greatly more chlorophyll, and the cell-contents are much more closely compacted. The cells swell out into egg-shaped bodies, and are closely filled with globules of chlorophyll and oil. These are the oögonia. The outer cell-wall of the oögonium is finally ruptured, when the spermatozoids which have been previously, or at the same time, liberated from a neighboring antheridium, press in and mingle with the cell-contents of the oögonium, and fructification takes place. Then the fructified oösphere clothes itself in a thick cell-wall and enters upon its resting period. "In the *Vaucheria* the formation of the oögonium and antheridium begins at evening; by the middle of the next forenoon they will be perfect, and between 10 and 4 o'clock of that day the fructification will takeplace." Sachs, Lehrb., p. 214.

The genus *Œdogonium* presents some peculiarities of fructification worthy of notice, and although Pringsheim, some years ago, studied and wrote the life-history of this plant, there are still some points which need further elucidation.

The oögonium and antheridium of this genus are produced by changes in the vegetative cells of the same plant—the former by the swelling and rounding of the cell and the thickening and final segregation of the cell-contents; the latter by the transformation of the cell-contents into motile spermatozoids. Plate XI., Fig. 2, *A*, represents a fragment of the middle part of a fertile thread of *Œdogonium ciliatum* magnified 250 times. At *a*, the plant cell has developed into an oögonium, and at *b*, several cells have undergone the necessary change to make of them antheridia, whence spermatozoids will emerge and fructify the oöspore at *a*.

At the same time with the oögonium, there is formed in other plants of the same species, a peculiar kind of swarm-cell which fastens itself to the side of the oögonium, and grows into a singularly-shaped male plant, or antheridium, called by the Germans, a "Dwarf-man," from the cells of which come spermatozoids, which fructify the oögonium upon which it is parasitical. Fig. 2, *B*, represents an oögonium (*o*) of *O. ciliatum*, at the moment when it is being fructified by the entrance into

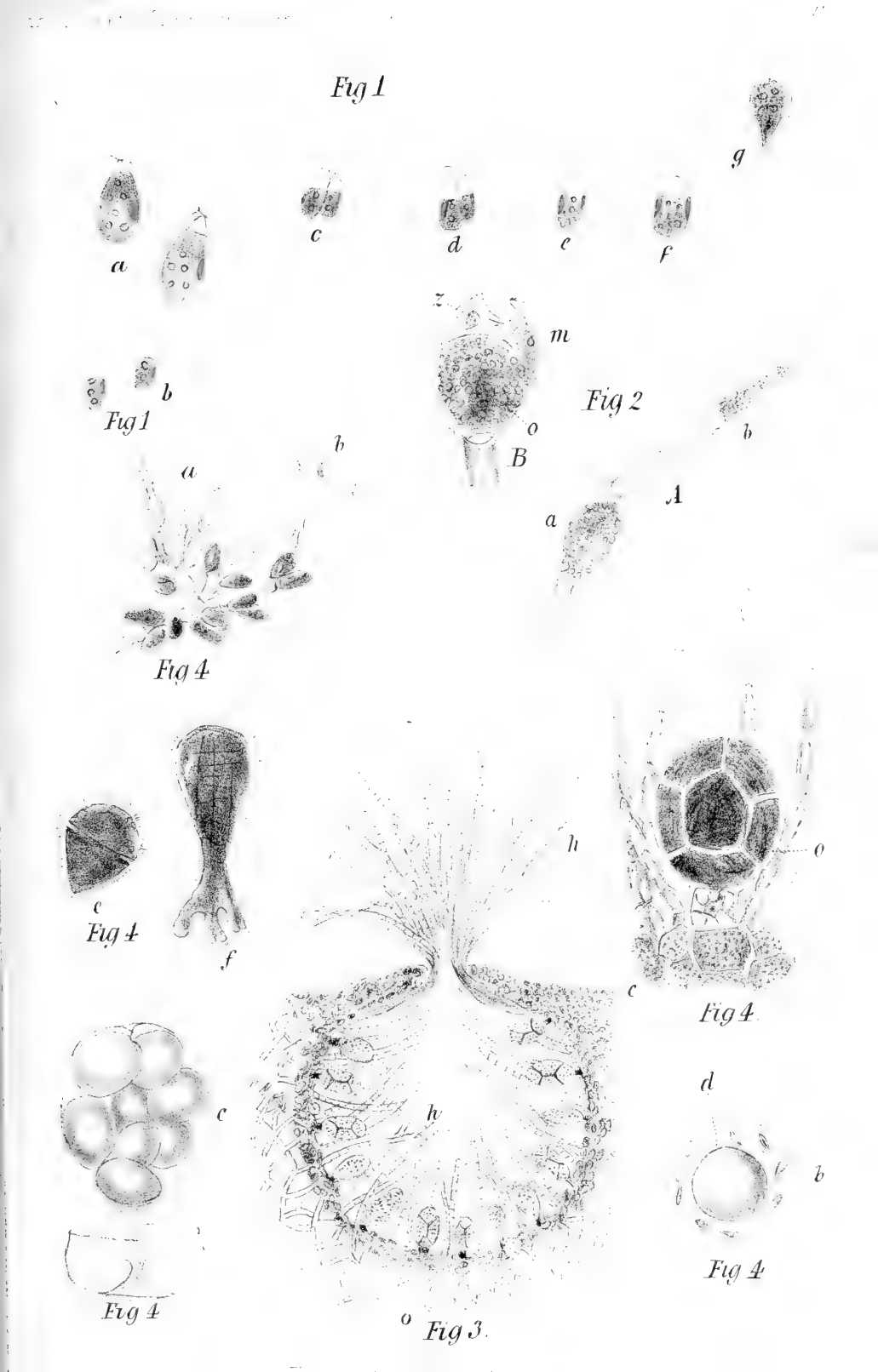
Fig 1
a
c
d
e
f
g
b
Fig 1
z
m
o
B
Fig 2
b
A
a
b
a
Fig 4
e
f
Fig 4
h
o
c
Fig 4
c
h
o
Fig 3
d
b
Fig 4

it of the spermatozoid (*z*) from the "dwarf-man" (*m*). Pringsheim, MORPHOLOGIE DER OEDOGONIEEN.

The fructification of the Fucaceæ was several years ago studied out and illustrated by the lamented Thuret, and is, perhaps, of all the Melanosperms best known, as it is the most easily observed. Plate XI., Fig. 3, represents a section through the conceptacle of *Fucus platycarpus*, after Thuret. At *c*, we observe the cortical layer of the frond which is seen to be continued quite around the interior surface of the conceptacle. The colorless hairs (*h*) which line the interior of the conceptacle extend out through the mouth and form minute tufts, visible to the naked eye, upon the surface of the frond. The oögonia (*o*) are seen plentifully scattered over the interior of the conceptacle. At first they grow up large, ovate, densely-filled cells. The cell-contents are soon seen to be divided, and in the *Fucus* there are formed in each oögonium eight oöspores. In other genera the cell-contents remain undivided, and one large oöspore is formed, as in *Pycnophycus*, *Himanthalia*, *Cystoseira*, *Halidrys*. In others it parts into two *Pelvitia*, and again in others, as *Ozothalia vulgaris*, into four.

The antheridia are formed in the extremities of the branched hairs which grow from the surface of the conceptacle. They are, indeed, the slightly swollen branches of the hairs, not shown in Plate XI., Fig. 3, but seen highly magnified at Fig. 4, *a*, which are filled at first with a granulous protoplasm, which, in the end, changes into great numbers of minute spermatozoids, each armed with two or more cilia, and marked laterally by a noticeable red point (Fig. 4, *b*, × 330).

Fructification takes place outside of the conceptacle. The oögonium parts with its eight oöspores, and they come forth from the conceptacle still enclosed in an inner sac of the oögonium. Fig. 4, *o*, shows an oögonium of *F. vesiculosus* with the cell-contents divided into eight parts. At *c*, the process has continued, and the oöspores fully rounded out and ripened. They are also stripped of the outer cell-wall of the oögonium. At this stage and in this condition, they come forth from the conceptacle and gather about the mouth on the surface of the frond. The antheridia also detach themselves from the hairs on which they grow, and pushing out collect in little heaps about the opening of the conceptacle. This all happens at low tide while the plant is lying out of the water in the moist air.

On the return of the sea the oöspore and the antheridia burst their cell walls, liberating both oöspore and spermatozoids. Immediately each oöspore, Fig. 4, *d*, is surrounded by a swarm of spermatozoids (*b*) which fasten upon it and discharge their contents into it. This fructifies the oöspore, which immediately clothes itself with a thickened cell-wall, and, without a resting period, locates upon some suitable substance, germinates, and grows (Fig. 4, *e* and *f*).

The *Fucus platycarpus* of the European coast, and the *F. furcatus* of our own, are monœcious; i. e., the oögonia and antheridia are produced in the same conceptacle; while *F. nodosus*, *F. vesciculosus*, and *F. serratus* of our coast are diœcious; i. e., the oögonia and antheridia are produced on different plants.

The life history of many of the Phæosporaceæ, to which the Fuci, Laminaria, and most of the olive-green Algæ belong, is but imperfectly known. Sachs writes, in 1874, that in many of them zoögonidia are known, and in many the antheridia, but not the oögonia. But Areschoug, in 1875, in some observations upon the *Dictyosiphon hippuroides* (Observationes Phycologicae, Part Tertia, p. 25), which has been heretofore classed with the Phæospores quite as confidently as the Laminaria, or the gigantic Macrocystis, has brought to light some things which go far to throw doubt, in view of what Sachs says above, as to whether this class of plants really belongs to the Oösporaceæ. The facts which he observed, viz., the conjugation of two swarm-cells quite exactly like those of the *Enteromorpha* and *Cladophora* and other conferva-like plants, would seem to put it, and perhaps the whole of that class except the Fucaceæ, in the second group, the Zygosporaceæ. Perhaps the supposed antheridia and spermatozoids which Sachs mentions are but the two swarm-spores of the class Zygosporeæ.

(*To be continued.*[1])

[1]It was found quite impossible to get the whole of the present paper ready in time for this number. The remaining portion will be a discussion of the fourth class, or red Algæ, in which much recent work has been done, and in the fructification of some of which curious resemblances to certain genera of Lichens have been noticed.

# THE AMPULLA OF VATER AND THE PANCREATIC DUCTS IN THE DOMESTIC CAT (*Felis domestica*).*

BY SIMON H. GAGE, B. S.

(*Received December 19, 1878.*)

As with nearly all organs, the pancreas and its ducts were first carefully investigated in man, therefore, it is necessary to turn to the history of human anatomy for the first exact knowledge upon the subject of this paper.

Anatomists attribute to G. Wirsung the discovery, in 1642–3, of a pancreatic duct in man, opening into the duodenum with the ductus choledochus (37 and 1, 383).†

Vesling, in 1664 (35 and 22, 509), and DeGraaf again in 1671,

## DESCRIPTION OF PLATE XII.

All the figures original except III.

Fig. I. Natural size, from an adult female cat, seen from the ventral surface. The great omentum, the jejunum, ileum, colon, and liver removed; the remaining parts shown *in situ*. The duct of Wirsung was afterwards injected with Berlin-blue, and both it and the duct of Santorini dissected out to show their branches and anastomoses.

1. Pyloric region of the stomach.
2. Pylorus. 2–3. The duodenum.
4. Gastro-splenic division of the pancreas, near the main branch of the duct of Wirsung.
5. The duodenal part of the pancreas and branch of the duct of Wirsung.
6. Duodenum at the point where the duct of Santorini pierces its walls. The dotted line shows the extent of the pancreas on the dorsal side of the intestine. The duct of Santorini is seen to anastomose with each division of the duct of Wirsung.
7. Ductus communis choledochus.
8. The point where the ductus choledochus and duct of Wirsung enter the duodenum.
9. Tip of the spleen, somewhat displaced.
10. The superior mesenteric artery sending the inferior pancreatico-duodenal branch to those parts.
11. Superior mesenteric vein receiving a corresponding branch.

Fig. II. Natural size, from an adult female cat. The liver turned to the right bringing the concave side up, the duodenum to the left, so that its right side looks directly upward, and then sliced off to the level of the ampulla of

*This paper is based upon investigations made in course of the preparation of a Manual for the Dissection of Cats, by Prof. Burt G. Wilder and the writer.

†See list of works referred to at the end of this paper. The first figure designates the number on the list; the last, the page; the middle, Roman numeral, the volume.

showed that in man there were sometimes two ducts, the larger opening in common with the ductus choledochus, and the smaller independently. Several others of the earlier anatomists noted the same fact, but, like Vesling and DeGraaf, considered the presence of two ducts anomalous.

Sometime before the year 1752, Vater, a Dutch anatomist, described an enlargement or diverticulum of the ductus choledochus in its passage through the duodenal walls, and stated that into this enlargement the duct of the pancreas, described by Wirsung, emptied (34 and 22, 455). This enlargement has been named after its discoverer, the *Ampulla of Vater.*

To resume the subject of the pancreatic ducts, it is to Santorini, 1775, that we owe the idea of the normal presence of

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Vater, and the duct of Santorini. When right or left is used, it is the right or left of the cat that is meant.

1. Plyorus.
2. The duct of Santorini passing obliquely through the duodenal walls.
3. Cut end of the inferior pancreatico-duodenal artery.
4. Same for the corresponding vein.
5. The duodenal branch of the duct of Wirsung.
5. Cut end of the duodenal pancreas, showing triangular section, and the intestines partly enveloped.
6. The ampulla of Vater.
7. The duct of Wirsung opening into the ampulla.
8. The ductus communis choledochus, also opening into the ampulla.
9. The duodenal branch of the duct of Wirsung.
10. The gastrosplenic branch.
11. Duct from the pancreatic reservoir opening by a large branch into 10, and by a small one into 7.
12. Pancreatic reservoir covering part of the gall-bladder.
13. The "impeding flexures" in the cystic duct.
14. The gall-bladder constricted in the middle, as is also the pancreatic reservoir, by a firm wide band passing over them.
15, 15. The cystic lobe of the liver.

Fig. III. Half natural size, from an adult man (After Bernard). Ventral view. The wall of the duodenum partly removed to show the openings of the ducts, which have been exposed by dissection.

1. Pylorus.
2 and 4. Duct of Wirsung.
3. Duct of Santorini anastomosing freely with the preceding, and opening into the intestine between the aperture of the ampulla of Vater and the pylorus.
5. Ductus communis choledochus.
6. Opening of the duct of Santorini at the summit of a papilla.
7. Opening of the ampulla at the summit of a similar papilla. These openings are usually about 10-15 mm. apart.

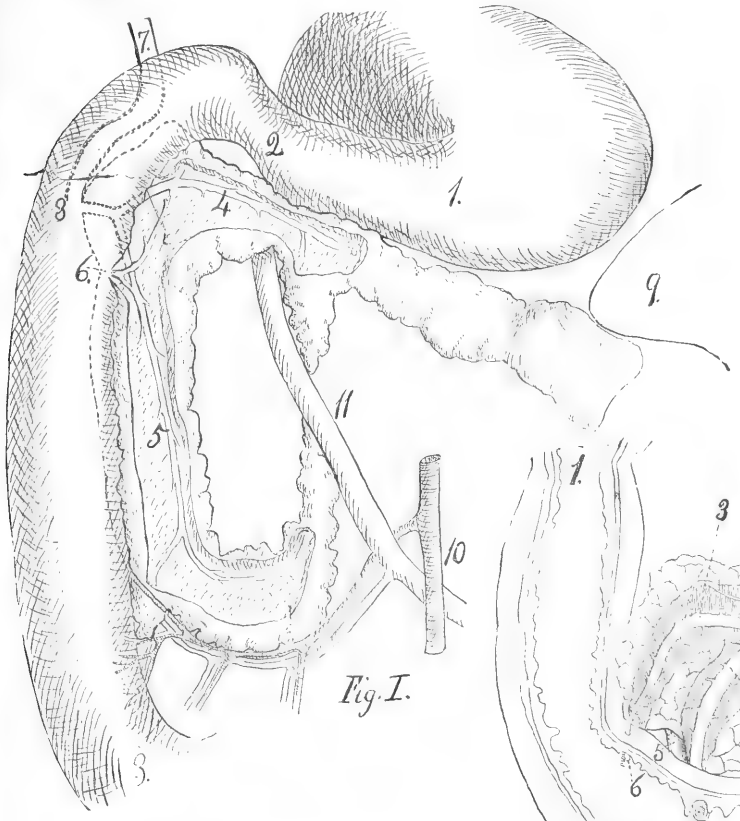


Fig. I.

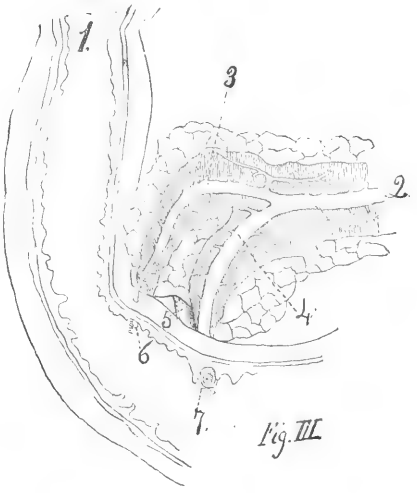


Fig. III.

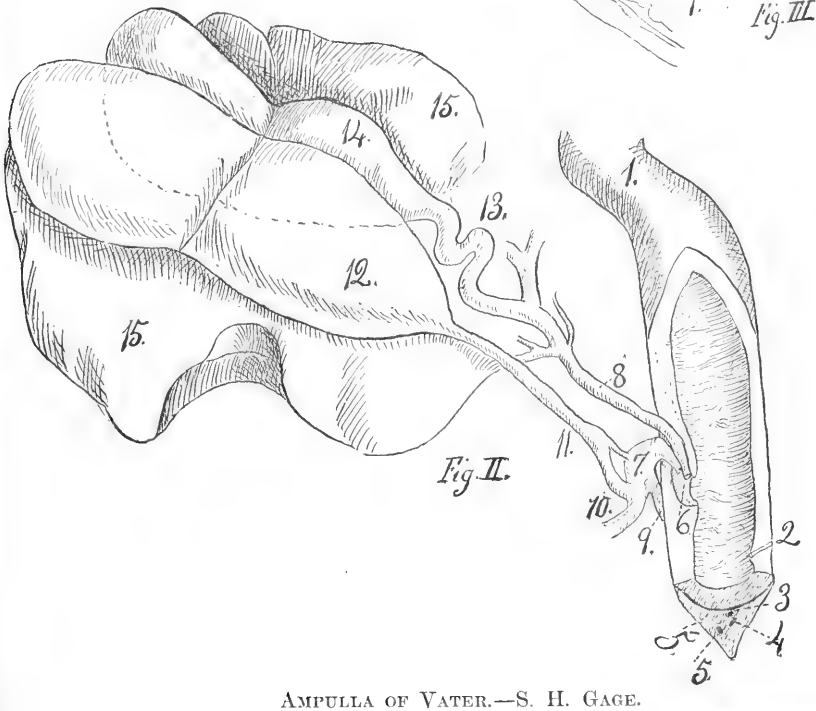


Fig. II.

two ducts. He figured the pancreas and the two ducts, with their mode of opening; viz., the larger into the ampulla of Vater, with the ductus choledochus, and the smaller independently into the duodenum nearer the pylorus than the ampulla of Vater (28 and 1, 383). The description and figures of Santorini seem to have been forgotten or ignored down to the time of Cl. Bernard, in 1846 (1, 383). At this period, the opinion was universal that the presence, in the adult, of two ducts opening separately was anomalous; and, although Meckel had shown conclusively in 1835 that two ducts constantly exist in the human fœtus, he supposed that one of them normally atrophied, and that its presence in the adult was merely an unusual persistence of the fœtal condition (20, 316, 317, 474 and 476). He was followed in this opinion by all anatomists.

Bernard called attention to the constant presence of two ducts in the adult, and his observations, which were very numerous, together with those of several other great anatomists, have shown that the absence of two ducts is the exceptional condition in the adult human being (18, 1137; 1, 385, 22, 509; 29; 10, 331 and 38). It is necessary to state that some modern anatomists and physiologists do not coincide with the above opinion, although they recognize the occasional presence of a second duct. Among these may be mentioned Quain (25, II., 396), Gray (14, 793), Colin (7, I., 794), Hyde Salter (27, 85), and Owen (23, 497). Prof. Owen looks upon the anomalous (?) second duct as an indication of the homology of the so-called head of the human pancreas with the duodenal pancreas of the lower mammalia.

With reference to the mammalia below man, Marshall (19, 595) has made the important generalization that the normal number of pancreatic ducts, opening independently into the duodenum, is two. Milne Edwards (22, 510), in confirmation of this idea, says: "Until lately, it was thought that with all the ruminants there was but a single pancreatic trunk, but it is now known that in the ox there are ordinarily two ducts opening separately, and sometimes even three; and it is probable that careful investigation will reveal a similar condition in many other mammals." This idea is further supported by the fact that with the animals most fully studied there have been found normally two pancreatic ducts, at some time of life at least. This is the case with man, the horse, dog, cat, and many others (1, 383; 22, 508; 23, 492; 27, etc.).

It is evidently necessary in both human and comparative anatomy to be able to designate the two pancreatic ducts, so that there can be no doubt as to which is meant in a given case. There would be no danger of confusion, if in all species and all individuals of the same species, the relative size and position of the ducts were invariable; but this is not the case, for in man (Plate XII., Fig. III.,) the duct opening separately into the intestine is normally nearer the pylorus than the one opening in common with the ductus choledochus, while in all other mammals, where two ducts are known, neither opens nearer the pylorus than the ductus choledochus. It should be stated, however, that both Owen (23, 497) and Salter (27, 85), figure and describe the independent second duct in man as opening into the duodenum "below," farther from the pylorus than the one opening in common with the ductus choledochus, as is the case in the lower mammals, although it may rarely open nearer the pylorus. But Santorini (28), Bernard (1, 384), and Robin (18, 1137), figure the ducts, and state very positively that the one opening independently is always nearer the pylorus ("au-dessus, mais non au-dessous") than the one opening with the ductus choledochus. Flint (10, 331) and Dunglison (8, 750) give the relative positions as the authors last mentioned.*

In nearly all the works which may be considered original (1, 3, 5, 22, 23, 25, 27, etc.), the ducts, in man and other mammals, have been called "principal" and "accessory." As in many instances, where parts of the human body have been named with reference to their size alone, so in this, comparative anatomy has shown that the lesser, while keeping the same relative position, often becomes the greater, and the

*Note by Professor Wilder. "I gladly avail myself of Mr. Gage's invitation to add a note at this point. How is it that the hundreds of human subjects annually dissected in our medical schools yield so few facts of physiological importance? Why, for example, has not the present question as to the normal number and relative position of the pancreatic ducts of man been settled long ago?

Three reasons occur to me: 1. The general attraction among medical students is toward surgery rather than medicine; hence, they pay more attention to surgical anatomy than to physiological anatomy. 2. The viscera of human subjects are rarely in condition, when removed, to furnish accurate information, and are usually thrown away after a brief inspection. 3. The average medical student is rarely qualified for the proper examination of viscera. If he has had any preliminary training at all, it has referred chiefly to bones and muscles.

Now, if the viscera were removed at an earlier stage of the dissection, such parts as the duodenum might easily be preserved in alcohol, for careful study. In the second place, the viscera of the cat are so nearly like those of man that there is really no reason why they should not first be examined as to both the gross anatomy and the histology of the various organs."

greater the lesser; hence, if the names are retained they can merely indicate that there are two of a kind and one is larger than the other, without any regard to absolute or relative position. The pancreatic duct opening with the ductus choledochus, is called, in man, the duct of Wirsung or the principal duct, and the other the accessory or minor (1, 384; 14, 793; 22; 51; 23, 497; 25; 27). It not unfrequently happens that the duct opening with the ductus choledochus is smaller than the one opening independently, which is now, from its size, called the principal duct, and the other is called the accessory duct, for the same reason (1, 386 and Plate XIII., Figs. I., II.,) (6, 172). Take, for example, this remark of Dalton's; "Even in the human subject, as shown by Bernard, Kölliker, and Sappey, there is often a small accessory duct opening into the intestine, sometimes above (nearer the pylorus) and sometimes below (farther from the pylorus) the situation of the principal one" (6, 172). If one has in mind the statements of Salter (27, 85) and Owen (23, 497), that the accessory or smaller duct opens independently into the intestine at a point farther from the pylorus than the common opening of the ductus choledochus and duct of Wirsung, he might properly suppose that the duct opening with the bile-duct remained constantly the larger, while the small duct opened independently into the intestine, sometimes nearer the pylorus and sometimes farther from it. Taking the statements of Bernard (1, 384) and Santorini (28; 1, 383, also 8 and 18) that the duct opening independently, or the accessory duct, is *nearer* the pylorus than the one opening with the ductus choledochus, the alternative is left to suppose that the duct opening with the ductus choledochus may sometimes be smaller than the other, and for that reason be called the accessory duct, while the other, from its size, is now called the principal duct. The figure added by Dalton (6, 172, Fig. 46) showed this last to be the meaning.

If we turn to comparative anatomy, the confusion is nearly as great, for in dogs the larger duct opens independently at a considerable distance farther from the pylorus than the ductus choledochus, and the smaller opens also on the same side, but very close indeed to the ductus choledochus (1). In the cat the case is reversed, the larger duct opening into the ampulla of Vater, and the smaller one independly and farther from the pylorus (Pl. XII., Fig. I., 1 and 2).

If in these cases we use terms to designate size, there can be no reference to position, either absolute or relative, and hence no comparison. It seems to me that all difficulty may be avoided by choosing two fixed points by which to determine the positions and names of the pancreatic ducts. The pylorus has already served as one point, and the ductus communis choledochus, which is single in all mammals so far as I know, may serve as the other.

As Wirsung was the discoverer of the pancreatic duct in man, which opens into the intestine with the ductus choledochus, that duct in all mammals which opens with or nearest it, may be properly called the duct of Wirsung. This name is recognized, at least as a synonym, by most anatomists (1, 3, 14, 20, 22, 23, 25, 27, etc.). And as Santorini was the first to accurately describe and figure a second duct in man, opening separately into the intestine, the duct so opening independently and the farther from the ductus choledochus, may be called, in all mammals, the duct of Santorini, without regard to its size. This name is also recognized by good authority (8, 750 and 18, 1137).

To briefly recapitulate: Comparison, both in human and comparative anatomy, would always be easy and intelligible if, where two pancreatic ducts are known to exist, the one opening with or next the ductus choledochus, were called the duct of Wirsung, and the one opening independenly and farthest from the ductus choledochus were called the duct of Santorini, without regard to size. Where but one duct is known, it should probably be called the duct of Wirsung.*

The form, position, and relation of the cat's pancreas may be well shown, as in Plate XII., Fig. I., by killing a fasting animal with chloroform, and securing it on its back with the legs horizontal and at right angles to the trunk. After it has stiffened, if the abdominal wall be removed, the great omentum turned over upon the thorax, the liver over the right hypochondrium, turning the concave side uppermost, and the jejunum and ileum into the left hypogastrium, the pyloric region of the stomach with the pancreas and duodenum will appear *in situ*. The pancreas (Pl. XII., Fig. I., 4 and 5) consists of two main divisions, one of which extends from the pylorus along

*For a consideration of the necessity of uniformity in anatomical nomenclature, see Quain (25, I., 20), Pye Smith in the *Journal of Anatomy and Physiology* (30, 15), and Wilder (36).

the pyloric region of the stomach to the spleen, by which its left ventral surface may be partly covered, while its dorsal surface rests upon the left kidney. The second division extends from the first, parallel with the left side of the duodenum, to the inferior pancreatico-duodenal vessels (Pl. XII., Fig. I., branches of 10 and 11). It then curves toward the left, and finally sends a narrowed part along the right side of the superior mesenteric vein (Fig. I., 11), nearly meeting a spur from the first division.

Following Cuvier (1, 585), Hyde Salter (27, 99), and Owen (23, 495), these parts of the pancreas will be named from their relations, the *gastro-splenic* and *duodenal* divisions.

The duodenal division of the pancreas is very thick next the intestine, and envelops about one-third of its circumference, while its free edge is very thin, thus giving a triangular appearance in a cross-section (Fig. II., 5).

Differing from the human pancreas, which is only covered on the ventral surface by the mesentery(25, II., 395; 27, 83), the cat's pancreas has a complete mesenteric investment, the duodenal division being enveloped by the duodenal mesentery, and the gastro-splenic by the dorsal fold of the great omentum.*

The ducts of the pancreas are imbedded in the gland substance throughout their entire extent. The duct of Wirsung extends about a centimeter from the intestine, and then divides into two nearly equal branches, one going to each division of the pancreas (Fig. I., 8, 4, 5). The duct of Santorini is usually very much smaller in the cat than the preceding, and always opens independently into the intestine at a point upon the left side and farther from the pylorus than the common opening of the ductus choledochus and the duct of Wirsung. The two ducts anastomose very freely (Fig. II., 4, 5, 6). The relative positions of the two ducts are accurately shown in Fig. II. There is a spur of gland substance following each duct to the intestinal wall, and clinging very closely to the duct until it penetrates the intestine (Fig. I., 6, 8). At all other points the pancreas is held to the duodenum only by the mesentery, numerous small blood-vessels and loose connective tissue, and can be very easily separated, save where the ducts enter. The

*This seems to be the normal condition in the Felidæ, judging from Prof. Owen's statement: "The pancreas in the feline tribe is composed of two parts, both having an entire investment of peritoneum" (24, 132).

duct of Wirsung is easily found, as it is large and close to the ductus choledochus (Figs. I., II., 7, 8).*

The duct of Santorini is usually much smaller than the preceding, and is, therefore, more difficult to find, especially as there is often an artery of about its own size piercing the intestine near it. It may be found without much difficulty, however, by carefully tearing away the mesentery on the ventral surface of the duodenal pancreas, when one point will be found where a spur of the gland substance clings to the intestine; in this the duct is inclosed. The artery spoken of above is not so imbedded in the gland tissue, and therefore need not be mistaken for the duct. It may seem unnecessary to be so strenuous as to the duct of Santorini, but when it is remembered that the ducts very freely anastomose, it will be seen that no crucial experiment could be made to determine the effect of shutting off the supply of pancreatic juice if either of the ducts were left open. See the experiments of Schiff, rendered inconclusive by ignoring one of these ducts (15, 353).

In Plate XII., Fig. II., 12, is shown, actual size, a curious anomaly in the cat; viz., a *pancreatic reservoir*, analogous to the gall-bladder. In this case it is larger than the latter and partly covers it. The two are very closely bound together for about half their longitudinal extent, by a broad, firm band, which produces a decided constriction in both. The walls of the reservoir are very firm and thick, as are also those of its duct (Fig. II., 11). The duct is nearly straight, and bifurcates before terminating, sending the larger branch to the gastro-splenic division of the duct of Wirsung, and the smaller to the common trunk (Fig. II., 11, 7 and 10). The communication between the pancreatic reservoir and the duct of Wirsung seemed to be entirely free, as air or liquid could be readily forced in either direction. There was no communication whatever between the pancreatic reservoir or its duct and the gall-bladder or the ductus choledochus. But one instance is on record of the presence of a similar reservoir, and that case was described and figured by Mayer in 1815 (21, 297, Tab. III., Fig. 2). Its size relative to the gall-bladder was less, and the duct terminated in the trunk of the

*It [illegible] the ductus choledochus may be made very prominent by pressing on the gall-[illegible] with [illegible].

duct of Wirsung without bifurcating. In all other respects that case seems to be identical with the one just mentioned.

So far as I know, this anomaly has been found only in the domestic cat. Its reported presence in the common seal (*Phoca vitulina*) by Cuvier (5, 587), Salter (27, 99), and Milne-Edwards (22, 511) is probably an error; for Fr. Tiedemann (32, 297), to whom they refer for their authority, states that the ductus choledochus, after entering the duodenal wall dilated between its coats forming a larger reservoir, into which emptied the pancreatic duct. He says of this reservoir that it bears great resemblance to that which appears in the gall-duct of the elephant as described by Pierre Camper (39). Owen (23, 480) and Miall and Greenwood (40) say of the elephant: "There is no gall-bladder, but the ductus choledochus expands in the wall of the duodenum into a sacculated pouch, which receives also the first pancreatic duct;" and Prof. Owen says of the seal (*Phoca vitulina*) dissected by him: "The ductus communis was one and a half inches long; it was joined by the pancreatic duct as it terminated in a dilated sacculus *within* the *duodenal coats*," (23, 487). It seems to me evident from all the above that Tiedemann simply referred to a large ampulla of Vater (See Pl. XII., Fig. II., 6, and Pl. XIV., Fig. 1).

(*To be continued.*)

## PRACTICAL HINTS ON PREPARING AND MOUNTING ANIMAL TISSUES.

BY CARL SEILER, M. D.

(*Received December 6th*, 1878.)

At first glance, it seems superfluous to add to the already extensive literature on practical microscopy, and one might think that such books as Beale's, Frey's, etc., could not be improved upon. Yet there are certain little details of manipulation, which are not generally described in larger works, and which, if they do not insure success, at least facilitate the working of the different processes. I shall, therefore, as briefly as possible, give a description of the method which, by personal experience, I have found to give the best results in preparing animal tissues for microscopical study.

### HARDENING.

With most tissues it is necessary to make a thin section, so

as to be able to study their histological elements, and in order to make a thin section they must be hardened; that is, the water must be extracted from them. The best agent, according to my experience, is alcohol, properly used. Its advantages over other hardening agents, such as Müller's fluid, chromic acid, osmic acid, etc., are, that the tissues become hard more quickly, the histological elements suffer less distortion, and the sections take the staining more readily and brilliantly.

In hardening tissues in alcohol, they should be cut into pieces not larger than a cubic-inch, and immersed in a sufficient quantity of proof spirits (45%) to fully cover them. After three or four days the proof spirits should be replaced by alcohol of 80% in which the pieces of tissue should also remain three days. After the expiration of this time, they should be placed in 95% alcohol, which will harden most tissues sufficiently in three or four days. Some tissues, however, such as lung, and some pathological new growths, require still further dehydration in Squibb's absolute alcohol, which is in reality 99½%. If this plan is pursued, the water is so gradually extracted from the tissue and replaced by the alcohol, that hardly any shrinking takes place, as may easily be verified by comparing a section made from a tissue hardened in this way with a section from one that has been frozen while fresh. Of course, the tissue should be as fresh as when put into the first alcohol, for if any post-mortem change has taken place, it cannot be hardened by any reagent. Nerve tissue, such as brain and spinal cord, is better hardened for a few days in Müller's fluid, and then finished with 95%, or absolute alcohol, if necessary. Treated in this way, nerve tissue becomes sufficiently hard for cutting without becoming brittle, as is the case when either Müller's fluid or alcohol alone is used. If the tissue contains bone and it is desirable to carry the section through it, the earthy salts must be removed, which is best done by immersing the piece in a solution composed of:

Chromic acid, gr. xv.
Nitric acid (C. P.), fl. ʒ i.
Water - - - fl. ʒ vii.

After several days a few drops of nitric acid should be added, and the bone tested for softness by piercing it with a fine needle. After the bone has been sufficiently softened, which will be

the case in from one to three weeks, according to the size and hardness, the soft parts should be hardened in alcohol in the manner described above.

CUTTING SECTIONS.

The great desideratum in sections of animal tissues, both normal and pathological, are extreme thinness, evenness, and sufficient size to bring into view the different parts of which it is composed. This last point has not, as yet, received sufficient attention from microscopists, especially from those engaged in the study of pathological histology, and yet it is of the greatest importance, for very frequently a pathological new growth will present different appearances in different parts, and often an erroneous conclusion is arrived at in regard to the nature of the tissue, from the fact that but a small section has been examined. The usual method of cutting sections is by imbedding a small piece of the tissue in paraffin or wax and oil, or by clamping it between two pieces of fresh carrot or boiled liver. When firmly held by the imbedding material, the latter is grasped by the thumb and forefinger of the left hand, and then slices are cut off from the tissue by means of a razor held in the right hand. In this manner, it is true, very thin sections may be made, but they are usually small, and not uniform in thickness. Larger and better sections can be made in a microtome, which consists of a well, surrounded by a glass ring, and having a sliding bottom which may be moved up and down by means of a micrometer screw. If such an instrument is to be used, the well is filled with one of the imbedding materials, the best of which I have found to be one part of mutton tallow to two parts of paraffin; the hardened tissue is suspended in it, and the whole allowed to cool. When cold and stiff the imbedding material is cut away from the tissue downward, in front and on either side, but left standing behind. This is done to cause the razor or section-knife to pass through the tissue only, and not through the imbedding material before it reaches the tissue. If this precaution is not observed, it will be found nearly impossible to cut a large, even section, on account of the difference between the consistency of the paraffin and tallow mixture and the tissue to be cut, and particles of the paraffin adhering to the knife are apt to tear a thin section before it is completely cut off.

An ordinary razor, one side of which is ground flat, or a

knife made with a stiff handle, expressly for cutting thin sections, should be used in connection with the microtome, and should be kept as sharp as frequent stropping can make it.

It will be found that the edge of the knife has a bevel, produced by honing and stropping, which will raise the cutting-edge above the glass plate when the flat side of the knife is laid on the plate, and will cause the knife to cut upward and out of the tissue, thus breaking the section before it is completed ; or, if the operator is conscious of this upward tendency and endeavors to correct it, alternate bands of thick and thin portions will be observed in the section. This difficulty can be obviated by raising the back of the knife slightly, so as to cause it to slide on the bevel. It will also be found, that it is much easier to cut a large thin section with a knife, the edge of which is perfectly straight, than with one that has a curved edge, as is always the case with razors. This is because the slightest variation in the inclination of the knife toward the glass plate or ring, will cause the curved edge to gouge into the tissue as it passes through it, and the result will be either a wedge-shaped or a wavy section. It will be seen, therefore, that the knife should be carried through the tissue with an even motion and at the same inclination to insure success. This is, however, not as easy as might be imagined, because the hands usually are not sufficiently steady without a great deal of practice.

It occurred to me some time ago that if the knife could be rigidly fastened to some apparatus, by means of which it could be moved over the well of the microtome in the same manner that the hands move it, sections of any size and thinness could easily be made, even by an unpractised hand. After some experimenting I constructed, with the valuable aid of my friend, Mr. Joseph Zentmayer, a mechanical microtome, which, on working with the finished model made for me by Mr. Zentmayer, proved to be all that can be desired in an apparatus of this kind.

It consists of two rigid, parallel arms of metal, which at one end revolve on pivots attached either to the microtome itself, or to the table to which the microtome is to be clamped. On the other end of these arms are fastened revolving clamps which hold the knife, the edge of which, when in position, rests upon the glass plate of the microtome. The handle of the knife is removed, so as to prevent a slipping and a hinder-

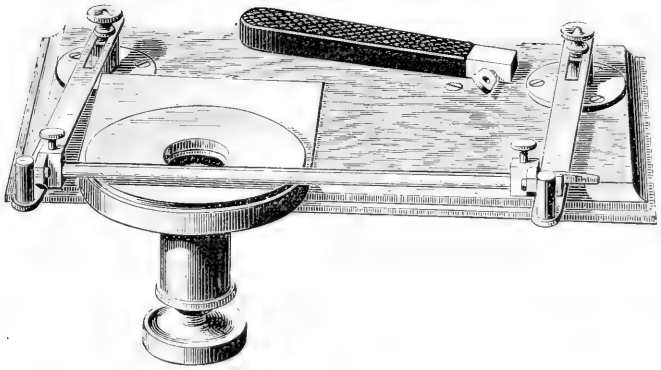

FIG. 3

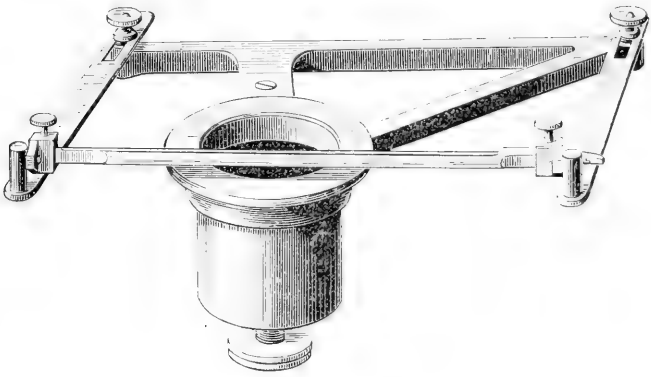

FIG. 4.

ance to the motion of the knife, but can be easily attached by means of a screw, for the purpose of stropping. When in position, and ready for cutting, the knife is pressed upon the glass plate, and a slight side motion is given to it by the hands, which causes it to pass through the tissue and cut a thin, even section without any difficulty. With this apparatus I have been able to cut a thin section of the leg of a five months fœtus from the knee downward, including the foot, the section measuring two inches in length by three-quarters of an inch in width. Several mechanical microtomes have been constructed by various workers, but to my knowledge they are all deficient in one point, viz., the knife or cutting instrument in them is carried through the tissue like a chisel, or in other words, the cutting edge is pressed through the tissue. But a knife, in

order to cut well and evenly, must be carried through the substance to be cut, especially if it is soft, in a slanting direction, so that each point of the edge describes a curve which is equal to a part of a circle. By referring to Figs. 3 and 4, it will be seen that in my apparatus this is exactly what takes place when the knife is moved, the radius of the curve being the length of the arms from the center of the clamps to the center of the pivots.

Another point of importance in cutting these sections is, that the knife should always be wet with alcohol so as to prevent the section from adhering to it. I find the simplest and most economical method of preventing this adhesion to be the wetting of the tissue, by means of a small camel's hair brush dipped in alcohol. Sufficient alcohol remains on the surface of the tissue to cause the section to float on the knife.

(*To be continued.*)

## OBSERVATIONS ON SEVERAL FORMS OF SAPROLEGNIEÆ.

BY FRANK B. HINE, B. S.

*Concluded.*

### ACHLYA.

In April, 1877, when searching in a springy pool for Algæ, I found a pine twig (*Pinus strobus*), which had the ends and scars of the broken branches, where resin had exuded, surrounded by a dense and very conspicuous cushion or ball-like mass of radiating filaments; the whole being white, with a slightly grayish tint (Pl. VI., Fig. 1). The specimens, which were just coming nicely into fruit through sexual reproduction, were placed in a jar of water and allowed to remain without change; but the filaments soon became so surrounded by Infusoria, Algæ, and foreign matter, that they were rendered unfit for examination. Others were then procured and the water kept fresh, in which condition they grew and were suitable for continuous study.

The filaments were generally simple, but branches sometimes appeared in very limited numbers. They were similar in structure to the filaments of the *Saprolegnia* already described, being formed of a slightly granular protoplasm, surrounded by a delicate wall of cellulose; as was shown by its blue color with the iodine test. Their diameter was

about .01 mm. A short specimen, magnified 120 times, is shown in Pl. VI., Fig. 2; its base was completely separated from the matrix on which it grew, so that its branching character could be readily seen, and in many other specimens this peculiar root-like branch ng was very evident. The same character also holds in the parthenogenetic forms, and in all, the base was perfectly clear. In the *Saprolegnia*, however, this dendroid character is not always present, for I have frequently seen the sporangium-bearing hyphæ spring from a thick net-work of mycelium. I think that considerable weight should be placed upon this character, for it is quite constant and very noticeable in old specimens.

The parthenogenetic form is largely similar to that already described under *Saprolegnia sp.*: the aggregation of the granules and segmentation of the protoplasmic contents took place in the same way, while the chief difference lies in the fact that in *Achlya* the zoospores, after escaping from the sporangium, remained clustered around the opening.

The distinction upon which Karl Lindstedt (4) places the most weight is that the zoospores of *Achlya* undergo the second change which I have described, while those of the *Saprolegnia* do not. This division is faulty, as shown in the case of *Saprolegnia*, where an occasional sporangium produced zoospores that underwent this rejuvinescence, although, as a rule, it did not take place. So in the genus *Achlya*, although germination without transformation is the exception, it does occur (Pl. VII., Fig. 3).

Taking up now the sexual generation, we find a very complete arrangement for the production of fertilized fruit. From the filaments are developed lateral, spherical bodies, the contents of which segment into spherical masses that are fertilized through the action of lateral branches (Pl. VI., Fig. 2).

In the development of this organ, there is first produced on the side of the filament a small swelling, having much the appearance of a lateral branch. As growth proceeds it increases but slightly in breadth towards the apex, until nearly the full length is reached, up to which time it is nearly as clear as the filament from which its takes its rise. At this stage, four hours from the filament, the granules become more dense, giving a dark center to the young oogonium, and as the organ swells more at the tip the granules increase, rendering the whole in-

terior quite dark. Ten hours from the filament these granules gradually unite to form larger particles, varying greatly in size, and grouping themselves in the center (Pl. VI., Fig. 7), leave the surrounding medium clear from granules, but of a dark, brownish-yellow color. A second cell-wall bounding the whole contents of the oogonium and separating it from the filaments, yet distinct from the outer wall, is now present. It has an irregular contour, sometimes meeting and occasionally passing through the outer membrane, again being very markedly separated from it. This was the condition at 38 hours from the filament; in twelve hours more the central mass of globules and granules segregated into a number of spherical portions with irregular boundaries, resulting from the varying size of the globules and absence of a surrounding membrane.

Before proceeding with a further description of this organ it is necessary to go back and trace the development of the male portion. At ten hours from the appearance of the oogonium, when it approaches a spherical form, yet being only about two-thirds its final diameter, and when the protoplasm is rendered nearly opaque from the density of the granules, there appears from one, or more generally two places on the pedicel of the female organ, a small branch which has an upward tendency, and in twenty-five hours has its upper—now bulbous—portion closely applied to the surface of the oogonium. Up to this stage it is quite clear, but now granules aggregate in the upper portion, at the same time increasing much in size; and about the time that segregation in the oogonium takes place, becomes separated from the narrower portion by a diaphragm, thus forming an oval or oblong cell, the antheridium. The exact time required for further development of these parts I am unable to give, as observations had to be made on different specimens.

Soon after the division has been formed, small flagellate bodies, the spermatozoids, are produced; at the same time the antheridium sends out a small tube, which piercing the membrane of the oogonium, passes in to meet the gonospheres (Pl. VI., Fig. 3): its office being to conduct the spermatozoids to the bodies requiring fertilization. I saw this tube in a single instance, and doubt its presence as a rule; for excepting the specimens from which Fig. 3 was made, the nearest ap-

proach was in the unopened antheridium, where a small papillary projection extended into the female organ; moreover, where the antheridium had already been emptied of its "fecundating corpuscles," its walls were very intimately connected with the inner walls of the oogonium (Fig. 10). This inner tube is figured and described by writers as being always present, but my observations show that in this form it is rarely produced; moreover, since the membrane of the oogonium is not pierced by holes, * to allow the escape of spermatozoa, which might take place through the delicate inner membrane, I see no reason why fertilization is not as sure as when the tube is present. This structure was noticed, not only with the plants growing on one twig, but was true for different plants found at different times.

Soon after the gonospheres have thus been fertilized, each is surrounded by a distinct membrane (Pl.VI., Fig. 9), and their contents undergo further change by dividing up into a great number of bodies of equal size—the oospores or final product of sexual generation. They are the resting spores, designed at some indefinite time to give rise to parthenogenetic forms. When undisturbed they remain in the oogonium a long time, and escape by no regular dehiscence as is the case in asexual generation, but the wall bursts irregularly, as also the wall of the gonosphere, setting the spores free at no definite time. I have seen gonospheres emptied, but have never observed the spores in the act of passing out. In one instance the oospores germinated in five days after their formation, but as a rule, they remained at rest a much longer period.

When germination takes place, the oospore swells to two or three times its original size, with a dark center; the filament then produced, which is clear except at the base and growing tip, is at first nearly the size of the spore (Fig. 13), and not a mere protuberance from one side as in the germinating zoospores. They were not grown to the production of fruit, and so I cannot say whether they ever reproduce themselves, as is sometimes the case in the genus *Monoblepharis*, or whether they always give birth to sporangia-bearing forms.

* In the diœcious species of *Achlya*, the greater part of the species of *Saprolegnia* and some of *Monoblepharis*, the wall of the oogonium is pierced by many holes, which are undoubtedly designed for the aid of fertilization (See Pl. VII., Fig. 21, and description of *Monoblepharis* further on).

These lateral, spherical oogonia are not the only forms produced, for very frequently in this species there were also developed cylindrical, interfilamental forms (Pl. VI., Fig. 11), which bear a single row of from two to seven gonospheres. I have never seen them terminal, though they always precede the lateral forms borne on the same filament. The gonospheres are of the same size and formed in the same manner as in the other case, but frequently occur oblong instead of round. I could rarely determine the presence of an antheridium, but when seen it extended only to the lower portion of the sac, so that the spermatozoids must pass free into the interior to insure perfect fertilization.

In October, 1877, a very similar form was found upon a leaf-petiole of the sycamore (*Platanus occidentalis, L.*), differing chiefly from the preceding in having oogonia of quite variable sizes, some being as large as forms growing on the pine twigs, while others contained but a single gonosphere each, and were then only large enough to hold it, also in being generally of a deep brown color.

This *Achlya* is, in many respects, similar to *A. racemosa*, Hild. (3), yet there are many differences worthy of notice, although they may not be of sufficient importance to merit for it a specific name. The plant that I have described is much more simple, being slightly branched, when branched at all; the sporangia are always terminal, presenting no raceme-like character whatever; the oogonia are rarely terminal, and the antheridia empty their contents, as a rule, directly into the oogonium;* also the frequent production of cylindrical, interfilamental oogonia. *Achlya lignicola*, Hild. (3), which presents about as prominent differing characters as these, is considered by later authorities (2) (6) to be only a variety of *A. racemosa;* and so in this case I shall designate the form dealt with by *Achlya racemosa*, var., suggesting, at the same time, that *Achlya variabilis* would be a much more appropriate name for the three combined.

In September, 1878, I found a very branching form of *Achlya* growing upon a dead frog which had been trapped in a spring; the water was very cold and fresh, conditions most favorable for the growth of Saprolegnieæ. In this case the filament reached

*I have since seen an antheridium just before, and again just after, the spermatozoids had passed out, and no tube was formed.

a length of 2 cm., and produced both sporangia and oogonia on the same plant. The sporangia were always terminal, produced a little in advance of the oogonia, and gave off a much greater number of zoospores than the form before noted. The oogonia were lateral and borne upon much more slender pedicels than in *A. racemosa*, var. The granules never united to form globular particles, and in segregation remained in proximity to the wall of the oogonium, leaving a light center until assuming spherical forms. The antheridial branches arose from various places on the filament, and never from the oogonium. Before reaching the oogonium, they invariably branched a number of times, the branches clasping the same oogonium, except in rare cases when one passed to another (Plate VI., Fig. 15) or even came in contact with none; the number of antheridia to each female organ varied from one to several, and, in some cases, nearly covered the whole surface of the oogonium. In most of its characters it agreed quite well with *A. polyandra*, Hild. (3), and doubtless belongs to that species (Plate VI., Fig. 15).

MONOBLEPHARIS, Cornu.

As already stated, the distinguishing characters which M. Cornu (2) gives to this genus are, that the zoospores are provided with a single cilium, and the wall of the filaments is not formed of celulose. I have never seen the zoospores passing from the form of sporangium which I have studied, so cannot place it in this genus from the nature of the cilia; moreover, Lindstedt (4, 55) states that there are forms in some of the other genera which produce zoospores with a single cilium; so that this character alone cannot be considered a distinguishing one until the whole group is more thoroughly worked up. In the character of its filaments it agrees with this genus, and the sexual generation more nearly approaches that of *Monoblepharis* than it does any other form.

It differs largely in its specific characters from the two species (*M. sphærica* and *M. polymorpha*), described by Cornu (2, 82), and probably from the third (*M. prolifera*), the sexual reproduction of which he states to be unknown. I do not think that it presents a great enough difference to merit a new genus, and so propose for it the specific name *M. lateralis*, n. sp., which designates, at the same time, the position of the oogonia and of the antheridia.

The first specimens were found upon a fly which had fallen into a dish of creek water. The filaments, about 5 mm. in length, formed a dense mat, differing in general appearance from *S. ferax* found in similar situations, by being very white, when heavily in fruit, instead of light-gray. After a careful examination, other flies were placed in small bottles and sown with spores from the specimens found. In one day from the time of sowing, growth was evident by very short filaments, giving a velvety appearance to that portion of the fly on which they were; in two days the fly was entirely surrounded, the largest filaments having a length of about 4 mm. At the end of the third day many oogonia were present, but, out of some sixty noted, only three had formed gonospheres, four showed segregation, while all the rest were dark and granular or just forming. Good specimens for study were produced, but I could not watch the development of the oogonia with sufficient care. Flies were then placed in watch-glasses and sown with spores from the second crop; this was repeated six times, seeding each experiment with spores from the one preceding, and proved to be a desirable manner of growing to permit examination in their natural condition.

In all cases the fruiting took place on filaments near the surface of the water, where the oogonia were produced in such profusion as to give the mass a white and very fine granular appearance. A meager growth of filaments extended below, but were, in most cases, barren. When the flies sank, so as to be entirely covered by water, a very small number of oogonia were produced. When a young and thrifty specimen was caused to sink, the production of oogonia was very materially checked, and occasional sporangia were produced. Thus we see that for the successful production of the sexual form, the specimen must be near the surface of the water. I could not see that any of the oogonia were formed above the surface, and it will be seen farther on that fertilization could not be effected if such were the case; so the only reason that I can assign for this fact is, that the plant may have some aerial hyphæ, and thus need the action of air on some of its parts. When a very thrifty growth took place, there was formed a light mat of anastomosing filaments just at the surface. Closer observations were not then made, and experiments since, to determine more satisfactorily this as well as other points, have resulted in the non-appearance of the fungus.

As may be already inferred, there is attributed to this genus, as to the others noticed, an alternation of generation. I have not been able to give the parthenogenetic form a very thorough study, but in two experiments which occupied twelve or thirteen days, sporangia, much resembling the late forms in *Saprolegnia*, were produced. They were later than the oogonia, and borne on shorter filaments which radiated from the fly. The oogonia are produced in great abundance at irregular intervals on different sides of the filaments, very seldom appearing terminal. They are developed in a similar manner to the oogonia of *Achlya racemosa*, var., smaller, being from .04 mm. to .05 mm. in diameter, and the contents are more densely granular; the pedicel is as small in proportion to the oogonium as in *A. polyandra*, but generally larger and curved its whole length, giving a drooping character to the organ (Plate VII., Fig. 5). The oogonium membrane is pierced by many holes (Fig. 21)—a provision for the aid of fertilization—in which respect it differs from *M. sphærica*, Cornu, and *M. polymorpha*, Cornu (2, Plate II.), for to these species is attributed a single opening at the extremity of the oogonium. The greatest difference from the sexual generation already described, rests in the development of the male organ, which is ultimately a free body, formed from the side of the oogonium instead of its pedicel, and seldom fertilizing the one from which it is produced.

When the oogonium has nearly reached its full size, there appears a small swelling on its side, generally near the pedicel. This projection increases to form a nearly spherical mass, of about one-fifth the diameter of the oogonium, and filled with granules of varying sizes, though not as dense as the oogonium. Whether this body was formed by a projection through an opening already existing in the outer membrane or not I cannot definitely say, but think it highly probable, for the place of attachment is about the size of some openings noticed, and its membrane is delicate like the inner membrane of the oogonium. It reaches its full size (Plate VII., Fig. 5) in about seven hours, when it is separated from the contents of the oogonium by a diaphragm, and in two hours more a lightly granular protoplasmic body bursts through the top of this lateral cell, escaping free into the surrounding medium (Plate VII., Figs. 6 and 7), leaving a transparent delicate sac attached

to the oogonium. This antherozoid is then spherical and swims off with a slow, irregular rotation. Three minutes after leaving the sac, and after it has settled down to a state of rest, it gradually assumes an irregular shape, and crawls along the filaments, or on whatever object it has chanced to alight, with a true amœboid movement, sending out irregular rounded projections in different directions and drawing itself into a simple mass again, being in many of its shapes so precisely like an amœba that I could hardly believe that they came from the empty sacs seen on the oogonia, until I had watched their development in a number of instances. Several of these antherozoids may be given off from the same oogonium, but never more than one from the same sac; and since many oogonia are developed at the same time, the water surrounding the filaments swarms with great numbers of the antherozoids, making the chances of fertilization almost certain. I have seen as many as five antherozoids on one oogonium. I have carefully noted the change of an amœboid body over the surface of an oogonium, but as there were presented no very important differences, have only given drawings made at intervals of twenty minutes (Plate VII., Figs. 13—18). How long they are capable of continuing this movement I am unable to say, but have noted it in specimens for two hours and a half. When they do not take part in fertilization, they eventually settle down to a spherical form, and are of no further value in the economy of the plant.

According to M. Cornu (2 Pl. II.) the antherozoid in *M. spœhrica* and M. *polymorpha* passes through an opening in the top of the oogonium—the only opening present—to effect fertilization, but in *M. lateralis* the antherozoid sends through one of the many openings a small tube through which the mass of the antherozoid passes, leaving a delicate membrane, but smaller than the antherozoid sac, on the outside. I cannot give the time required for germination after fertilization takes place, but have known it to occur within seven or eight days. These sexual forms have the power of reproducing themselves, for in six experiments, each of which was sown with spores from the one preceding, and with one exception done before any other forms of fruit were produced, each resulted in the development of oogonia.

It was suggested that these forms might be an aquatic con-

dition of *Empusa muscæ*, Cohn., as the specimens were grown in the fall and winter. I have made some experiments bearing upon this point, the results of which I am not prepared to give in detail now, but as a whole they tend to disprove it.

I have never seen any mention made of American forms of this group, but as far as my observations have gone, I find as great a difficulty in identifying them with European species as in the case of the higher Fungi; the variation being in many cases truly specific differences. The group, as a whole, makes a very interesting microscopical study, and those doing microscopical work will find it well worth the while to give specimens with which they may meet, at least a passing observation. They flourish in springs, water-tanks, and fresh pools, also in aquaria containing water-plants. In the vicinity of Cornell University, I have recently found eight different species, representing the genera *Leptomitus*, Agardh; *Saprolegnia*, Eseub.; *Pythium*, Pring.; *Dictyuchus*, Leitgeb.; *Achlya* and *Monoblepharis*, Cornu.

When valuable specimens in aquaria are attacked by these parasitic plants, the following may prove of some use. Mr. S. H. Gage, of the anatomical laboratory of Cornell University, informs me that he effectually removed a species of *Saprolegnia* which had become well seated on an eel, by sponging the animal with a ten *per cent.* solution of carbolic acid; also that specimens of *Menobranchus* infested by the form of *Saprolegnia* treated of in this paper, were thoroughly cleansed by carefully sponging them with camphorated water. Rev. M. J. Berkeley in the "Treasury of Botany," states: "it is said that doses of carbonate of soda prevent their growth, and if so it is probable that bisulphate of potash may be more effectual from its known effects on obscure cryptogamic growths."

In closing I wish to acknowledge the kindness and encouragement of Professor A. N. Prentiss, through which the production of this paper has been rendered possible.

WORKS AND PAPERS REFERRED TO.

1. Berkeley, M. J.; Introduction to Cryptogamic Botany.

2. Cornu, M.; Monographie des Saprolegniees, étude physiologique et systematique (Ann. des Sc. Nat., tome VI., Bot., 1872).

3. Hildebrand; Notes Mycologiques, translated from Pringsheim's Yahrbücher (Ann. des Sc. Nat. Bot., t. VIII., 1867).

Fig. 4. Lindstedt; Synopsis der Saprolegnieen, Berlin, 1872.

5. PRINGSHEIM; Morphologie et étude systematique des algues. (Ann. des Sc. Nat., Bot. tome XI., 1859).

6. PRINGSHEIM; Weiter Nachtrage zur Morphologie und Systematik der Saprolegnieen (Jahrbücher f. Wis. Bot., Bd. IX.. Heft 2. 1873).

7. SACHS; Text Book of Botany.

8. THURET; Recherches sur les Zoospores des Algues (Ann. des Sc. Nat., Bot. 3me. ser. tome XIV., 1850.)

9, REINKE, J.; Über de Geschlechtsverhältnisse von *Saprolegnia monoica* (Archiv f. Mikroskop. Anatomie, Bd. V., pages 183—191).

[The author's corrected proof of the first part of this article was received too late to permit any changes. We therefore add the following errata:

Page 19, line 32 for "*lanceolatus*" read "*lateralis.*"
" 21, " 17 for uniform " read "reniform."
" 21, " 19 for "simple cilium " read "single cilium."
" 22, " 5 for "several modes" read "sexual mode."
" 23, " 4 for "is" read "in."
" 23, " 29 for "another" read "a mother."
" 25, " 13 for "out" read "only."
" 26, " 39 for "unsexual" read "asexual."
" 27. " 17 for "germs" read "genus"—ED.].

## THE SIMPLEST FORMS OF LIFE.

BY B. EYFERTH.

(*Translated from the German for this Journal, with additions.*)

Apart from the purely scientific interest attached to the lower forms of life, the beauty of their appearance under the microscope, their graceful motion and wonderful adaptation to their surroundings, make them objects worthy of careful examination. To those who have an intimate acquaintance with these lower types the classification here presented will not seem entirely satisfactory. However, upon this subject writers will not all agree, and if the author has placed certain forms among animals which we believe to be plants, we cannot criticise him very harshly.

The object in presenting this classification is simply to place before those of our readers who desire some simple classification of common organisms, a plain and easily followed guide by which the specimens they find may be named.

The parts in brackets [ ] are added by the translator. Dimensions are given in terms of m m.

Cells entirely or partly filled with chlorophyll, without admixture of other coloring matter, color, pure green. (CHLOROPHYLLACEÆ.)
- Growth only or principally at the end
  - of a filament consisting of a single branched cell, SIPHONEÆ.
  - of the cell family consisting of several, generally many cells, CONFERVACEÆ.
- Growth in every direction, with division of all individual cells,
  - propagation by swarm-spores, PALMELLACEÆ.
  - propagation by still zygospores after copulation, CONJUGATEÆ.

Cells partly furnished with golden-yellow coloring matter, besides chlorophyll, but covering the latter, DIATOMACEÆ.

Cells likewise with blue or verdigris-green coloring matter, which hides the chlorophyll as above, PHYCOCHROMACEÆ.

## ORDER I. SIPHONEÆ.

Much elongated cells, growing at the ends, which branch by budding. The branches likewise have terminal growth, cell-wall clothed uniformly with chlorophyll granules. Mostly salt water forms. Of the family

*Vaucheriaceæ*, Ktz., there are found living in fresh water and upon moist ground, many species of the genus

*Vaucheria*, D. C. Filamentous, at the base root-like, branched cells without articulations. Only when spores are to be produced do the ends of the branches become jointed. There the swarm-spores originate. Besides these, resting-spores are produced in short, lateral cells, near which are the, usually hook-like, antheridia. The species are only to be distinguished by their fructification. The following are common :

*a.* Oögonia and antheridia lateral, separated, near together.

*V. sessilis*, Lgb. Spores egg-shaped, sessile, the two near together, between them an antheridium of equal length, hook-like, and bent. Very common. Forms loose, dirty green, floating flocks.

*V. dichotoma*, Ag. Spores round, sessile, scattered or in groups, with isolated antheridia. Filaments separated, dichotomously branched. More robust than the former.

*b.* Oögonia and antheridia together on lateral branches.

*V. geminata*, Lgb. Fertile branches three-pronged. The central prong forms an antheridium, the lateral ones bear elongated, often slightly bent spores, blunted above.

*V. hamata*, Lgb. Branches with one oögonium and one hooked, bent, antheridium.

*V. terrestris*, Lgb. With horn-shaped, bent, antheridia, on the back of which lie the single oögonia, with flat bases. Is found on moist ground.

In moist places out of water also take root the small species of the genus

*Botrydium*, Wallroth [*Hydrogastrum*, Desv.], especially on shores subject to inundation.

*B. granulatum*, Grev. Pear shaped little cells, the size of mustard seed, leek-green.

[With a branched, root-like portion growing in the ground. By budding the plants form tufts like bunches of grapes. *Hydrodictyon* is now placed in this family by some writers.]

## ORDER II. CONFERVACEÆ. FILAMENTOUS ALGÆ.

Many celled Algæ of very different forms. Propagated by swarm-spores and oöspores. Many of them are ærial Algæ: in water the following families and genera are found:

Membranous, coherent layers of cells formed by division of the cells in two directions (ULVACEÆ, Agh.)
closed in form of a tube, *Enteromorpha*, Link.
(Leaf-like, lying upon solid bodies: *Prasiola*, Ag., incrusting: *Protoderma*, Ktz.)
Cell family with terminal growth,
Swarm-spores with 2-4 cilia, several in one cell,
Terminal cell often with hair-like point, (CHÆTOPHOREÆ, Rbh.)
disk like, *Coleochæte*, Bréb.
filamentous,
filaments branched with tufted branches
in soft gelatinous matrix, *Chætophora*, Schrk.
in slippery flowing flocks,
branches like the stem, *Stigeoclonium*, Ktzg.
branches finer than the stem, *Draparnaldia*, Agh.
Terminal cell without hair-like end,
Cells longer or as long as thick, (CONFERVEÆ, Ktzg.)
Filaments without branches, cylindrical,
forming swarm-spores, *Microspora*, Thuret.
sterile [no spores observed], *Conferva*, L.
Filaments branched
branches like the stem, *Cladophora*, Ktzg.
branches fine, like hair roots, *Rhizoclonium*, Ktzg.

Cells very short, broader than long, (ULOTRICHEÆ, Ktzg.)
Filaments adhering loosely together [unbranched], *Ulotrix*, Ktzg.
Swarm-spores with crown of cilia, solitary in the articulated cells, others of which expand to spherical oögonia, (ŒDOGONIACEÆ.)
Filaments not branched, *Œdogonium*, Link.
Filaments branched with long bristles, *Bulbochæte*, Ag.
APPENDIX: *Chantransiaceæ*, Rbh. Color bluish-green, violet, or purple-red, spores only in the terminal cells, *Chantransia*, Fr.

## I. FAMILY. ULVACEÆ.

Membranous, coherent layer of cells. Propagation by swarm-spores.

1. Gen. *Enteromorpha*, Link. Tubular or saccate membranes, which grow attached to the bottom or floating free. Cells angular, rounded.

*E. intestinalis*, Link. Tubular fronds, grass-green, 15-30 cm. long, cells 0.01-0.018 d. [size very variable; found also in salt or brackish water.]

2. Gen. *Prasiola*, Ag. Leafy layers upon moist ground, out of water.

*P. crispa*, Ktz. Crispy, wrinkled coatings.

3. Gen. *Protoderma*, Ktz. Forms crust-like coatings.

[4. Genus. *Merismopedia*, Meyen. Cells globose, oblong, joined in families of 4, 8, 16, etc. Free swimming, or resting on the bottom of stagnant pools. On account of the deep green color of the chlorophyll classed by some among the Phycochromaceæ. Propagated by cell division.

*M. nova*, Wood. Cells oval, close, in families of 16; sometimes constricted in the middle, margin of thallus straight, entire.

*M. convoluta*, Bréb. Thallus more or less folded; families composed of 256 cells arranged in sub-families. Cells spherical or oblong, homogeneous, green.

5. Genus. *Schizomeris*, Ktz.? Thallus filliform, cylindrical, here and there strongly contracted, adnate by the strongly contracted base. Growth by cell-division in two or three directions. Propagation by swarm-spores.]

*P. viride*, Ktz. Upon stones under water.

## II. FAMILY. CHÆTOPHOREÆ.

Filaments dichotomously [or otherwise] branched, or laterally tufted. The ends of the branches often with hair-like points. [Fronds invested with gelatin.]

1. Gen. *Coleochæte*, Bréb. The short dichotomously branched

filaments form a flat, discoidal, cellular layer. Swarm-spores form in the outer cells; oögonia are scattered on the surface or erect.

*C. sceutata*, Bréb. Peripheral cells with hair-like ends. Filaments growing into a circular disk.

*C. pulchella*, Rbh. Peripheral cells devoid of hairs, otherwise like the former.

2. Gen. *Chætophora*, Schrk. Branched filaments with tufted branches, in soft gelatinous layers on water plants, etc. Stem and branch cells transparent with transverse bands in the middle (similar to both of the following genera); branches made up of cells rich in chlorophyll. These produce the swarm-spores. Terminal cells of the branches awl-like or bristly, not fruiting and clear. [Filaments combined by gelatin into a compound frond.]

*Ch.pisiformis*, Ag. Globose. Size of a pea. [Formed of numerous erect, radiating, sub-parallel filaments, branching to the surface.]

*Ch.endiviæfolia*, Ag. Layer flat, leathery.

[Harvey says, frond elongated, much branched, branches linear, scattered, or fasciculate, very patent, dichotomous, or pinnate, or secondly ramulose, longitudinal filaments parallel, hyaline, or transversely banded, emitting at short intervals, tufts of multifid bright-green ramuli.]

3. Gen. *Stigeocloneum*, Ktz. Jointed filaments, branched, without gelatinous matrix, branches ramifying, as large as the stem, formed of colorless cells with a transverse band. Branches scattered, close, seldom in tufts, and flabby, with short green cells in which swarm-spores form singly, out of the entire contents. Branches turned about their axes, terminal cells often with bodkin or hair-like bristles. Forms small, green flocks on blades of grass, twigs, etc.

*St. lubricum*, Lgb. Cells of the stem 0.01 d., 2-3 times as long. Terminal cells generally awl-shaped.

*St. protensum*, Dillw. Stem-cells 0.015 d; and as long, or twice as long, slightly turgid. Terminal cells of the branches bristly.

4. Gen. *Draparnaldia*, Bory. Similar to the former, but branches smaller than the stem. [Filaments separate, only differs from *Chætophora* by absence of a gelatinous

matrix uniting the filaments.] Branches tufted, terminal cells hyaline, bristly. Forms lively-green flocks.

*D. glomerata*, Ag. Stem-cells almost or entirely colorless; 0.033 d., twice as long, and more or less turgid in the middle. Branches fan-shaped, horizontal. [Ramuli alternate.]

*D. plumosa*, Ag. Stem-cells like the latter, but larger, as much as 0.04 d; length=½ to 1 d. Branches upright, slightlv expanding, very elongated. [Ramuli opposite.]

[*D. opposita*, Ag., is also described by authors, but it partakes of the characters of both the above species, and is probably not distinct from them.

*D. Billingsii*, Wood. Frond very gelatinous, filament and primary branches d. $\frac{1}{250}''$ very sparsely branched, cells 2-6 times longer than broad, often turgid in the middle. Chlorophyll band bright green, often wanting. Fascicles of branches distant, alternate, opposite, or in whorls of three. Ultimate branchlets terminating in a long, robust, hyaline hair. Resting spores globose, arranged in filaments.]

## III. FAMILY. CONFERVEÆ.

Jointed filaments, the cells of which have the property of self-dividing within the lengthening mother cell, so that each generation deposits a new cell-wall within the earlier.

1. Gen. *Microspora*, Th. Jointed filaments, slender, simple, not branched, with chlorophyll granules lining the walls. All cells produce swarm-spores which are freed by rupture of the filament. Forms floating, flocky masses.

*M. vulgaris*, Rbh. Cells about 0.01 d. L.=1.5-3.0 d., bright green.

*M. floccosa*, Th. Cells more slender, slightly contracted at the ends.

2. Gen. *Conferva*, Link. Slender, unbranched cells, mostly with homogeneous contents, forming loose, floating masses, and which perhaps are only sterile forms of the preceding genus. [Species very difficult to determine.]

*C. tenerrima*, Ktz. Cells pale green, smooth, 0.0035 d. L=2-3 d. Common in springs and ditches.

3. Gen. *Cladophora*, Ktz. Filaments branched, robust, cells several times longer than broad. Forms floating, intricate, often large masses, swimming free, or attached. [Filaments not gelatinous, tufted.]

*C. fracta*, Ktz. Branches scattered, spread out or bent backwards. Cells smooth, 0.1 d. Common in standing water, forming so called "meteoric paper" when the ponds in which it is abundant become dried up. [In salt, brackish, and fresh water.]

*C. crispata*, Ktz. Cells striped, otherwise like preceding.

*C. gossypium*, Ktz. Cells cylindrical, 0.02-0.03 d, L=4-6 d, forms stiff or motionless dirty masses.

*C. glomerata*, Ktz. Branches tufted, bushy, much branched, not grown together at the base. Attached in long, flowing filaments.

*C. canalicularis*, Ktz. Like the preceding, but branches growing together at the base.

4. Gen. *Rhizoclonium*, Ktz. Jointed filaments as in conferva, but with scattered, root-like young shoots. Only known sterile.

*Rh. rivulare*, Ktz. Bright green. In brooks.

[*Rh. riparium*, Roth. Filaments long, slender, pale-green, angularly bent, furnished with root-like processes at the angles.]

## IV. FAMILY. ULOTRICHEÆ.

Filaments of very different forms, with chlorophyll evenly distributed. Cells broad as long.

1. Gen. *Ulotrix*, Ktz. Not branched, very short, jointed filaments; several, often many, swarm-spores form in the cells, and issue through the walls, often already germinating. Numerous forms, difficult to determine, generally of a bright green color.

*U. tenerrima*, Ktz. Cells 0.008 d. and l.

*U. zonata*, Ktz. Cells 0.025 d. and l. For fruiting, constricted somewhat at the ends.

*U. mucosa*, Th. Cells 0.015-0.02. Half as long up to the same length.

Here belong some very distinct forms living out of water: *Hormidium*, Ktz. (*murale*, and others) and *Schizogonium*, Ktz., which form the familiar green coverings on tree-trunks, board fences, etc.

## V. FAMILY. ŒDOGONIACEÆ.

Jointed filaments with dissimilar cells. Many produce from their entire contents a single broad egg-shaped swarm-spore, with a crown of cilia on the tapering end, which, on germinating produces a root-like growth. Other cells produce several small (male) swarm-spores, still others expand into spherical oögonia, to which the androspores

become attached, and set free the spermatozoids. The latter pass from the cell, the roof-like cover being opened, and enter the oögoium through the opening likewise prepared, and fertilize the contents, from which now a single resting spore is formed.

1. Gen. *Œdogonium*, Link. Unbranched, often hair-like filaments at the ends, at first growing attached, later free, forming intricate, floating masses. Species numerous.

*Œ.capillare*, Ktz. Cells 0.033 d., and of equal or twice this length, with spherical spores, which entirely fill the slightly turgid sporangium. Very common, and often forms "meteoric paper."

*Œ.fonticola*, Al. Br. Similar to the former, but spores angular.

*Œ.minutum*, Ktz. Only 0.005.

*Œ.tumidulum*, Ktz. Cells 0.03 d., 2-6 times longer; spores spherical, loose, in elliptical sporangium.

*Œ.ciliatum*, Hass. Cells 0.01 d. (? 0.02), 2-6 times as long. Terminal cell bristle-like, transparent, very long. Basal cell club-shaped, with spread-out or disk-like foot, attached to water plants. Sporangia egg-shaped, much inflated, entirely filling the spore.

*Œ.capillaceum*, Ktz. Cells 0.01 d., of equal length, or twice as long, with roundish egg-shaped spores, that fill the slightly turgid sporangium. In large masses.

2. Gen. *Bulbochæte*, Ag. Short, branching, jointed cells, often on other Algæ, with club-shaped, thickened cells which bear laterally above a long bristle with a thickened bulbiform base.

*B. setigera*, Ag. Cells 0.02 d., 2-5 times as long. Spores spherical, verrucose, not entirely filling the sporangium.

Genus. *Chantransia*, Desv. Jointed filaments branching, cylindrical, with delicate, transparent membrane, and red or bluish contents.

*Ch.Chalybea*, Fries. Cells 0.01 d, tufted, of about 1 cm. in length. Springs and brooklets.

## ORDER III. PALMELLACEÆ.

Single celled, chlorophyll-green Algæ, of round or elongated form, living singly, or together in families.

### FAMILIES AND GENERA.

Multiplying only by free cell formation (swarm-spores), *Protococcaceæ*, Ng.

Multiplying by cell division in the last generation, sometimes by swarm-spores, *Palmelleæ*, Ktz.

Protococcaceæ.

Cells single, without gelatinous investment,
- spindle-shaped, stalked, fixed, *Characium*, A. Br.
- cylindrical, worm-like, crooked, *Ophiocytium*, Ng.
- three or four cornered, *Polyedrium*, Ng.

Cells together in families,
- cylindrical, fixed, in tree-like groups, *Sciadium*, A. Br.
- cylindrical, in reticulated large masses, *Hydrodictyon*, Roth.
- elliptical, with points, bound together in series, *Scenedesmus*, Meyen.
- cells in single layers, or two or more strata, discoidal families, *Pediastrum*, Meyen.
- club-shaped, *Sorastrum*, Ktz.
- roundish, polyhedric, in hollow balls, *Cœlastrum*, Ng.
- quadratic, in cubical families, *Staurogenia*, Ktz.

## I. FAMILY. PROTOCOCCACEÆ.

Propagation by division of the cell contents into large and small parts, which form swarm-spores.

[Unicellular, living single or in families. Both macrogonidia and microgonidia are produced; the first oblong, with two cilia, grow into new plants, the second into resting-spores.]

1. Gen. *Characium*, A. Br. Cells long, egg or spindle-shaped, stalked, growing attached to other plants, ends colorless. Swarm-spores produced by repeated division of the cell contents. [A doubtful genus. Very likely these plants are stages in the development of others.]

*Ch. minutum*, A. Br. and others. In standing water on filamentous Algæ.

2. Gen. *Ophiocytium*, Ng. Cells cylindric, bent, worm-like, with a little point on one end. Swarm-spores eight.

*O. apiculatum*, Ng. Swimming free in ponds and ditches.

3. Gen. *Polyedrium*, Ng. Cells 3-4 angled with thorny points on the angles.

*P. trigonum*, N. and P. *tetragonum*, N. Swimming free, single, in swamps and ditches.

[*P. enorme*, De Bary. This is the only species known in America; found in Florida. Frond irregular or quadrate, spinous, end view 3-4 lobed, lobes more or less emarginate or bifid with simple or branched spines.]

4. Gen. *Sciadium*, A. Br. Cells cylindrical, fixed with stalk-like base, above single or ramified. Swarm-spores 6-9.

[The young plant is attached to foreign bodies, and consists of a cylindrical cell in which are produced 8 gonidia; the top of the cylinder falling off the gonidia emerge and form an umbel of similar cylinders, the bases of which stick in the primary cell. The gonidia of the third generation are set completely free and become primary cells of new families (*Mic. Dict.*).]

*Sc. arbuscula*, A. Br. Cells 0.2-0.3 long. In ditches, swamps, etc.

5. Gen. *Hydrodictyon*, Roth. Cells cylindrical, with the ends bound together into large reticulated hollow sacs. The ordinary swarm-spores (Macrogonidia) arrange themselves into new sacs within the mother cells, which later disappear; others (Microgonidia) swarm out, remain first at rest, then return, after a generative change, to their original form.

# Editorial.

## MICROSCOPIC VISION.

The subject of microscopic vision has been carefully studied by Prof. Abbe, but his results have not yet been placed before the American public in a clear light. Recently, Mr. Frank Crisp read a paper before the Quekett Club entitled, "The Influence of Diffraction in Microscopic Vision," in which the main results of Prof. Abbe's studies, upon the formation of the image in the microscope, are plainly stated. On removing the eye-piece of the microscope, previously focussed upon a lined object, and looking down the tube, we see not only a small circle of light but also a series of colored ovals with the blue nearest the center. These ovals are diffraction images of the open front of the objective. As the light passes through the lined object it is decomposed and the colored rays produce the colored images of the opening, the blue being within the others, on account of its greater refrangibility.

From a study of these diffraction images Prof. Abbe has adduced the theory that the image formed in the microscope is generally made up of two images, one of which shows the larger parts—the outlines &c.; the other giving the finer structure—markings and minute structure. The first is the dioptric image, formed as we are accustomed to explain it; the other is produced by the spectral rays. If we stop out the central rays so that only the spectra are to be seen, and then replace the eyepiece, we shall only see the fine markings. If we stop

out the spectral images and admit the dioptric beam, the grosser parts of the object, the outlines *e. g.*, will be visible, but not a trace of the minute structure. Mr. Crisp was provided with a series of diaphragms placed behind the objective, which enabled him to illustrate these facts.

It is well known that the finer the ruling the greater is the dispersion produced, hence, our diffraction images will be more or less widely separated according to the closeness of the lines on the object. By taking two series of lines, one set ruled twice as closely as the other, the diffraction images of the latter will be twice as far apart as those of the former. It is a curious fact that by arranging a diaphragm to cut out the intermediate spectra of the coarser band (thus leaving spectra corresponding in position to those of the finer set of lines), we will see in the microscope double the number of lines actually present; *i. e.*, the same number as are in the finer band. We have not space to treat this subject more fully now, but we hope to give a good account of Prof. Abbe's investigations in the near future. It appears that the image in the microscope is of a peculiar spectral nature, and does not necessarily show us the true structure of an object; or, as Mr. Crisp says: "It is not possible to determine the real structure of *P. angulatum* merely from its image as presented by the microscope." It would seem that the microscopist of the future will need to be also a mathematician, if he is to study minute structure.

## YELLOW FEVER.

Medical literature has lately embraced many contributions relating to yellow fever and the germ theory of disease.

In the *American Practitioner* of November, 1878, Dr. J. B. Marvin, of Louisville, has an article upon yellow fever which is of sterling value. The microscopical observations may be stated briefly as follows: "Pure glycerin was placed upon a slide and breathed upon by the patient. After a few minutes, large quantities of active vibrios and bacteria were revealed. The blood-corpuscles were crenated, frequently breaking up. After the occurrence of black-vomit there was found a great increase in the number of white corpuscles, frequently one white to five red ones. Bacteria and vibrios were found in the blood, as many as five or six being found in the field at once.

Unlike many observers, Dr. Marvin hesitates to attach much importance to their presence. The hepatic cells were granular and often stained with bile, with many oil-globules surrounding them, showing fatty infiltration as well as degeneration. Sections of the kidneys frequently showed tubal and intertubal hemorrhages, and some indications of fatty degeneration. "The disease is clearly dependent upon a specific blood-poison as yet not demonstrated by the microscope, unless we regard the changes found in the blood, as detailed above, as the *cause* rather than a *result* of the disease. By adopting the theory of specific blood-poisoning, the symptomatology of the disease is readily understood."

No restrictions seem to have been imposed upon the employees of the hospital. People from the city paid frequent visits to the wards. No clothing was burned or disinfected, and yet, not one of these persons was troubled with the disease.

## A LETTER FROM PROFESSOR ABBE.

On page 30 of the paper "The Oil Immersion of Carl Zeiss Compared, Etc.," in the first issue of this Journal, Prof. H. L. Smith pronounces the objective tested by him to be a three-system objective, in opposition to the statement of Mr. Zeiss's circular. I hope Prof. Smith will give credit to my assertion, that the objective in question is, really, a four-system; *i. e.*, is composed of four separate lenses, though, in his opinion, the front lens may be too large for any four-system combination of equivalent focus.

Relative to the aperture of these objectives I beg to state, that every standard $\frac{1}{18}$th or $\frac{1}{12}$th made on this immersion plan by Mr. Zeiss, will admit, and *bring to an exact focus*, rays of such an obliquity that, the angle of the extreme ray with the axis being considered in the immersion-fluid, or in any other medium in front, the *sine* of this angle multiplied by the index of this medium yields a product equal to the number 1.26 to 1.27; which corresponds to a balsam-angle of 114 to 116 degrees.

But I must add, that in consequence of a mistake in the application of my formulas, caused by me, several specimens of the $\frac{1}{18}$th have been made with a balsam-angle of 107 to 109 degrees only (not less). This defect having been overlooked for a short time, some of these lower-angled glasses have been sent away—two or three to England, and one to America. From what Prof. Smith mentions about the aperture of the objective, I infer that he has examined the lower-angled $\frac{1}{18}$th which was sent to Charlestown, near Boston.

I beg not to be understood as intimating by this remark, that in this case the slight difference of aperture would hold good for any notable difference in the performance of the lens, in comparison with a standard objective of the same kind—which is not at all my opinion.

I must consider as of much greater importance for the result of a given trial that the length of the tube, in observing with the oil-immersion, be accurately adjusted according to the direction in Mr. Zeiss's circular; and that for observations with oblique light the oil be applied which Mr. Zeiss prescribes for oblique light, and for observations with central light the oil prescribed for central light.

JENA, Dec. 14th, 1878. DR. E. ABBE.

## NOTES.

—In a recent letter to the editor, Mr. W. H. Bulloch, of Chicago, writes: "If it is not too late, will you put a notice in your next number that one of my 'Congress' stands will be on exhibition at your office?" This explains itself, and any reader who is interested will be welcome to examine this stand as soon as it arrives. It is the rival, and the only one, of the "Centennial" of Mr. Zentmayer; and as one of the latter is also in this city on exhibition, we are glad to afford this opportunity for their comparison.

—Professor Engelmann thinks that the contents of the contractile vesicles of the Infusoria are expelled into the surrounding water. He was not able to determine whether any water was taken in during expansion, but believes not.

—White of egg is now recommended as an imbedding medium for soft tissues. The material to be imbedded, freed from alcohol, is placed in the albumen in a little paper box, and the whole exposed to heat until it becomes hardened, then placed in alcohol as usual. The sections should be passed through oil of cloves into balsam. The albumen thus becomes clear and transparent.

—It is stated that a cold 5–6 *per cent.* solution of borax will remove all the red, blue, purple, or violet coloring matters from vegetable cells, leaving the green chlorophyll intact.

—The study of bacteria promises to be greatly aided by the recent processes for staining them. The most elaborate process, and the one giving the best results, is that of Dr. Koch, of Wollstein. In brief, his process is as follows: A drop of the fluid containing bacteria is placed on a slide and dried in a very thin layer. For simply preserving the forms, a solution of one part of potassic-acetate in two parts of water, is added, and a cover cemented on. To stain them, aqueous solutions of methyl-violet, known to the trade as B B B B B, and fuchsin are preferred, although almost any anilin colors will act. For photographic purposes,

anilin brown is used. The dried specimens are simply treated with the coloring fluid, which moistens and stains without removing them from the glass. For mounting as permanent objects, only those stained with methyl-violet or fuchsin can be preserved in Canada balsam. Glycerin is best for those stained in anilin brown, and potassic-acetate may be employed with the methyl-violet and fuchsin for photographic purposes. A more rapid process, perhaps more suited to the wants of medical practitioners, is that of Dr. W. A. Haupt. The coloring matter (hæmatoxylin, anilin violet, fuchsin, erythrusin and others in aqueous solution) is added to the fluid containing the Fungi, and when sufficiently stained, as shown by the microscope, thin layers are dried on the slide, and mounted. Hæmatoxylin is highly spoken of. *Bacterium termo* is the most difficult to color well. Both processes are given more fully in the *Zeitschrift für Mikroskopie*, 1878; but by following this brief outline success will be assured.

—It appears, from the remarks of Prof. W. C. Williamson, before the Dublin Meeting of the British Association, that we have, as yet, no proof that Radiolarian or Diatom remains have been found in the Carboniferous rocks of Britain.

—Dr. Lang, of Berne, uses the following mixture for preserving Planaria, and finds that the color and histological characters are retained:

| | | |
|---|---|---|
| Distilled water | 100 | parts by weight. |
| Sodium chloride | 6–10 | " " |
| Glac. acetic acid | 5–8 | " " |
| Mercury chloride | 3–12 | " " |
| Alum | ½ | " " |

This fluid kills the worm in its natural shape. After half an hour, remove the fluid and harden in alcohol of increasing strength up to absolute. For staining, picro-carmine is preferred.

—We have received from Mr. Tolles and Mr. Stodder, of Boston, an admirable photograph of *Amphipleura pellucida*, taken with a Tolles's 1-10th. The frustule was magnified 2,500 diameters, and the lines are seen well defined throughout its entire length.

—The Zoölogical Laboratory of Prof. Alexander Agassiz, situated at Newport, R. I., as described in the annual report of the *Curator* of the Cambridge Museum of Comparative Zoölogy, appears to be admirably adapted to the wants of students. It is fitted up with tanks supplied with sea-water, with all the arrangements for aerating; and so perfectly is this carried out that the most delicate animals can be kept living much longer than is usual in aquaria. Prof. Agassiz designs to accommodate in this laboratory students of the museum, and also teachers in the common schools.

—The Johns Hopkins University has established a summer laboratory for the study of Zoölogy. It is situated on the Chesapeake Bay, and is under the charge of Associate W. K. Brooks, who has already shown

the value of the laboratory in the study of the marine fauna of that location. The laboratory is intended to furnish advanced students with opportunities for original investigation; to provide material for winter work; to give practical instruction in the methods of marine zoölogical work; and to increase our knowledge of the zoölogy of the Chesapeake. As to the scientific results of the first year's labor, they are highly creditable and promise well for the future. Mr. H. J. Rice studied the development of *Amphioxus*, and was able to make valuable additions to our knowledge of this interesting vertebrate, which is thought to be a rarity on this coast. *Lingula* was studied under particularly favorable conditions, and Mr. Brooks was able to follow its development from a very early stage up to the adult form.

## LABORATORY NOTES AND QUERIES.

1. Very excellent permanent preparations of the red blood-corpuscles of Amphibia may be made by Ranvier's method, as follows: Some blood is allowed to drop from a wound into about 200 times its volume of a saturated picric acid solution. After a few minutes the picric acid is carefully poured off, leaving most of the corpuscles at the bottom of the dish; a solution of picrocarmine is then poured over them, and allowed to stand a day or two. The picrocarmine is then poured off and the sediment put into acid glycerin (glycerin 100 parts, acetic acid 1 part). The corpuscles so treated will last a long time, and may be mounted in the acid glycerin at any time. The nuclei of the corpuscles are stained bright red, and the body light yellow. Corpuscles of *Menobranchus*, which are about twice as large as those of the frog, prepared in this way nearly a year ago, appear perfect as ever.

2. When tissues are imbedded in paraffin for making sections, the imbedding mixture gets into the meshes of the loose, external, connective tissue, and the mouths of the ducts, glands, etc., so that the outlines of the sections are greatly obscured, unless they are put into some medium that dissolves the paraffin. If they are to be mounted in glycerin, or some other fluids, this cannot be done except by tedious manipulation. The imbedding mixture may be kept entirely away from the tissue, by first dipping it into thick gum-arabic, and then putting it into strong alcohol for a short time. The alcohol hardens the gum, which forms a protecting coat, and also a mechanical support for the loose connective tissue around the outside. The gum may be dissolved from the sections by immersing them for an hour or two in 25 *per cent.* alcohol. Sections prepared in this manner may be cleared, and mounted in balsam or damar, by the usual method.

3. In a very able article upon the preparation of rocks and fossils for microscopical examination by R. Fritz Gaertner, in the April num-

ber of the *American Naturalist* for 1878, the advantages of slides measuring 25×45 mm. over those 3×1 inch, were stated to be as follows: (1) They can be rotated on the stage; (2) they are less liable to break if dropped; (3) they take up less room. It was also stated that this size was adopted by the New York State Museum of Natural History, and by lithologists and palæontologists generally, both in Europe and America.

These arguments seemed to me quite as valid as applied to microscopical objects in general; I therefore adopted this size (25×45 mm.) for my own preparations, and they have proved very satisfactory indeed.

S. H. GAGE.

## DIGEST OF CURRENT LITERATURE.

IT is intended to make this a valuable record of the work going on throughout the world. As may be readily understood, it is impossible to make the record complete in our first one or two numbers For the accuracy of these abstracts the Editor holds himself personally responsible. Reprints will be noticed only by title, as a rule.

### THE JOURNAL OF THE ROYAL MICROSCOPICAL SOCIETY

*November*, 1878.

ON THE FOSSILS CALLED "GRANICONES;" BEING A CONTRIBUTION TO THE HISTOLOGY OF THE EXO-SKELETON IN REPTILIA.—Professor Owen.—The name "Granicone" was applied by the author to designate certain bodies found in the "feather-bed stratum" of Dorsetshire. From microscopical examination of thin sections it is concluded that "the granicones are dermal scutes, that they are Lacertian, and, as far as contiguity and association indicate, have formed part of the extert nal armor of the large, extinct Purbeck Lacertian, *Nuthetes destructor*."

ON SOME NEW GENERA AND SPECIES OF DIATOMACEÆ.—P. Petit.—Translated by F. Kitton.

FURTHER REMARKS ON A "SIMPLE DEVICE" FOR THE ILLUMINATION OF BALSAM-MOUNTED OBJECTS, FOR EXAMINATION WITH IMMERSION OBJECTIVES WHOSE BALSAM-ANGLE IS 90° OR UPWARDS.—J. J. Woodward, Surgeon, U. S. A.—Dr. Woodward mounts his prism by cementing the truncated right-angle to a piece of brass upon the end of a straight rod. The rod is slipped into the holder of the dark-well.

### THE JOURNAL OF THE QUEKETT CLUB.

*October*, 1878.

ON AN APPARATUS FOR FACILITATING THE USE OF "POWELL'S SMALL BULLS-EYE" ILLUMINATOR IN THE RESOLUTION OF TEST OBJECTS.—Geo. Williams.—The diatoms are mounted upon a circular disk of glass, supported on a holder. The flat side of the condenser is placed next to the disk, thus condensing the light very obliquely upon the frustule. The disk can be revolved to place any diatom in the proper direction.

On the Influence of Diffraction in Microscopic Vision.—Frank Crisp.

Address of the President.

## ZEITSCHRIFT FÜR MIKROSKOPIE.

*October*, 1878.

Development and Present Condition of Microscopy in Germany.—Dr. Edward Kaiser.—Concluding article of a series upon this subject. An historical summary of the work of German investigators, containing copious references, which is of great value.

On Preparation and Preservation of Microscopic Water-Inhabitants.—For some time Duncker, of Bernau, has been selling a fluid in which Infusoria are well preserved, but its composition is a secret. The author has used a medium which he thinks may be the same, at least it acts equally well. For preserving Infusoria, Rhizopoda, Flagellata, Ciliata, Chlorophyllaceæ, Desmidiaceæ, Acineta, Daphnia, etc., the following process is followed:

In the center of a lac-cell, not fully hardened, place the organism in a few drops of water, apply the cover-glass, and then place a couple of drops of Pyroligneous acid so that it will be drawn into the cell. Cement the cover down and the work is done. The objects may be stained by such anilin colors as are soluble in water (the best are anilin blue, or diamond fuchsin) by staining in the following solution:

Anilin blue, 1 part, water, 200 parts, after filtering, Pyroligneous acid, 800 parts (all by weight). This stains the objects in a few hours, and they may then be mounted in pure Pyroligneous acid.

Study of Foreign Microscopes.—Dr. J. Pelletan.

A New Cover-Glass Tester.—A simple device for measuring the thickness of glass covers.

On Collecting and Cleaning Diatomaceous Material.—C. Janisch.—Silk gauze is useful to separate small from large forms, and diatoms from foreign matters.

## JOURNAL DE MICROGRAPHIE.

*November*, 1878.

Micrography at the Exposition of 1878.—Dr. J. Pelletan.—A review of the decisions of the jury on instruments of precision.

In every respect the decisions do not appear to the author just. Mr. Zentmayer's "Centennial" stand was worthy of the finest gold medal, which he did not secure.

List of Prizes at the Exposition.—A full list of prizes and medals given for instruments of precision. Among the names familiar to our readers we mention the following:

M. Cailleett received a grand prize; Brunner frères a grand medal; Dallmeyer, Dubosque, Nachet, Prazmowski, Ross, Chas. A. Spencer

and Sons, Verick, all received gold medals. The Bausch & Lomb Optical Company, Crouch, Pillischer, Plössel & Co., Swift, and Joseph Zentmayer, silver medals.

LYMPHATIC HEARTS.—Prof. L. Ranvier.—Action of poisons and résumé of the subject. Among other results arrived at are the following:

1. The lymphatic hearts constitute simple organs, composed of a contractile vescicle, in which no distinct parts can be admitted comparable to auricles and ventricles.
2. They present variable interior characters.
3. They belong to the lymphatic system, and not to the venous system.
4. Their musular fibers are striated, but they differ from those of the heart.

The subject is not yet completed.

ANGULAR APERTURE OF OBJECTIVES.—Dr. Geo. E. Blackham.—Memoir read before the Buffalo Microscopical Club.

STUDIES ON FOREIGN MICROSCOPES.—Dr. J. Pelletan.—Continued. A full description of Bulloch's "Congress" stand is given, illustrated by full page engravings.

OBJECTIFS A LIQUIDE INTERPOSE.—This is the heading of an article describing Gundlach's new glycerin objectives, made by the Bausch & Lomb Company.

THE NEW $\frac{1}{8}$ OIL-OF-CEDAR IMMERSION OF CARL ZEISS.—Dr. Henri Van Heurck.

## THE AMERICAN JOURNAL OF MICROSCOPY.

*October*, 1878.

This number opens with an article on VOLVOX GLOBATOR, illustrated, taken from *Popular Science Review* A translation entitled "Prof. Abbe on the DEFINING AND RESOLVING POWERS OF THE MICROSCOPE is given, and Mr. John Michels states the results of his examinations of OLEOMAGARINE BUTTEER. We will not review this subject here, as it will be more fully treated in these pages in future. THE HARD TISSUES OF ANIMALS—THEIR ORIGIN AND FORMATION is the title of a paper read before the San Francisco Microscopical Society by Mr. Xenos Clark.

(*November*, 1878.)

THE GERM THEORY OF DISEASE, AND ITS PRESENT BEARING UPON PUBLIC AND PERSONAL HYGIENE.—Prof. Jos. G. Richardson. HYALODISCUS SUBTILIS AND H. CALIFORNICUS, by F. Kitton, with some additional remarks by Prof. H. L. Smith. NOTES ON MICROSCOPIC LIFE IN THE BUFFALO WATER SUPPLY, by D. S. Kellicott. THE WOODWARD PRISM is discussed by J. D. C., and there are two articles on Zeiss's OIL-IMMERSION OBJECTIVES; one from the *English Mechanic*, describing the 1-12 inch, the other from the October number of this journal.

## GREVILLEA.

*September*, 1878.

This number contains several lists of Fungi from California. A new disease of the vine, known as ANTHRACNOSE, which appeared during 1878 in the Narbonne district of France, was the subject of a communication by Dr. Maxime Cornu, published in the *Bulletin of the Botanical Society* of France, a translation of which is here given. Anthracnose is caused by a fungus, which produces a circular black spot with a white center upon the grapes, and corrodes or burns through the stem even to the pith. It resembles *Cladosporium*, but is much smaller. At Étamps, the vine has been attacked by a fungus, probably a *Cladosporium*. The development of both of these may have been caused by the unusual rainfall of the year. An article on *Chætophoma*, by M. C. Cooke, will be read with interest by students of Fungi. *Chætophoma* is the name applied to a number of small forms, which may be the pycnidia of other known Fungi. A Proposal of PHÆNOLOGICAL OBSERVATIONS ON MOSSES, by William Arnell, deserves attention. The importance of the study of periodical phenomena need not be insisted upon at this day.

## PROCEEDINGS OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA.

*April—September*, 1878.

There are several articles in this number of interest to microscopists. Dr. Joseph Leidy has found *Amœba quadrilineata* common in this country, and, associated with it, *Amœba verrucosa*, which he believes is merely the young of the former. He believes the forms *Amœba natans*, Perty, *Amœba terricola*, Greef, and *Thecamœba quadripartita*, Fromentel, to be the same as *Amœba verrucosa*. A NEW SPECIES OF SPONGE, *Aplysina pedicillata*, Hyatt, probably from the East Indies, is described and figured by Alpheus Hyatt. It measures from a foot to sixteen inches in length, and not over one and one-eighth inch in diameter. The walls of the tubes are composed of fibers of two kinds; the inner surrounds the tube, the outer consists of palmate extensions of the inner sheet. The meshes are usually quadrangular, fibers hollow, the primary ones filled with debris. The sponge is referred to the genus *Aplysina*, although it also possesses characters belonging to *Verongia* and the true Spongiæ.

Prof. Leidy placed on record a number of synonyms and descriptions of some new species of Rhizopods. The species belonging to *Euglypha*, *Trinema*, *Pamphagus*, and *Cyphoderia*. A very interesting account is given of some *Amphipoda* from mid-ocean, collected on the Pacific by Surgeon W. H. Jones, U. S. Navy. The specimens collected are fully described, and a plate accompanies the article. Several new species were found, and a new genus, *Calamorhynchus*, was required for one form. This genus is thus characterized:

"*Calamorhynchus*, n. gen. Body elongated, slender, almost rod-like. Head large, depressed; produced anteriorly to the eyes in a broadly expanded, triangular rostrum, constricted behind the eyes into a short, narrow neck. Superior antennæ, with the peduncle three-jointed; in the female, straight. First and second pairs of thoracic legs, small, chelate; the fourth joint broad and long; the fifth, short and narrow. The last three pairs of legs with the basal joint narrowly dilated; the seventh pair diminutive. The sixth segment of the abdomen long and narrow. Caudal appendages long and linear. Telson short, triangular."

An interesting part of this article throws light upon the habits of these Crustaceans. During the day-time, almost nothing could be collected by the tow-net, except under peculiar conditions. A quiet sea and a dark, cloudy night are the most favorable for this kind of collecting. Bright moonlight and rough weather seem to drive them from the surface. About twilight, or just after dark, they come to the surface and remain for two or three hours.

PROF. LEIDY has incidentally examined the shore sands of Cape May and Atlantic City, and found shells of Foraminifera between tides, They all appeared to be *Nonionina millepora*.

DR. J. G. HUNT examined the flower of *Stapalia asterias* under the microscope, and observed flies eating the excretion covering certain parts, but the instant any one touched, with its tongue, one of five black spots, situated near the stamens, the tongue was seized and firmly held, and the insect could only escape by tearing out the black spot, carrying with it masses of pollen. Mr. E. Potts had examined species of *Asclepias*, and found that the black spots in these flowers were sensitive and possessed contractile power.

Drs. Elliott Coues and H. C. Yarrow publish an article entitled NOTES ON THE NATURAL HISTORY OF FORT MACON, N. C., AND VICINITY, being the continuation of a series of similar contributions. As an appendix to the above, J. S. Kingsley gives a list of DECAPOD CRUSTACEA OF THE ATLANTIC COAST.

## NEW YORK MEDICAL JOURNAL.

*November*, 1878.

Dr. William Hassloch describes some results obtained in examining certain FUNGI, using gold chloride as a staining fluid. He employed a one-half *per cent.* solution, which stains in from one to six hours, and the specimens were mounted in diluted glycerin.

According to these researches, the fine granules, seen in the mycelium and in various parts of these plants, are connected by very delicate threads, giving a peculiar net-work appearance to the filaments. The granules of yeast are likewise united in this manner. In the vacuoles, isolated granules are also found.

In the December number, Dr. J. E. Atkinson, of Baltimore, gives the results of his experiments in the cell culture of TRICHOPHYTON TONSURANS. The paper is an interesting one. The cell used consisted of

a ring cemented to a slide, with a thin cover containing the nutritive fluid and spores upon its under surface, the interior being protected from outside influences by a few drops of oil around the edge. The growth of the fungus was carefully watched, and, in spite of some minor differences, the author believes this fungus is a *Mucor*.

—*Index Medicus* is the title of a new monthly periodical which is to appear in January, 1879. It is to be a classified record of the current medical literature throughout the world, compiled under the supervision of Dr. J. S. Billings, Surgeon, U. S. A., and Dr. Robert Fletcher, M. R. C. S. F. Leypoldt, 37 Park Row, New York, is the publisher. A work of this kind will be of great value to students of medicine and deserves their hearty support.

—*Science News* is a fortnightly magazine, of 16 pages, octavo size, published by S. E. Cassino, Salem, Mass., for $2.00 per year. Ernest Ingersoll and Wm. C. Wyckoff are the editors. The first number was issued November 1, 1878. It aims to publish all scientific news promptly, and furnish notes of current literature. The first three numbers have reached us, and the matter is excellent. It seems to be just the kind of a journal for a large class of readers, and we believe it is to become a valuable periodidal.

—Mr. S, H. Gage writes: "Among some eels received at the anatomical department of Cornell University, in March 1874, there was a female with the ovaries very large and crowded with ova, averaging about 23 mm. in diameter. The nucleous and viteline membrane were both very plain. In October of the present year, a very large eel was received from Cayuga Lake. In this the ovaries were likewise conspicuous, but upon examination, their size seemed to be mostly due to an accumulation of fat; but ova were also found in great abundance; their average size being only .092 mm. The nucleous and viteline membrane were very evident."

## MICROSCOPICAL SOCIETIES.

### MICROSCOPICAL SOCIETY, OF CAMDEN, N. J.

The popular interest in microscopy is growing rapidly in this country. We are pleased to notice the formation of THE MICROSCOPICAL SOCIETY, OF CAMDEN, N. J. We trust that the energy displayed by the members thus far will not be allowed to grow less in the future.

### SAN FRANCISCO MICROSCOPICAL SOCIETY.

We receive regularly the reports of the meetings of this society, for which our thanks are due. Among the recent papers read, we mention the following: "The Hard Tissues of Animals—Their Origin and Formation," by Xenos Clark, September 19; "The Microscope in Medicine," by Dr. S. M. Mouser, October 3; "The Fruiting of Sea Lettuce," by Dr. C. L. Anderson, November 7. On the evening of November 21, President H. C. Hyde read a long paper on "The Microscope in

Medical Jurisprudence." in which he showed the value of this instrument in examining blood in trials, and treated the subject in an interesting manner.

### THE STATE MICROSCOPICAL SOCIETY, OF ILLINOIS.

The members of this society were recently entertained by the Calumet Club of Chicago. About eighty microscopes were exhibited, besides other apparatus, and the evening appears to have been enjoyed by all. Among others, the objects shown by Dr. W. T. Belfield and H. F. Atwood, are worthy of more than a passing notice. These gentlemen had been feeding Trichinæ to some rats, and some pieces of muscle from these animals were placed upon a warm stage, and the worms were thus shown in the living condition, moving about. It is claimed that this is the first time that living Trichinæ have been shown in public. The value of such exhibitions, in arousing a public interest in scientific studies, must be very great, and we trust they will become more frequent.

### TROY SCIENTIFIC ASSOCIATION.

The officers of the microscopical section for the ensuing year are as follows: Chairman, Dr. R. H. Ward; Vice-Chairman, Rev. A. B. Hervey; Secretary, C. E. Hanaman. At a recent meeting Mr. Hervey described the development of the cellular structure of plants. The subject of micrometry was brought up and referred to a committee consisting of Dr. R. H. Ward and Prof. A. W. Bower.

## BOOK NOTICES.

AN OUTLINE OF GENERAL GEOLOGY, WITH COPIOUS REFERENCES TO THE BEST AUTHORITIES. DESIGNED FOR THE USE OF BOTH GENERAL AND SPECIAL STUDENTS. By Theo. B. Comstock, B. Ag., B. S. University Press, Ithaca, N. Y., 1878. In this volume, Professor Comstock has systematically arranged such prominent facts and figures of geological science as ordinarily constitute the groundwork of a course of lectures in our best colleges. It seems to us well adapted to the purposes for which it is designed, and the system is the result of several years of practical experience.

A valuable feature of the work is found in the numerous references to authorities, thus directing attention to the most accessible sources of information upon particular subjects.

Space is provided for additional notes and drawings by liberal interleaving with blank pages. The work throughout bears evidence of great care on the part of the author. A number of important tables are given, and many illustra-

tive examples of subjects but little discussed in text-books, some of the latter embodying the results of the author's own observations in South America, the Yellowstone Park, British America, and elsewhere. The parts devoted to Physiography and Archæology are quite fully outlined, and the various theories of subterranean agencies, mountain elevation, etc., are concisely presented A classification of plants and animals, with brief descriptions of groups of geological importance, occupies six closely-printed pages, and must prove very useful as a reference table.

## PUBLICATIONS RECEIVED.

POPULAR SCIENCE MONTHLY. October–January, 1879. JOURNAL OF THE ROYAL MICROSCOPICAL SOCIETY. November. PROCEEDINGS OF THE BOSTON SOCIETY OF NATURAL HISTORY. Vol. XIX., parts I., II., III., IV., and Memoir on *Distomum crassicolle*. SMITHSONIAN REPORT. 1877. GREVILLEA. September, December. THE NORTH AMERICAN REVIEW. November, December. NATIONAL QUARTERLY REVIEW. October. NEW YORK MEDICAL JOURNAL. November and December. VAN NOSTRAND'S MAGAZINE. November, December. MEDICAL RECORD. October, December. NEW PREPARATIONS. July. CATALOGUE OF THE PUBLISHED WORKS OF ISAAC LEE, LL.D. Pamphlet, pp. 22. Philadelphia. FURTHER NOTES ON "INCLUSIONS" IN GEMS, ETC. By Isaac Lee, LL. D., Philadelphia. Pamphlet, pp. 11, with plate. Collins, Printer, 1876. PROCEEDINGS OF THE MEDICAL SOCIETY OF THE COUNTY OF KINGS. October, November, December. NEW YORK ECLECTIC MEDICAL AND SURGICAL JOURNAL. November, December. LIBRARY TABLE. November–December. VALLEY NATURALIST. September, October, November. KANSAS CITY REVIEW OF SCIENCE AND INDUSTRY. October–December. BULLETIN OF THE TORREY BOTANICAL CLUB. Vol. VI., Nos. 37–47. AMERICAN MACHINIST. SCIENCE NEWS. November–December. CANADIAN JOURNAL OF MEDICAL SCIENCE. November. CINCINNATI MEDICAL NEWS. October–December. AMERICAN JOURNAL OF MICROSCOPY. October, November. SCIENCE OBSERVER. October. AMERICAN MEDICAL JOURNAL. November. BREBISSONIA. August. PROCEEDINGS OF THE ACADEMY OF NATURAL SCIENCES OF PHILADELPHIA. April, September. THE HOSPITAL GAZETTE. A HISTORY OF THE DIAGNOSIS, PATHOLOGY ANDTREATMENT OF YELLOW FEVER. By J. B. Marvin, M. D., Pamphlet, p p. 15. From the *American Practioner*. ZEITSCHRIFT FUER MIKROSKOPIE. Numbers 1 to 10. AN OUTLINE OF GENERAL GEOLOGY. By Theo. B. Comstock, B. Ag., B. S. Ithaca, N. Y., University Press, 1878. LEGENDS, CUSTOMS AND SOCIAL LIFE OF THE SENECA INDIANS OF WESTERN NEW YORK. By John Wentworth Sanborn. Pamphlet, pp. 76. "Enterprise" print, Gowanda, N. Y. JOURNAL DE MICROGRAPHIE. November, 1878. THE AMERICAN BOOKSELLER. Christmas Number, pp. 175. December 2, 1878. THE MEDICAL JOURNAL ADVERTISING BUREAU GAZETEER. Vol. I., No. 1. BOTANISKA NOTISER, No. 5, 1878. ON THE SPORE-FORMATION OF THE MESOCARPEÆ AND ESPECIALLY OF THE NEW GENUS GONATONEMA. V. B. Wittrock. Pamphlet, pp. 18, with plate. PRODROMUS MONOGRAPHIÆ OEDOGONIARUM. V. B. Wittrock. Pamphlet, pp. 64. with plate. THE SANATARIAN. January, 1879. THE DENTAL REGISTER. November. NEW REMEDIES. December. TRANSACTIONS OF THE CONNECTICUT ACADEMY OF SCIENCES. Vol. IV , part I.

THE

# TRANSACTIONS

OF THE

# NEW YORK MICROSCOPICAL SOCIETY,

No. 1267 BROADWAY,

NEW YORK.

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Committee on Papers and Publications:

D. BRYCE SCOTT, CHAS. H. HASWELL, G. I. WHITEHEAD.

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VOLUME I.

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*PUBLISHED FOR THE SOCIETY.*

TRANSACTIONS

OF

THE NEW YORK MICROSCOPICAL SOCIETY.

JANUARY, 1879.

## MECHANISM BY WHICH ECHINORHYNCHUS ANCHORS HIS SNOUT.

BY J. D. HYATT.

*Echinorhynchus* is a genus of Entozoa, of the natural order Acanthocephala.

These formidable parasites inhabit the alimentary canal of fishes, and the one upon which my observations have been made is probably *Echinorhynchus fusiformis*, found in the intestinal canal of the lake white-fish. These fishes are brought to the New York market in the fall and winter, and, thinking that I might possibly find some interesting microscopical objects from the bottom of the lakes, I carefully examined the stomach and intestines of several of these fishes obtained at Fulton Market in the month of October; but if these organs had been carefully washed they could not have been more completely destitute of every semblance of food. The intestinal canal, however, was uniformly lined with these parasites, with their snouts so thoroughly anchored in the tissues that they would sometimes suffer themselves to be pulled asunder rather than let go their hold; for although the fish had probably been several days out of the water, these parasites were always alive.

Placing some of them in water under the microscope, I had an opportunity of observing the manner in which they manage to anchor their snouts so firmly; for when detached they constantly repeat the exercise by which this is accomplished. The snout is first slowly retracted, by inverting it, or turning it outside in, until nothing appears beyond the body but the

points of a single circle of the recurved hooks; then with a sudden motion the proboscis is thrust up to its whole extent, the sharp, glittering hooks forming a beautiful sight as they come out in rapid succession, resembling the bayonets of a company of soldiers rushing out of a sally-port and quickly forming to right and left.

If the points of the first circle of hooks touch any animal tissue, these, striking from a center outward, are first anchored and serve as a fulcrum for projecting the snout its whole length into the tissue.

It is this beautiful mechanical contrivance to which I wish to call your attention, for it would be impossible to conceive anything more perfectly adapted to accomplishing the end in view.

## EUGLENA AND TRACHELOMONAS.

BY R. HITCHCOCK.

Certain fresh-water ponds about Port Morris are covered during the summer with a bright-red or scarlet coating, when the sun is shining brightly. My attention was first drawn to this appearance by President Hyatt, and I have found the organisms which produce it very interesting for study. The color is caused by some species of *Euglena* which does not exactly correspond with any species described by Ehrenberg or Dujardin, but I am inclined to the belief that the specific characters in this genus, as given by authors heretofore, are by no means constant or reliable.

The particular form which I have most carefully examined undergoes many changes. At first it appears of a bright green color, shaped like an elongated flask with two long cilia in front, and a red pigment-spot. The body is finely granular, very soft, and as changeable in form as an *Amœba.* It swims freely by the aid of the cilia, or crawls along the slide like a leech. Forms, in every way identical with this, are also found without the cilia. Owing to the location of the ponds, somewhat inaccessible to me, I have not been able to follow the successive stages in the life-history of the organism through every detail, so I refrain from giving my inferences, hoping for an opportunity to study them more completely. However, it will be in place to describe some

of the various conditions of this species, to indicate the uncertainty of specific characters.

Besides the green, granular condition, there is a form also green but having numerous large, round, or oval, and clear cells, very closely resembling starch-cells when viewed in water. After a time, these cells appear to be set free, but I have watched them for weeks and found no change in them.

From the green condition the color becomes bright red, and between the two extremes forms can be found partly red and green, the red color occupying more or less of the central portion.

In the red forms we find variations precisely the counterpart of those already described in the green; the granular and the large celled forms, with or without cilia. Either the green or the red forms may lose their cilia, become spherical and surrounded with a thick coat, outside of which may be seen a layer of gelatinous substance which, if the forms are numerous, may unite them into large, flat sheets. Within the thick and unyielding coat the form may exhibit amœboid movements, may be seen to revolve, and finally subdivide into two parts which finally emerge by the rupture of the shell as two independent forms, similar to the original.

President Hyatt had observed that a certain *Trachelomonas* was at times very abundant in the water which contained the Euglenæ, and he strongly suspected that the two organisms were closely related in their life-history. The same idea had occurred to me, and on September 27th I was pleased to notice the following occurrence: In examining a collection from the Port Morris pond, I found many specimens of active *Trachelomonas* with which were associated green Euglenæ. Among the rest were a number of broken shells of *Trachelomonas* (whether ruptured naturally or by the pressure of the cover-glass I could not tell), but within one of them there was a bright green body exactly resembling the free Euglenæ, alternately contracting and elongating and protruding part of its body through the fracture of the shell, moving the two cilia vigorously all the time. Soon the cilia became quiet, the green organism issued from the shell, leaving the cilia attached, and crawled about precisely like the ordinary Euglenæ without cilia. By an accident this particular form was lost and could not be distinguished from the others.

It seems very probable from this, that *Trachelomonas* and *Euglena* are different conditions in the life-history of the same organism.

## PROCEEDINGS.

Regular meeting, held October 4th, 1878.

President J. D. Hyatt in the chair.

On motion the reading of the minutes of the last meeting was dispensed with.

A letter from Mr. Walter C. Hubbard, suggesting a plan for increasing the usefulness of the society, was then read, and was then referred to the Board of Managers for consideration.

The Secretary then briefly gave the results of a short and incomplete study of a species of *Euglena* found at Port Morris, N. Y.

Twelve members present.

Regular meeting held November 1st, 1878.

President J. D. Hyatt in the chair.

The minutes of the meeting of September 20th were then read.

Mr. Phin objected to a part of the report of the proceedings of that meeting as published in the *Transactions* of the society, concerning some remarks offered by him, and claimed that he had been incorrectly reported. He asked that the minutes be altered to conform to his actual statements. On motion this was directed to be done, and Mr. Phin presented the following correct report of his remarks which was directed to be incorporated in the minutes:

"There are two important features in every micrometer, one being the accuracy with which it conforms to a given standard, and the other being the equality of its divisions amongst themselves. An examination of the first point is in general beyond the means at the command of working microscopists, but the degree of accuracy with which any given space is divided may be easily determined by means which can be extemporized by any one."

The minutes of October 4th, 1878, were then read and approved.

The Board of Managers then reported on the matters contained in the letter of Mr. Hubbard, which had been referred to them at the last meeting, and offered the following preamble and resolution:

WHEREAS, The New York Microscopical Society is desirous of extending the field of its usefulness, by offering to such of its members as desire to pursue a particular branch of microscopical research and investigation, opportunities to meet members of the society who are engaged in the like branch of research or investigation, therefore

*Resolved*, That special meetings of the society be held on each and every Wednesday evening, at half-past seven o'clock, at the rooms of the society. That such special meetings shall be held under the direc-

tion of the Board of Managers of the society, who shall designate the subject to be considered on each evening. Such designation shall be made by the Board of Managers as far in advance of the meetings as shall be deemed desirable, but in every case the designations for a month shall be made prior to the first day of such month, and conspicuously posted in the rooms of the society. At such meetings the members present shall constitute a quorum, but no business shall be transacted thereat; such meetings shall be informal, but the society will expect a report of the results of such meeting at the first regular meeting of the society thereafter, embracing what has been accomplished in the particular branch of microscopy to which such evening shall be devoted.

The report was accepted and approved, and on motion the preamble and resolution therein was carried.

The following donations were received:

Eleven copies of the published *Transactions*, from the publishers.

Vol. I., No. 1, of *The American Quarterly Microscopical Journal*, from the publishers.

Möller's Balsam Probe-Platte, Millimeter Micrometer and catalogue of slides, from Mr. J. L. Wall.

Twenty-four numbers of *The Monthly Microscopical Journal* (London), from Mr. G. I. Whitehead.

One slide of *Sapharina*, from Capt. John H. Mortimer.

A specimen of sea-weed, mounted on paper, from the Secretary.

Mr. W. H. Mead was proposed for active membership by Mr. Hitchcock.

Mr. John Phin moved to reconsider the resolution passed September 20th, commending the action of the National Microscopical Congress with regard to micrometers.

The motion was carried.

Mr. J. A. Hoyt moved that it be the request of the society that each member prepare six slides for mutual exchange at the meetings. Carried.

The President explained an offer, made by the American Postal Micro-Cabinet Club, to send boxes of the club to him for exhibition at the meetings of the society. Messrs. Phin, Scott, and Hoyt, were appointed a committee to arrange the details for carrying out the suggestions made in this offer.

Fourteen members present.

Regular meeting November 13th, 1878. President Hyatt in the chair.

The minutes of the previous meeting were read and approved. The committee appointed to propose a design for a society seal was discharged.

Mr. W. R. Mitchell was nominated for active membership by Mr. Hitchcock.

The President described a species of *Echinorhynchus* from the white-fish, illustrating his remarks by a large colored drawing.

Mr. Hitchcock resigned from the committee on papers and publications, and Mr. G. I. Whitehead was appointed in his place.

The Secretary proposed some amendments to the by-laws, which were laid over for consideration.

Mr. Walter H. Mead was elected an active member. There was received a copy of the YAHRBUECHER DES NASSAUISCHEN VEREINS, from Prof. D. Kirschbaum. R. HITCHCOCK, Secretary.

THE

AMERICAN QUARTERLY

# MICROSCOPICAL JOURNAL.

Edited by ROMYN HITCHCOCK.

Devoted to the Interests of Microscopical Study in all Branches of Science.

WITH WHICH IS ALSO PUBLISHED

THE TRANSACTIONS OF THE NEW YORK MICROSCOPICAL SOCIETY.

VOLUME I.

PUBLISHED BY
HITCHCOCK & WALL,
150 NASSAU STREET,
NEW YORK.

# The American Quarterly Microscopical Journal.

"Go forth, under the open sky, and list
To Nature's teachings."—*Bryant.*

VOL. I. NEW YORK, APRIL, 1879. NO. 3.


## THE AMPULLA OF VATER AND THE PANCREATIC DUCTS IN THE DOMESTIC CAT (*Felis domestica*).


BY SIMON H. GAGE, B. S.


(*Concluded.*)

### MICROSCOPIC ANATOMY.

The ducts of the pancreas are quite variable in size, but the average for the duct of Wirsung is about 2½ mm. and 1 mm. for the duct of Santorini. The inner surface of the duct of Wirsung is usually thrown into longitudinal folds. It is composed of three tolerably distinct layers (Pl. XIII., Fig. 3, *a*, *b*, *c*). The inner layer of epithelium is composed of but a single layer of broad low cells with a very large clear nucleus, and a granular nucleolus. Many of the cells are divided at the base (Pl. XIII., Fig. 6, d), and alternating cells may have their thicker extremities turned in opposite directions. There is no sign of a striated margin as in Pl. XIII., Fig. 5.

The middle coat is very complex, but its main tissue is the elastic. The fibers run both longitudinally and circularly. The longitudinal fibers are quite coarse, while the circular ones are very fine, and by their anastomosing make a complete network. The middle coat is especially dense next the epithelium, and contains many roundish nuclei, which take a deep color in staining. The vascular supply of the pancreatic duct is very great, and so thickly are the vessels placed that the middle coat seems to be half composed of them (Pl. XIII., Fig. 4).

Finally, the outer layer is made up of areolar tissue which becomes very loose and indefinite toward the outside, but toward the middle layer it is quite dense, and receives many

anastomosing, circular, elastic fibers from that coat. Its fibers are likewise both circular and longitudinal. The vessels entering it are comparatively large and go straight through to the middle layer. The nuclei in this layer are less numerous than in the middle one (Pl. XIII., Fig 3, *c*).

In the branches of the duct, the middle layer becomes relatively thicker, and the outer coat is composed mostly of longitudinal fibers.

According to J. Arnold, in Stricker's MANUAL of HISTOLOGY (31,150), the pancreatic duct of the cat contains a proper muscular layer, but he does not give its position. Although sections were made of ducts hardened in Müller's fluid and alcohol, and in alcohol alone, and stained with picro-carmine and

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PLATE XIII.

All the Figures original, and drawn by camera lucida.

Figures 1 and 2 are lettered alike, but their corresponding parts point in opposite directions.

Fig. 1. Stained in hæmatoxylin. Section nearly at right angles to the duct of Santorini in its passage through the intestinal walls (Pl. XII., Fig. 2). The narrower end is the surface of the papilla, exclusive of the mucous membrane, upon which the duct opens. The wide end is toward the muscular coat. ×48.

*b.* Muscularis mucasæ cut obliquely.

*c.* Sub-mucous connective tissue.

*d.* Slender bundles of unstriped muscles rising toward the mucous surface, and surrounding the duct.

*e.* Cross section of the duct.

*f.* A band dividing the lumen into two parts.

Fig 2. Stained in hæmatoxylin. A section like the preceding, but near the termination of the duct. ×48.

*a.* Transverse section of the glands or crypts of Lieberkühn.

*e.* The lumen of the duct very greatly divided by anastomosing folds.

*g.* Glands of Brunner.

Figures 3 and 4 are similarly lettered, and are a small part of a transverse section of the trunk of the duct of Wirsung, and both sections were made of the fresh duct by means of Rutherford's freezing microtome. Both ×150.

Fig. 3. Doubly stained in picrocarmine and hæmatoxylin.

*a.* Single layer of short columnar epithelium.

*b.* Middle coat of the duct, very dense next the epithelium, and composed of circular and longitudinal elastic tissue and blood vessels.

*c.* External areolar coat composed mostly of circularly arranged connective tissue, with many fine anastomosing elastic fibers.

*d.* Cross section of two simple glands imbedded in the middle coat.

*e.* Circular, elastic anastomosing fibers.

*f.* Cut ends of longitudinal elastic fibers.

Fig. 1.

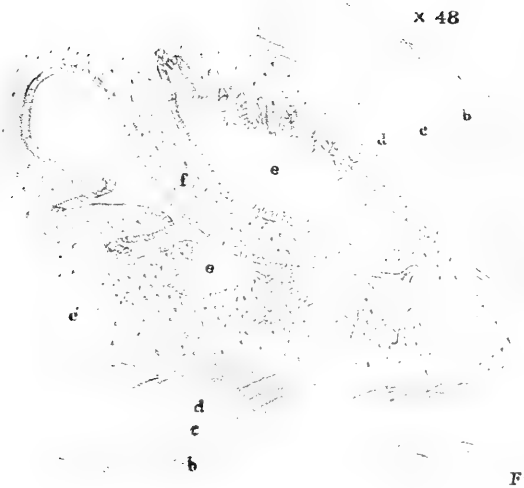


Fig. 7.


Fig 5.

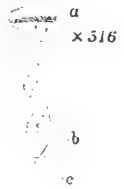


Fig 6.


Fig. 2.

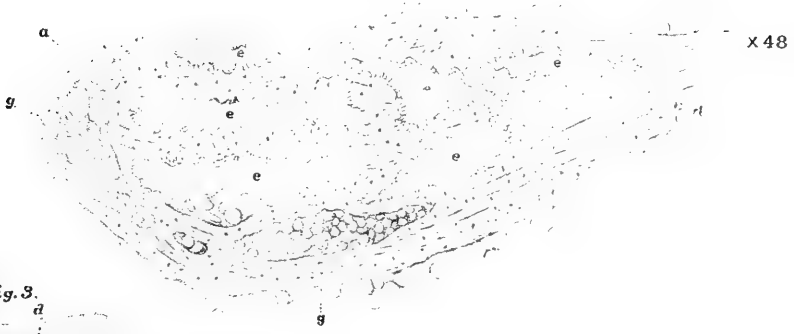


Fig. 3.

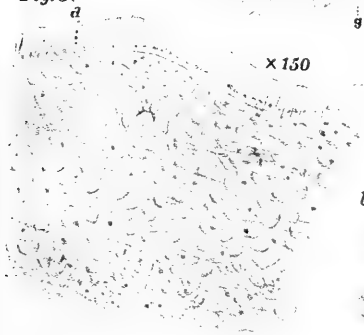


Fig. 4.

hæmatoxylin, and doubly stained by these agents, and sections of the fresh duct were treated as above, and with dilute acetic acid, yet no muscular layer or even scattered bundles could be found.

The structure of the human pancreatic duct, as given by Kölliker (17,358), Salter (27,90), Owen (23,497), and Milne-Edwards (22,507), corresponds mainly with the description here given of that of the cat. Kölliker states that the wall of the duct is composed solely of connective tissue with elastic fibers, but Salter says (27,89) that there are a few unstriped muscular fibers in the middle coat, judging from the appearance of nuclei upon the addition of acetic acid, although he was never able to see the fibers satisfactorily.

As the duct of Wirsung approaches the intestine, it nearly meets the ductus choledochus (Pl. XII., Figs. I., and II., Pl. XIV., Fig. 1, *h* and *i*). The two penetrate the intestine a very short distance apart, and extend somewhat around it from the dorsal toward the ventral surface, and at the same time obliquely away from the pylorus (Pl. XII., Fig. III., and Pl. XIV., Fig. 1). Within the duodenal wall at this point is quite a large space, the ampulla of Vater, which communicates with the lumen of

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Fig. 4. Stained in picrocarmine. This preparation shows the vascular net work in the duct. Injected with Berlin blue through the superior mesenteric and cœliac arteries.

*h.* Vascular net work, much denser in the middle coat, and becoming very fine next the epithelium.

Figures 5, 6 and 7. Teased from preparations hardened in Müller's fluid and then in alcohol, stained in picrocarmine. All similarly lettered. All × 516.

Fig. 5. A single granular cell from a villus near the aperture of the ampulla of Vater.

*a.* Striated border of the free end of the cell.

*b.* Large, clear nucleus near the narrow, attached extremity.

*c.* Nucleolus, granular and deeply stained.

Fig. 6. Two cells from the duct of Wirsung. Several groups of cells like this were seen where the broad part of one cell was applied against the narrow part of another, most of them were, however, of nearly equal thickness at the two ends.

*d.* The divided base of one of the cells. This is common in the ampullar epithelium also.

Fig. 7. Cells from a cross section of a simple glandular depression in the ampulla (Pl. XIV., Fig. 6).

They were drawn in position but set apart somewhat to show the large process (*d*), fitting under the base of the next cell.

*e.* Basement membrane.

the intestine by a contracted orifice. The ductus choledochus extends nearly to the orifice of the ampulla before opening, and forms part of its pyloric boundary. The duct of Wirsung, at first separated from the ductus choledochus by a wedge of the muscular coat, is now close to it, and extends parallel with it for a short distance into the ampulla, and then opens (Pl. XIV., Fig. 1). After the two ducts come in contact their walls are fused, and it is impossible to separate them in any way

DESCRIPTION OF PLATE XIV.

All the figures original, except 2 and 3, which are from Claude-Bernard. They were all carefully outlined by means of a camera lucida, at a distance of 25cm. The magnifying power of the microscope used was computed at the same distance. The same parts are similarly lettered in all the figures of this plate.

Fig. I. A vertical, longitudinal section of the ampulla of Vater, stained in picrocarmine. The duct of Wirsung had been previously injected with Berlin blue. ×10.

*a.* Villi extending to the edge of the aperture of the ampulla.

*b.* Crypts of Lieberkühn, growing shorter toward the opening (*f*) on the side of the ductus choledochus.

*c.* Submucous connective tissue, containing Brunner's glands, and sending a narrow band to the edge of the aperture of the ampulla.

*d.* Circular layer of muscular fibers, arranged in fasiculi, and cut transversely. It extends along the ductus choledochus on the side next to the pylorus; on the opposite side it thickens and abuts squarely against the duct of Wirsung.

*e.* Longitudinal muscular layer, extending nearly as far as the ductus choledochus, but becoming thinner.

*f.* The contracted opening of the ampulla of Vater, which is at the summit of a large papilla.

*g.* The interior of the ampulla, which is traversed by numerous anastomosing folds and processes, their general direction being *toward* the aperture *f.*

*h.* The ductus communis choledochus traversing the duodenal wall obliquely from the pylorus, and opening near the aperture of the ampulla. Its interior is divided by numerous anastomosing folds.

*i.* Duct of Wirsung entering the intestine somewhat less obliquely than the preceding, and opening sooner. The interior contains many anastomosing processes and folds.

*j.* Narrow wedge of the muscular coats between the two ducts.

Fig. 2. Magnified two diameters. Longitudinal vertical section of the ampulla of Vater in man, from Claude Bernard (1,553, pl. 1, 2, fig. 4 bis). This is said by Bernard to be the normal condition.

*h.* Ductus choledochus opening at the bottom of the ampulla.

*i.* Duct of Wirsung opening into the ampulla at the same level as the preceding, but separated from it by a salient fold.

*g.* The interior of the ampulla with two folds on the side.

*f.* Orifice of the ampulla.

*l,* Valvular fold in the duodenal mucous membrane, on the side next the pylorus.

Fig. 1.

× 10


Fig. 2.

× 2

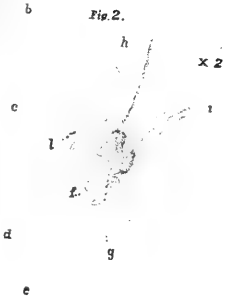
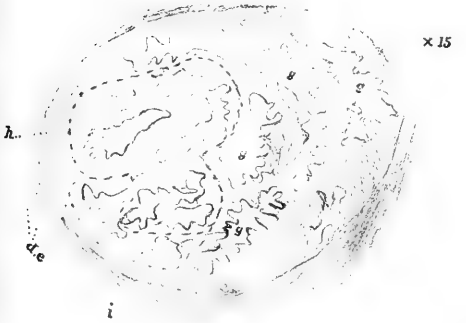



Fig. 4.

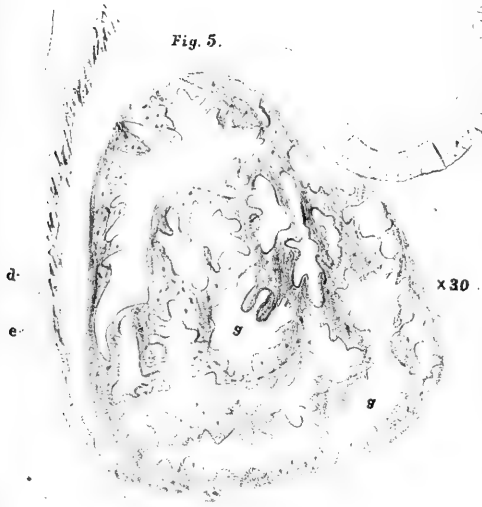
× 15




× 250

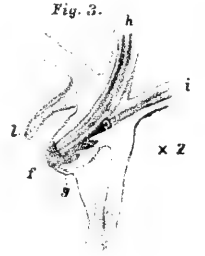
Fig. 6.


Fig. 5.




× 30

Fig. 3.




× 2

At the point where the ducts penetrate the muscular coat, the latter is decidedly thickened. The longitudinal layer parts, allowing the ducts to pass between its fibers, and on the side of the ductus choledochus, the thickening of the muscular layer is due to an addition of special fibers to this layer These fibers interlace in a most complex manner, and extend as a tapering bond along the pyloric side of the ductus choledochus nearly to its orifice. On the side of the duct of Wirsung no such process of fibers is sent along that duct. The circular layer, however, is much thickened on this side, and abuts squarely against the duct. On the opposite side it curves, following the direction of the ductus choledochus. It tapers toward the extremity, but ends somewhat abruptly (Pl. XIV., Fig. 1, *d*, *e*). The wedge of muscular fibers between the ducts is made up partly of longitudinal, and partly of circular fibers.

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Fig. 3. The same as 2, except that the ductus choledochus is prolonged nearly to the orifice of the ampulla. This is of rare occurrence.

Fig. 4. Section made at right angles to Fig. 1, to show the ducts and ampulla in cross section. Stained in picrocarmine. The duct of Wirsung previously injected with Berlin blue. ×15.

*h*. Transverse section of the ductus choledochus, which is enclosed by a dotted line. Its lumen is divided into compartments by the anastomosing processes seen in Fig. 1.

*i*. Duct of Wirsung also surrounded by a dotted line, and divided into compartments. The dotted line is double at the left of the figure, as the exact limit of the duct could not be determined.

*e*, *d*. Plain muscular fibers, partly surrounding the ampulla and ducts on the side toward the pylorus.

*g*. All the interior not surrounded by the dotted lines belongs to the ampulla, and is greatly divided by folds and processes.

Fig. 5. Magnified 20 diameters, stained in hæmatoxylin. Section like the preceding, but nearer the aperture of the ampulla. This figure is given to show the exceeding complexity and sieve-like division of the ampulla by its anastomosing folds and processes.

*d*, and *e*. The thin edge of the muscular coats prolonged toward the summit of the ampulla.

Fig. 6. Longitudinal section of a single minute process, like that near *g*, fig. 5; stained in hæmatoxylin. Many simple glands dip down into the surface: they are merely depressions, for their epithelium is identical with that covering the general surface of the process. ×250.

*m*. A glandular depression becoming double.

*n*. Simple glandular depressions.

*o*. Cross section of one of the preceding.

*q*. Substance of the process made up mostly of adenoid tissue, containing many deeply stained nuclei.

Near the external surface of the longitudinal layer, some of the fibers are sent straight between the ducts, and other, apparently special, fibers wind round the two ducts and form a common sphincter. Still other fibers pass around the ducts separately, and thus form special sphincters. The one which belongs to the duct of Wirsung is most marked.

On the internal surface of the ducts appear very many thin folds. These may originate on any part of the internal surface, and their free edges are always directed toward the orifice of the duct. Not only are the folds very numerous, but they anastomose and apparently give rise to secondary folds, thus making a most complex net work, and the complexity increases toward the orifice.

The walls of the ducts in their passage through the coats of the intestine, are composed mostly or entirely of areolar tissue. Processes of this tissue extend into the valvular folds spoken of above, and give them a strong framework.

The ampulla is also furnished with very many folds. These may arise from any part of its surface, and are like the folds in the ducts always directed *toward* its orifice. The folds anastomose, or arise partly from the wall of the ampulla, and partly from the surface of some other fold, or a large fold may give rise to secondary ones. The attachment of these folds and those in the ducts is somewhat similar to that of the valves in the veins (Pl. XIV., Fig. 1). In cross section the appearance is as if very many anastomosing trobeculæ were stretched across the cavity of the ampulla, and the lumen of the terminal part of the ducts which open into it (Pl. XIV., Figs. 4, 5).

In 1727, Duvernoy (9,346) described a reservoir, the ampulla of Vater, between the coats of the duodenum, in the *Chatpard*,* into which emptied the ductus choledochus and the duct of Wirsung. This reservoir was beneath a prominent papilla, and opened at its summit by a single orifice into the lumen of the intestine. "*In quo bilis et succus pancreaticus invincem permisceri videntur, antequam in cavum intestini effluant.*" In 1802 was published the description of the same condition in the elephant (39). (See the quotation from Owen, in an earlier part of this

* I have been unable to decide which one of the cats was meant by Duvernoy. He says of the *Chatpard* in question, *Catus pardus sen Catus montanus Americanor*, implying at least that it was an American felis. But in Cuvier and all other systematic works where *Chatpard* is defined, it is called *Felis Serval*, of South Africa and Senegal.

paper, describing the ampulla of the elephant.) A few years later, in 1819, appeared the description by Tiedemann of a reservoir in the seal (*Phoca vitulina*) like that in the elephant (32, 350). The first description of the ampulla in the domestic cat, so far as I know, is that given by Cuvier (5,520), where he says: "The ductus choledochus dilates between the muscular and mucous tissues of the duodenum, and its walls present several small culs-de-sac, which make the cavity anfractuous. It is at the bottom of one of these culs-de-sac that the pancreatic duct opens."

Most authors consider the ampulla as an enlargement of the ductus choledochus, but Hyde Salter says of the ampulla in man: "Since the mucous membrane lining the ampulla is of the same structure as that lining the intestine, and unlike that lining the ducts, these latter must be said to open by two distinct orifices at the base of the papilla and not by one at its apex as is usually described; in fact, the lining of the cavity of the papilla is part of the general mucous surface of the duodenum (27, 85)." Bernard (1,551–2) says of Pl. XIV., Fig. 2, that the ductus choledochus opens at the bottom of the ampulla, and that from the appearance of the epithelium the membrane lining it should be considered as the continuation of that lining the duct of Wirsung. In Fig. 3, where the ductus choledochus extends almost to the surface of the duodenum, he says of the pancreatic duct which opens at the base of the ampulla: "Point d'abouchement du conduit pancreatique properement dit dans l'ampoule de Vater, qui n'est que sa continuation." As the condition just described in man is the normal one in the cat, so far as the relative extent of the two ducts is concerned, doubtless one might say with equal propriety that the ampulla in the cat is only a continuation of the duct of Wirsung (Pl. XII., Fig. II., 8, 6; Pl. XIV., Fig. 1 and 3, h).

In my own investigation on the cat's ampulla, it was found impossible to determine in transverse sections whether a given part belonged to the ductus choledochus, the duct of Wirsung, or the ampulla proper, as the epithelium etc. seemed to be identical in character in all parts of the section. Hence it was necessary to devise some means of distinguishing the different parts. At first red was injected into one duct and blue simultaneously into the other; but the fluids so mingled in the ampulla that it was impossible to determine the exact limits of

either duct. It was found, however, that if only the duct of Wirsung was injected, none of the mass got into the ductus choledochus, hence in transverse sections uninjected parts were known to belong to that duct. In Pl. XIV., Figs. 1 and 4 were prepared in this way.* Not only did the epithelium of the ampulla and ducts appear identical, but their walls were covered with papilliform processes and simple glandular depressions, which seemed to be similar in the three situations (Pl. XIV., Fig. 6). The sections were stained in hæmatoxylin or picrocarmine, or unstained. As to the similarity of the epithelium of the duodenum to that of the ampulla in the cat, there seems to be but very little; they are certainly not identical. 1. The cells of the ampulla do not have a striated or hyaline border as do those of both the villi and crypts of Lieberkühn, Quain (25,362), Stricker (31,388). 2. Goblet cells are rarely or never found in the ampulla. With a power of 675 diameters, I have carefully examined the epithelium of all parts of the ampulla, following it to the level of the crypts of Lieberkühn, but neither goblet cells nor those having a striated border could be found, although in the same section the striated border of the cells of the villi was so plain that they looked almost as though they were ciliated, and goblet cells were very plentiful both in the villi and the crypts of Lieberkühn.

Turning for a moment to the cross sections of the duct of Santorini in its passage through the intestinal wall, it is seen to be divided into two compartments in the first section (Pl. XIII., Fig. 1); but in a section nearer the orifice the divisions are numerous, and the appearance is like the cross sections of the ampulla of Vater (Pl. XIII., Fig. 2). The epithelium, the papilliform processes, and the glandular depressions of this duct within the intestinal wall are similar to those in the ampulla.

The anastomosing folds and processes in the ampulla, the duct of Wirsung, and the ductus choledochus, being arranged somewhat as are the valves in the veins, allow a flow toward the orifice into the intestine, but greatly impede one in an opposite direction. It would probably be impossible for any solid matter to get into either duct, for it would be caught by some of

* The extent and course of the ducts within the intestinal wall are much more easily determined in macroscopic investigations if the duct of Wirsung be first injected with plaster of Paris colored blue, and after it has set, the ductus cholechodus may be injected with a similar mass colored red. The whole should be put into strong alcohol for half a day or more.

the folds. The duct of Santorini in its passage through the wall of the intestine is also well guarded by valvular folds with their free edges toward the orifice, and is therefore well calculated to prevent any regurgitation of liquid or the entrance of solid substances. In this duct, the folds are seen to increase in number toward the orifice, as is the case with the ductus choledochus and the duct of Wirsung (Pl. XIV., Fig. 1, and Pl. XIII., Figs. 1 and 2).

The duct of Santorini seems to be kind of a reserve, and it may be the main channel for carrying the pancreatic juice, as is shown by its occasional great size in the cat and in man (1,389), while in the dog it is normally the larger (1,386; 22,510). Doubtless, in any case if the duct of Wirsung becomes clogged, it would assume the entire office of both ducts. In the fœtal dog and cat two ducts are of very nearly the same size and appear to be potentially of equal importance.*

In conclusion, it seems to me that the weight of evidence is greatly in favor of considering the ampulla of Vater as an appendage of the ductus choledochus or of the duct of Wirsung, and not of the duodenal mucous membrane. And, as the ampulla has been found so constantly whenever the two ducts enter the intestinal wall separately, and open by a common orifice, I would suggest that Duvernoy be followed in his opinion, viz., that the ampulla belongs to *both* ducts.

## Summary.

1. The pancreas in the cat is constantly provided with two anastomosing ducts of unequal size which open separately into the intestine.

2. One of the ducts, usually the larger, after passing through the muscular coat of the duodenum, opens into its lumen through a contracted orifice common to it and the ductus choledochus.

3. The ducts have been named, from their size, principal and accessory; but the comparative size is variable; and as position in morphology is doubtless of much greater importance than size, names should be used which have no reference to size. Accordingly, in this paper, the following names, sanctioned by high authority, have been used:—Duct of Wirsung, for the

*It would be of the greatest interest to know whether the pancreatic ducts are developed simultaneously, or one earlier than the other, as is the case in the chick (11,133).

one opening into the intestine with the ductus choledochus, and duct of Santorini for the one opening independently.

4. The pancreas in the cat is covered on both sides by peritoneum.

5. Occasionally there occurs a reservoir for the pancreas, like the gall-bladder for the liver, which communicates freely with the duct of Wirsung. The presence of this anomaly seems to have been noted but once before, and then, as in the present case, in the domestic cat.

6. The pancreatic ducts are composed of a lining of columnar epithelium, a middle layer of elastic tissue, and an external coat of areolar tissue or a tunica adventitia. The vascular supply is very dense, especially in the middle coat next the epithelium.

The structure is like that of gland-ducts in general as given by Robin (16), and somewhat comparable to the elastic type of blood-vessels as given by Stricker (37,200) and Ranvier (26,561).

7. As the ductus choledochus and duct of Wirsung pass through the longitudinal muscular coat of the duodenum, they are provided by it with a common, and each with a special sphincter.

8. The ductus choledochus and the duct of Wirsung empty into a common reservoir, the Ampulla of Vater, situated between the muscular and mucous coats of the duodenum.

9. The Ampulla, and the terminal part of the ducts of Wirsung and Santorini, and the ductus choledochus are provided with valvular folds whose free edges are directed *toward* the orifices in each case.

10. The structure of the mucous membrane of the Ampulla is like that of the terminal part of the duct of Wirsung and the ductus choledochus, and not like that of the duodenum; hence, it should be considered, in the cat at least, as an appendage of the ducts and not of the duodenal mucous membrane.

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## A TYPICAL CASE OF TUBERCULAR MENINGITIS.

BY PROF. I. N. DANFORTH, M. D.

(*Received December 14th, 1878.*)

Although tubercular meningitis is by no means an uncommon disease in this country, it is, nevertheless, rarely the case that the Pathologist has an opportunity to study its peculiar lesions, because it is next to impossible to obtain permission to make post-mortem examinations upon the bodies of children. For this reason, it seems to me all the more important, that every opportunity for increasing our knowledge of the pathological anatomy and histology of this terrible malady, should be carefully improved; and special pains should be taken to study thoroughly and record accurately the pathological changes in every uncomplicated or typical case. With the hope of contributing somewhat to our knowledge of tubercular meningitis, I present the following case for publication:—

Lilian N. first came under my care April 4, 1878. She was two years and nine months old, and was, up to a short time previously, a bright, active child, well developed, and possessing a good degree of health and strength. She had blue eyes, light complexion, and fair, transparent skin. From her parents, I obtained the following history of her case:—About the first of January preceding, Lilian fell down stairs, and received a slight contusion over the right parietal bone. It was regarded as a trifling affair, however, and as no immediate consequences followed, it was soon forgotten. But not long afterwards, members of the family began to observe that the child manifested unusual irritability and fretfulness, and this was all the more noticeable, because she had always been remarkably cheerful and happy. Her wonted cheerfulness and vivacity were replaced by a notable degree of depression and irritability. She would cry long and vigorously, upon the smallest and most absurd provocations; and she acquired an unnatural and un-

accountable irritability of temper. This state of things progressed from bad to worse, until April 4th, when I was called. About that time she became rapidly worse, and the symptoms assumed an intermittent, febrile type. At first, I was inclined to regard the case as one of simple intermittent fever, and the disturbed condition of the nervous centers was looked upon as the natural impatience and restlessness of a sick child. But a few days' observation of the case, together with the prompt development of the **cerebral tache* or *macula*, led me to suspect tubercular meningitis. An inquiry into the history of the case strengthened this opinion; and, upon consultation with Drs. Norman Bridge and Chas. W. Earle, the conclusion was fully adopted by all of us, that we had to deal with quite a typical case of this fearful disease. Subsequent events demonstrated the correctness of this conclusion: the symptoms developed themselves and the case proceeded to its fatal termination without any intercurrent complications or interruptions of any kind. I do not stop to detail the treatment pursued, as it is the purpose of this paper to deal mainly with pathology.

I may say, however, that the treatment was essentially such as is generally pursued by the profession under similar circumstances, and, for curative purposes, was thoroughly ineffectual. My little patient was the pet and favorite of a large family of relatives. Among them was an uncle who was profoundly grieved at the prospect of losing his little niece; and when I announced that I could not save the child, his thoughts very naturally turned toward homœopathy, and he asked me to allow him to call in a homœopathic physician, to which I very cheerfully assented. I advised him to call Dr. T. C. Duncan, a homœopathic physician of excellent reputation, and at the same time, a courteous gentleman. The result was a very pleasant interview between Dr. Duncan and myself, and our substantial agreement as to the pathology of the case, and its inevitable result.

On the 16th of April the patient died comatose. For two or three days before death the symptoms were very grave, including intermitting strabismus, uncontrolable vomiting, slight convulsive efforts of various groups of muscles, paralysis of the sphincter ani, and sphincter vesicæ, gradually increasing coma,

* Turesseau: Clinical Medicine, Vol. I., p. 877.

ending in death. No general convulsions occurred at any time.

With a regard for the interests of science, which cannot be too highly commended either for its intelligence or its self-denial, the parents reluctantly consented to a post-mortem examination.

SECTIO CADAVERIS, 24 hours after death. Present, Drs. C. W. Earle, T. C. Duncan, and the writer.

The body was not very much emaciated; the disease having run an unusually rapid course, the wasting of the body was somewhat less than usual.

*The Head.* Very slight adhesions were found between the dura mater and the calvarium. The dura mater was opaque and slightly rough, and its usual glistening appearance was gone. Along the line of the sagittal suture, numerous white elevations as large as bird-shot were seen. The vessels of the dura mater were engorged with blood. Well-marked fluctuation was felt when pressure was made upon the surface of the dura mater. Upon removing the dura mater, the vessels of the arachnoid were found to be greatly distended with blood, and inflammatory products were plainly visible on both margins of the longitudinal fissure. Upon examining the smaller vessels of the arachnoid with a hand-glass, a great number of minute, bead-like nodules were seen around and along their margins. The microscopic structure of these nodules will be described presently. The common vascular plexus of the pia mater was the seat of very extensive tubercular deposit; upon nearly all the smaller vessels masses of tubercle were deposited: some of these masses were too small to be seen with the naked eye, some were so large as to present distinctly projecting, nodular eminences upon the periphery of the vessel, but the great majority consisted of deposits from the size of a small pin's head to the size of a medium bird-shot. They generally surrounded the vessel, and were either fusiform or spherical. Each nodule was quite isolated, and seemed to be the product of a special center of growth. The appearances described are well shown in Plate XV., Figs. 1 and 2. The microscopic appearances will be described hereafter.

The floor of the lateral ventricle was not particularly changed, but the superior surface of the left posterior cornu was softened. The choroid plexus was very pale and anemic. The

floor of the fourth ventricle was thickened, and the seat of considerable tubercular deposit. The substance of the cerebrum and cerebellum was slightly softened, but not otherwise changed. The thoracic and abdominal organs were healthy.

The most notable pathological lesions were in or upon the vessels of the pia mater. I therefore selected my specimens for microscopical study from this structure, and especially that portion which formed the vascular fold between the walls of the left fissure of Sylvius.

The specimens were stained with hæmatoxylin, dehydrated by alcohol, passed through oil of cloves, and mounted in damar. The microscopical appearances presented by them are quite faithfully recorded by the accompanying plate, which is certainly creditable to the enterprise of the publishers of this journal. The several figures will be readily understood by reference to the appended explanations.

A careful study of a considerable number of mounted specimens, under different powers, by different methods of illumination, and by different observers, whose opinions concurred with mine, seems to me to suggest * the following conclusions:

1. The lesions peculiar to tubercular meningitis are necessarily, if not exclusively, confined to the smaller blood-vessels of the membranes (especially the pia mater), and of the brain substance; and all other lesions are probably secondary to those above mentioned, and are, directly or indirectly, produced by them.

2. The lesions in question are *always* exterior to the tunica interna, and therefore have no direct structural relation to the circulating blood.

3. The primary seat of pathological activity in tubercular meningitis, is in the perivascular spaces or canals, which surround the smaller blood vessels of the brain and its membranes, as described by His † and others; and in its early stages at least, is essentially inflammatory in its nature, the inflammation being at first limited to the meninges.

4. As a consequence of the initiative hyperplasia, which re-

* I use the term "suggest" instead of a more positive term purposely. In all departments of pathology intense activity prevails: new facts are constantly being discovered, and former theories are being displaced or modified. This is especially true with reference to tuberculosis; and hence no positive or permanent conclusions are warranted.

† Stricker's Histology, p. 231.

sults from, or rather forms a part of the process of the inflammation, an abnormal rapidity of cell-proliferation takes place within the perivascular spaces; in other words, the leucocytes or bioplasts (Beale) contained in the lymphatic channels, are produced with unwonted haste, and therefore with corresponding imperfection, and the product of this rapid and imperfect growth is the so-called "tubercle."

In the foregoing propositions, I have endeavored to condense the *essential* pathology of tubercular meningitis, so far as it expresses itself in recognizable, structural lesions. I do not attempt to deal with the intangible cause which determines the production of tubercle; at best we can only give utterance to vague conjectures.

In addition to the lesions which I have noted above, and characterized as essential, there are others which I think may, with equal propriety, be regarded as consequential. Among these secondary changes, the most important are, (*a*) the diminished caliber or obliteration of blood-vessels; (*b*) the transudation of serum, and its accumulation in the cavities of the brain; (*c*) the softening of brain substance in the later stages of the disease.

(*a*) Altered caliber of blood-vessels. In consequence of the rapid and excessive cell growth within the perivascular canals

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## DESCRIPTION OF PLATE XV.

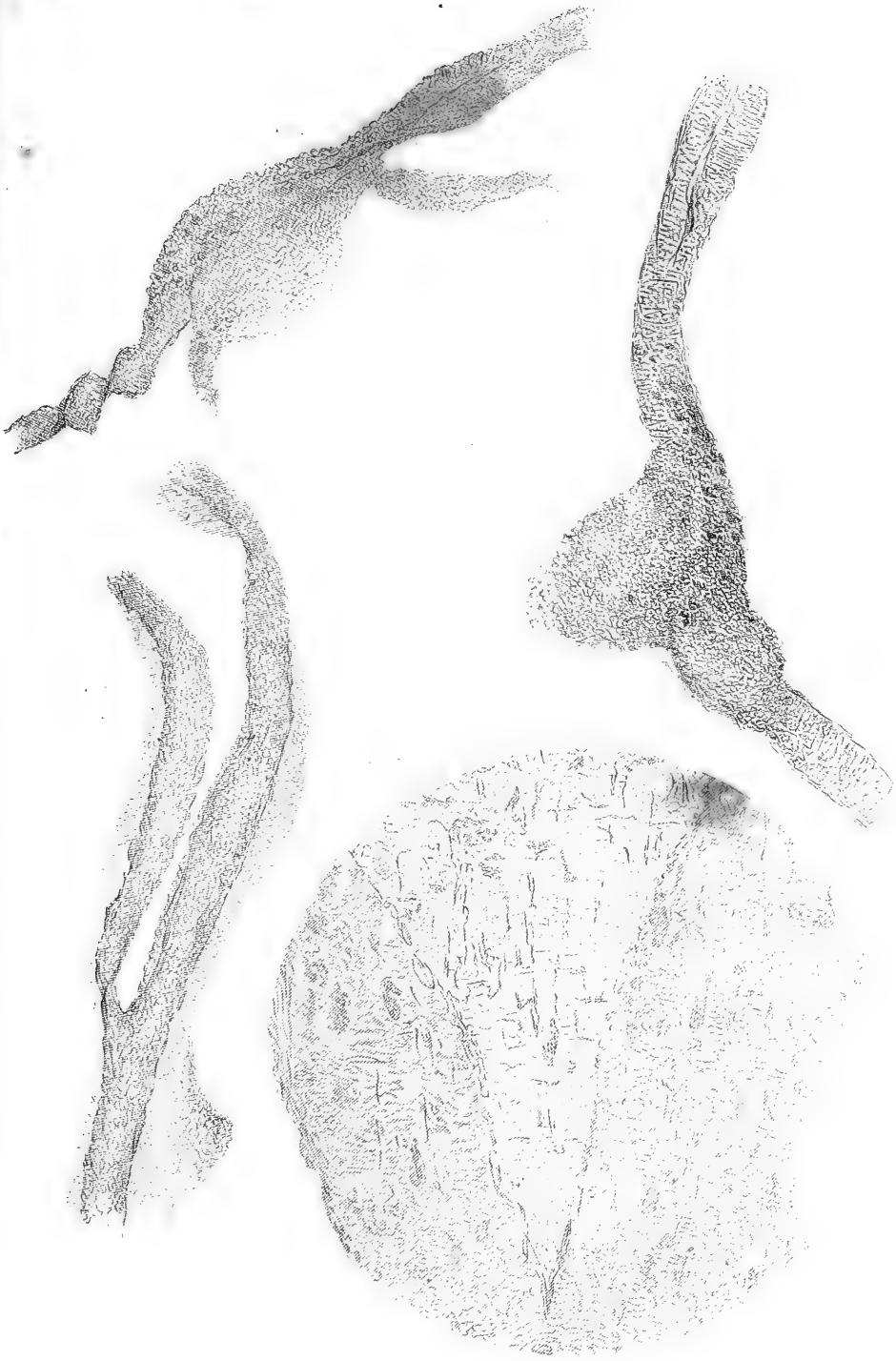
From a Camera Lucida Drawing by Dr. Mary F. Mergler.

Fig. 1. Showing a fusiform nodule of tubercular deposit, at the point where the arterioles originate. The shriveled appearance of the distal portions of these vessels is well shown. ×75.

Fig. 2. A tubercule nodule in the continuity of a larger arteriole; at one point (*a*) the wall of the perivascular canal has apparently given way, and the tubercle corpuscles are escaping. It is barely possible that the manipulations incident to mounting the specimen may have produced the rupture, but I think not. At all events, the perivascular wall at this point was thinned to the last degree, and would very soon have yielded to the pressure of the multiplying, tubercle corpuscles. ×75.

Fig. 3. A blood-vessel dividing into two branches: around these vessels are seen the perivascular canals or "lymph paths," not yet very much affected by tubercular infiltration. The actual microscopic appearance is but very slightly exaggerated. ×75.

Fig. 4. Showing a group of tubercle corpuscles from Fig. 3. The granular appearance of the cells, and the general cloudiness of the field, due to the presence of granular matter, are well shown. ×375.



Mary J. Mergler, del.

and without the blood-vessels proper, the latter are encroached upon by the cell accumulation, and their caliber is more or less diminished. Moreover, the tubercular masses are generally deposited in bead-like nodules, or spindle shaped growths; hence, the blood-vessels are alternately contracted and dilated, the contraction always occurring opposite the points of tubercular deposit. Moreover, during the progress of the disease, the external coat of the implicated vessels undergoes inflammatory hypertrophy and subsequent contraction, and this process also aids in the production of the changes in the blood-vessels. It is very common to find the tubercular nodules at points where afferent vessels subdivide; in such cases, the distal branches usually present a withered or shriveled appearance, and sometimes they are quite obliterated (Fig. 1).

(*b*) Transudation of serum. This is probably mainly due to a mechanical cause, namely, the retardation of the blood-stream, in consequence of tubercular deposit around the blood-vessels. Everybody knows that an obstructed circulation is more than likely to produce transudation. In the case upon which this article is based, the lateral ventricles were distended with fluid, and some fluid was found beneath the arachnoid. But it is certain that some portion of the escaped fluid was inflammatory exudation, since flakes of lymph were floating therein, and the microscope demonstrated that the fluid contained multitudes of leucocytes. Whether these leucocytes migrated from the blood-vessels proper, or from the lymph-channels, is an open question; and it is a question which concerns the source of wandering leucocytes, in other locations than the one now under consideration.

(*c*) Softening of the brain substance. This is the consequence of mal-nutrition, and is the inevitable result of the diminished caliber of the afferent blood-vessels above noted. It is simply a process of local starvation, and proceeds rapidly or slowly as the vascular changes proceed rapidly or slowly. It is not peculiar to tubercular meningitis, but takes places whenever the nutrition of the brain is interrupted.

Woman's Hospital Medical College,
Chicago, Ill.

# ON THE FORMATION OF THE PARABOLOID AS AN ILLUMINATOR FOR THE MICROSCOPE.

BY F. H. WENHAM.

(*Received December 21st, 1878.*)

In a paper read before the Microscopical Society, in the year 1856, I announced a new and important principle of illuminating objects under the highest powers of the microscope, or with close working object glasses of large aperture, utilizing the glass cover as a lieberkühn by various methods of causing rays to impinge upon the upper surface beyond the angle of total reflection. The principle was described in the following sentence: "The principle of operation consists in causing rays of light to pass through the under side of the glass slip upon which the object is mounted, at the proper angle for causing *total internal reflection from the upper surface of the thin cover*, which is thus made to act the part of a speculum for throwing light down upon the under-lying objects immersed in the balsam or fluid."

The first and most simple method was by means of a right-angled prism connected to the under surface of the slide by a fluid intermedium, which transferred the total reflecting surface from the prism on to the top plane of the cover. The next illustration referred to a truncated lens considered as a hemisphere minus the thickness of the slide. In this I demonstrated the loss of light from using water as the intermedium, and the advantage of introducing a connecting fluid of a refractive index the same as the glass, in order to utilize the most oblique rays which would otherwise not be transmitted;* for this purpose I selected oil of cloves. In the paper I showed a form of truncated paraboloid mounted so as to be used also as an animalcule cage or live box, the object to be placed in water on the flat top and confined by a thin glass cover: rays from a lamp made parallel to be sent in beneath, using a dry object glass.

* For the purpose of eliminating the aberrations in an immersion object glass, caused by an intermedium of low refractive power, in the MONTHLY MICROSCOPICAL JOURNAL for June 1870 I suggested the "oil immersion" object glass in the following words: "If a medium of similar refraction to the glass were to be used, no *adjustment* would be required for any thickness of cover, supposing the test objects to be mounted thereon (they generally are), for, in fact, we should then view them all with a front of the same thickness—considering the cover, the front lens, and the interposing medium as one."

In no way have I ever seen minute organisms or animalculæ so beautifully displayed as in this. The minutest details are visible in their true colors on a black field. I am not aware that any one has provided himself with this piece of apparatus, and the knowledge of its effects probably does not extend beyond some half dozen friends that have seen my demonstration; it is, perhaps, destined to be announced as a new discovery.

The so-termed immersion paraboloid has recently been claimed in this way by Prof. Edmunds, who has attached his name to it—not quite in ignorance of what I had previously done; for in the only interview that I ever had with him, he insinuated that I had made the focus fall within the body of the glass. I had previously made various experimental paraboloids up to three inches in diameter, with the result that I did not find that the effect was increased by the diameter of the annulus of light, but quite the reverse. The most perfect form of immersion paraboloid would be of smaller size, to be used with objects mounted on thin glass. It is always an easy matter to condense light by extraneous means, so as to obtain any required degree of intensity.

It is to be regretted that in this country the noble art of mechanical construction should be held in such low esteem as not to be considered a worthy element of education, enabling persons to carry their own ideas into practice without being hampered, or altogether stopped, by heavy artisan's bills.

The parabola is a definite geometrical curve, and the only variation that can be made is one of focus. In all that I have yet constructed, I have not wasted my time with such a blunder as working any one of them with the focus uselessly within the glass.

This statement leads to the inference that information relating to practical methods of obtaining parabolic forms may be useful to those engaged on the subject. My descriptions must be taken as interpretations divested of the ever recurrent lettering, under which geometrical demonstrations are usually smothered.

The glass parabolic illuminators are ground up to form by means of templates. These may be accurately formed by a purely mechanical method, based on the principle that every section of a cone taken in a plane parallel to the opposite side is a parabola. Proceed as follows: Turn a cone, either of metal

or hard wood, between the lathe centers, then on the face plate (which of course should run quite true) chuck the cone on one side either by cement or clamps, as shown in Fig. 5. With the slide rest take off the section (*a*), remove the cone, and on the parabolic face screw a well flattened piece of sheet brass, slightly exceeding it in size; back this up by a block of the same wood as the cone; fix both thereto by two countersunk screws passing through holes drilled in the brass plate. The cone is now returned to the lathe centers, and the surplus piece of wood turned down, together with the edge of the brass plate, by means of the slide rest, till the cone is again complete. A dead smooth file may then be held against the revolving cone; this trims the edge of the contained template, which comes out as a true parabola. Unless this is made to match a parabolic figure of known focus, it may be necessary to ascertain the focal point of the blank parabola. This can be easily found, as follows (Fig. 6): draw a line (*a*) equal to the diameter of the base of the parabola; take a perpendicular to this (*b*), equal to the height from the base to the vertex; from the termination of the perpindicular take a line (*c*) intersecting the half diameter of the base-line at *d*; another line is set off from this point at right angles to *c*: the distance at the inter-

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EXPLANATION OF FIGURES.

Fig. 5. A wooden cone clamped down by screws on to the face plate of a lathe. The axis from which the cone was turned inclined in the direction shown. The dotted section (*a*) is turned off parallel with the opposite side; on the parabolic face the template is formed.

Fig. 6. Method of finding the focal distance of a blank parabolic figure:

*a*. Diameter of base.

*b*. Distance from base to vertex.

*d*. Half the semi-diameter.

Connect *d* with end of *b* by line *c;* a perpendicular to this taken from *d*, at the point where it intersects the axis below the base, will be equal to the focal distance below the vertex.

Fig. 7. Outline of rectangular brass plate to form a template for paraboloid.

*b*. Focal distance.

*a*. Equal to focal distance above vertex of parabola.

Cross lines drawn at irregular, but increasing distances, as shown, measurements on the axis, by compasses from *a* to each of these lines; each line bisected by the same measurements from the focus or point *b* describes the outline of a parabola.

The dotted segment of a circle is struck from the focus *b*, representing a non-immersion paraboloid.

section of the axis beyond the base-line, will be the required focal distance of the parabola.

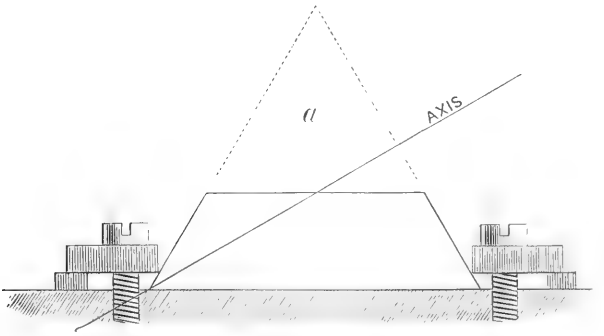


FIG. 5.

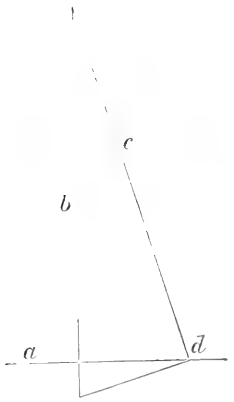


FIG. 6.

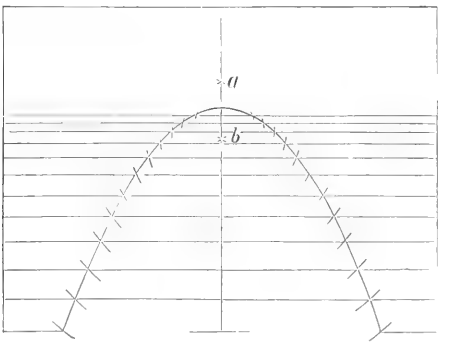


FIG. 7.

To those not possessing the requisite tools, this method of cutting out a template, of course, cannot be available. The plan of drawing with a square and piece of string, described in all elementary works on geometry, is so irregular in its action as to be useless for small parabolas; bisection must therefore be resorted to, which, by careful manipulation, gives a very true figure. This operation depends upon the following property of a parabola: that any point, taken on the axis at a distance beyond the vertex equal to the distance of the focus within it, to any transverse line on the axis, will be equidistant from the same line to the focus. Proceed as follows:

Provide a thin brass plate (Fig. 7) perfectly square and flat, of sufficient size to enclose the required parabola, for which it is to serve as a template. In a center line quite parallel with the sides, prick off two equidistances, the directrix (*a*) without and the focus (*b*) within the vertex of the parabola. Draw a number of parallel lines at right angles across the center line; these lines need not be set at any particular distance, but may be ruled at sight, taking the precaution of setting them close together towards the vertex, and progressively increasing the distance between them towards the base. With fine pointed dividers, take the distances of these lines on the axis from the directrix or outside mark (*a*) in succession. For each measurement shift the point to the focus (*b*) within the vertex, and bisect the line from which the distance was taken on both sides, the intersection of all the lines by the arcs from the focus, will give the outline of a true parabola. The crossing points are now to be dotted in with a thin, sharp pointed center punch, applied at the right spot under a hand magnifier. The surplus brass is cut out with a fine saw, and the template carefully filed up till the punch marks appear as sunk in the metal.

The block of glass, if intended for a flat-topped or immersion paraboloid, should have both its base and apex polished off to the right thickness, before it is cemented to the lathe-chuck with black sealing wax. By means of the rough edges of an old saw-file, ground on one side and used with plenty of turpentine, the glass is turned away at a very slow speed till it is seen approximately to fit the template. The edges of this are then lightly smeared with reddle and oil, and the paraboloid fine turned with a keen edge, until the template marks it evenly all over. In order to take out the rings left from the turning, a block of brass, not larger than half an inch square, is traversed over the revolving glass with coarse and then smoothing emery, till all scratches disappear. The glass is then polished with a buff stick and crocus and water, and finally, a piece of hard bees-wax is held against it with finer crocus, in order to obtain the last degree of polish.

If the paraboloid is to be a non-immersion one with a cupped op, it may be turned flat on the end, till the required thickness is arrived at, and the hemispherical cavity roughly turned out to a half-circle template, till the center is brought to the focus; the cavity is then finished in the same way as a concave lens.

Finally, while rotating in the lathe, the paraboloid is perforated through the axis with a steel drill and turpentine.

Paraboloids can be made true enough for most purposes, if finished as above described, but if great accuracy is a desideratum, the figure may be corrected after the rough turning, by means of the following appliance.

It is a property of the paraboloid that the face of every section taken parallel to the axis, is an exact counterpart, and, in form, is the same parabola. This enables us to verify and correct the figure. From the further end of a base-board, clamped to the bed of the lathe, hinge a piece of board about two inches wide. Let this be so adjusted that when the front edge is raised the upper plane of the board falls exactly parallel with the lathe centers. Rough file out a piece of sheet brass, something like the template, to serve as a grinder. Lay this on the face of the hinged piece of wood, and press it up on the revolving glass, smeared with fine emery and water. After a few turns lower the board and shift the brass grinder endways to another position, either in or out. Repeat this continually, occasionally turning the brass over in order to equalize the sides. By this operation the parabolic figure of both the grinder and the glass will soon correct each other; of course, a piece of the swing board must be scooped out sufficiently to admit nearly half the paraboloid.

In accordance with the above mode of procedure, the parabola is originated and its size pre-determined by the given focal distance. The ordinary dry parabolic illuminator is usually made about $\frac{1}{8}$ inch focus; for an immersion $\frac{1}{10}$ will do better; but if this is to be used as an an animalcule holder, $\frac{1}{15}$ will be found sufficient.

## NOTES ON THE STRUCTURE OF OPHIOGLOSSUM.

BY MARK W. HARRINGTON, M. A., F. L. S.

(*Received December 16th, 1878.*)

During the winter of 1876–7, I had the opportunity of studying, in the botanical laboratory of Professor Hofrath Schenck, of Leipzig, the structure of *O. pedunculosum*, Desv., and of comparing it with the structure of several other species of the genus. I compared my results at each stage with those ob-

tained by Russow,* as well as those obtained by Holle.† In the following notes I mention only the points of structure when I find them differing from Holle's or Russow's account, or when they are mentioned by neither. As Holle carefully analyzed earlier literature, the following notes on points not mentioned by him may fairly be considered new. When the species is not mentioned, *O. pendunculosum* is always meant.

A.—Root.

The outer walls of the epidermal cells are not visibly thickened in *O. pedunculosum*, or *O. vulgatum*, L. The parenchyma is uniform and filled with starch and oil. The grumous masses and mycelial threads in the middle parenchymatous cells, described by Russow and Holle, I found in about half of the specimens of *O. vulgatum*, but in no other species. The xylem of the root is usually on the under side of the bundle, though it is sometimes at the side, and rarely above. The vessels of the xylem were, in nearly every case, reticulated. The protective sheath was not distinctly marked by woodiness, but in longitudinal sections the radial walls were beautifully wavy. The parenchyma of the bundle has little starch, but contains many tears of a brownish-yellow color.

The roots of *O. lusitanicum* and *O. pendulum* are like that of *O. pedunculosum*. In *O. pendulum* the epidermis is often imperfect; the deterioration is caused by fungi. The external wall, when present, is decidedly thickened. In both species the xylem is proportionately larger than in *O. pedunculosum*. It is is large as the phlœm. The vessels are more frequently scalariform than reticulated.

*O. Bergianum*, Schldl., a S. African species, has a diarch vascular bundle. The xylem is divided into two opposite parts, with the phlœm between and partly embracing them. The protective sheath is decidedly woody.

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DESCRIPTION OF PLATE XVI.

Fig. 1.—Transverse section of vascular bundle of *O. pedunculosum*. The upper side is toward the center; *x*, xylem, *p*, phlœm.

Fig. 2.—Transverse section of a vascular bundle in the leaf of *O. pendulum*. The xylem (*x*) inside and the phlœm (*p*) forms a ring around it, separated from it, above and below, by parenchyma (*c*).

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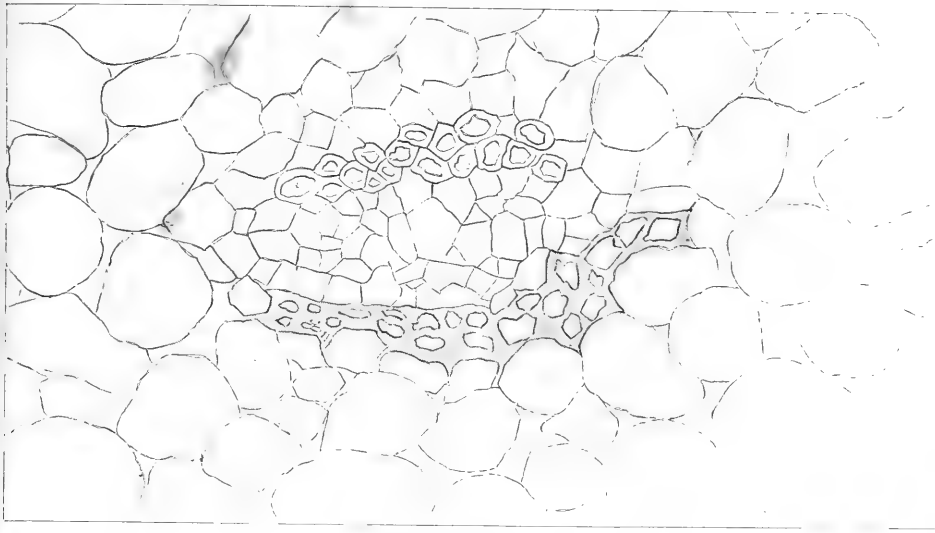
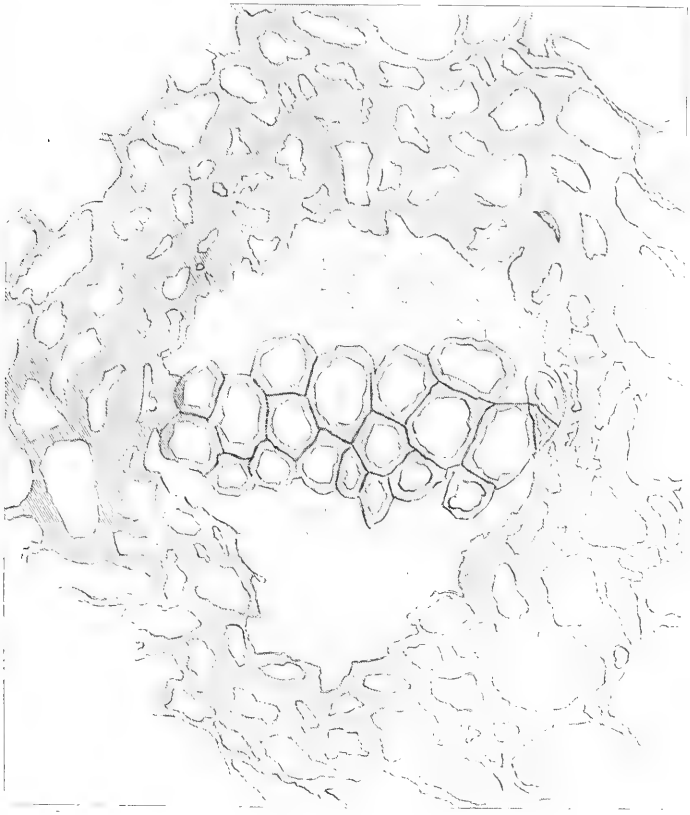
* Histologie der Leit-bündel Cryptogamen. Mem. de l'acad. Imp. de St. Petersbourg, VII. Série, Tome XIX., No. 1., pp. 117-128.

† Bau and Entwickelung der Ophioglosseen Bot. Zeit., 1875.





*O. macrorhizum*, Kze, has a diarch bundle, like that of *O. Bergianum.*

B.—Rhizome.

The epidermis is present in limited places. Holle found none in *vulgatum.* No cork was present in *pedunculosum* or *vulgatum.* Russow found it abundant, and Holle found some in *vulgatum.* There is a vascular net work in the rhizome, and the vascular bundle from leaf or root incorporates itself in this network. I could not demonstrate a direct connection between each leaf and a corresponding root, as Holle was able to do. Indeed, I could find no comparison in number or position between the leaves and roots, and was unable to draw Holle's conclusion from his own drawings from nature. Reticulated vessels were present in the rhizome. The rhizomes of *lusitanicum*, *Bergianum*, *macrorhizum*, and *pendulum* had the structure of that of *pedunculosum.*

C.—Leaf.

The structure in *pedunculosum*, *lusitanicum*, *reticulatum*, and *macrorhizum*, was like that of *vulgatum.* In *Bergianum* the external wall of the epidermal cells is much thickened. The edges of the leaf are thick, the structure compact, and the stomata small. The whole structure of the leaf suggests its habitat; viz., the dry climate of S. Africa.

In *pendulum* the phlœm has very thick walls and surrounds the xylem. The latter is in a zone running through the center of the circle formed by the phlœm and abutting on it at each end. The space on each of the xylem, between it and the phlœm, is filled with parenchyma. This arrangement is replaced by the ordinary one in the lower part of the leaf and in the petiole.

D.—Spike.

In *pedunculosum*, a special preparation is made in the tissue for the dehiscence of the sporangium. In *pedunculosum*, *lusitanicum*, *Bergianum*, *macrorhizum*, *palmatum*, *Surinamense*, *reticulatum*, and *bulbosum*, the sporangia show no trace of a division into two compartments.

In *vulgatum* there is an incomplete wall extending from the axial side of the sporangium, parallel to the axis of the spike. It presents a bow-shaped edge toward the exterior, being farther extended at the upper and lower ends than in the middle. In *pendulum* this division wall is usually nearly complete, and

is sometimes quite so. This division wall can be best seen in the sporangium just before it opens to give exit to the spores.

E.—Foreign bodies.

In specimens of *pedunculosum*, taken from a flower-pot, were many eggs of *Anguillula* in all stages of development. They lay in the tissue of the leaf stem, between the cells. The animal was often found on sections of the stem, but never in the tissue. It was probably displaced by the cutting of the sections. The earth in this pot contained many specimens of the same animal, but from the absence of sexual forms, no determination of the species could be made. No animal parasites were found in the leaves of this plant, but the epidermis was permeated with mycelial threads, and presented numerous swellings, filled with fluid. Notwithstanding both parasites, the plant was in an apparently vigorous condition.

## A FEW REMARKS ON ANGULAR APERTURE, AND DESCRIPTION OF A "UNIVERSAL APERTOMETER."

BY PROF. H. L. SMITH.

(*Received February 24th, 1879.*)

In venturing a few remarks upon the vexed question of angular aperture, and those scarcely orthodox as the subject is viewed by many, and for which I may receive the same kind of treatment that Mr. Wenham has experienced, I am not actuated by any desire to appear as the champion of a "lost cause," as some have called it, but I desire to make a few statements, the truth of which any one may readily test, and which I am confident few, if any, will deny.

Recently I invited a well-known optician to determine for me the angular aperture of what, to all appearances, was a Powell & Leland 1-12th inch, of old date. He readily consented, and after measuring it precisely as he would have done one of his own objectives, the same way in which he could obtain 179° for some of them, he announced the result, 89°. This, indeed, did not seem much for a 1-12th, even if it was made in 1852. I then told him that I had previously removed both back systems, and that he had been measuring

only the front lens, which was very far from a hemisphere. I need not say that he immediately saw that something was wrong, and candidly confessed that such a method of determining angular aperture was unreliable. This experiment, the credit of which is due to Mr. Wenham, strikes a fatal blow at the nomenclature derived from the old method of measuring angular aperture. I then took an excellent "professional" 1-8th of Spencer, and closing the systems, put a small dot of ink on the flat surface of the front lens, just large enough to cut off the little circle of light that appears when one looks into an objective with the front system toward the eye; the dot was barely one-third the diameter of the exposed flat surface of the lens: indeed, it looked ridiculously small. The objective was now attached to the tube of the microscope. Not a ray of light, except what came through the ink, could be obtained, neither axially or by oblique illumination. It was next put on the sector, as in measuring the angle the old way, and as soon as the arm was swung around sufficiently, lo, the light gleamed brightly, and continued visible until the sector arm read 179°! All this was from light outside the boundary of the little ink dot, within the area of which was comprehended all that was available of the objective front for work. As an immersion (and truly measured, as I shall presently show, both on my own plan and that of Dr. Abbe) this objective gave me 87° as the angular aperture, or balsam (glass) angle, and as this is 5° more than twice the critical angle, the maker might have concluded, as many have done, that the equivalent air angle of this objective was 180+, or in other words, that there would be nothing absurd in marking the objective 180°. Now the true air angle, at the same closed point, as I shall presently show, the angle of a triangle whose apex is the focal point, and whose base is the diameter of the spot of ink which just stopped all the light, is only 144°. This objective, made some time ago, was actually marked, in good faith, 170°, which was far within what it would measure the old way at the same closed point; but the angle 170°, if we compute from it a balsam angle, gives one much less than the objective would pass, and yet for air angle, it is 26° too much. It is evident that the old system of marking is all wrong, telling a false story in either case, dry or immersion.

Mr. Wenham, in a recent article on the "Measurement of Angle of Aperture of Objectives," in the *Journal of the Royal Microscopical Society*, December, 1878, says, in reference to the large angles of aperture claimed for immersion objectives: "We are not seeking for foci within the front lens, or yet on its surface," and he further remarks, "that every lens he had seen, professing 180°, does, in fact, focus on dry objects."

If I understand him, he admits that objectives on the immersion principle may, by immersing the object in what is really, for the time being, a portion of the lens itself, have an angle in balsam of 82°+, or more than twice the critical angle.

If Mr. Wenham, however, intends to say that because every objective he had seen, which was marked 180°, did in fact focus in air, these objectives could not have as much as 82°, balsam angle, to say nothing of more, then I must dissent. I may be wrong in so understanding him, and do not wish to be considered as positively asserting that he does imply this; but such is the inference that I draw from his words. A reference to Plate XVII., Fig. 1, will explain how an objective, whose true air angle is only 144°, may actually pass 87° in glass (balsam); *a* is the glass front of the objective, of a certain thickness; *b* the interposed immersion fluid, and *c* the cover, under which is the object *e* in balsam. We will suppose glass, fluid, balsam, and cover to have the same refractive index, and that when the objective is in focus, *e* is at the distance shown in the diagram from the curved surface *a*. It is quite evident that it is a matter of indifference, in the present case, whether the glass part or lens should be a little thicker, and the fluid or the cover thinner, or *vice versa*, so long as the distance from the curved surface to *e* remains unchanged.

Rays *e*, *d*, and *e*, *f*, diverging from *e* at an angle of 87°, will emerge at the posterior or curved surface *a*, without refraction, if *e* is in the center of curvature, or they will be refracted if *e* does not coincide with that point.

Supposing, now, we were to replace the fluid and cover by glass, *i. e.*, make the whole of glass as thick from *a* to *e* as it is when used as an immersion, it would no longer be possible to focus it; if *e* was uncovered and infinitely small, it would be just on the flat surface of the lens. By removing the fluid portion, however, and not replacing its thickness

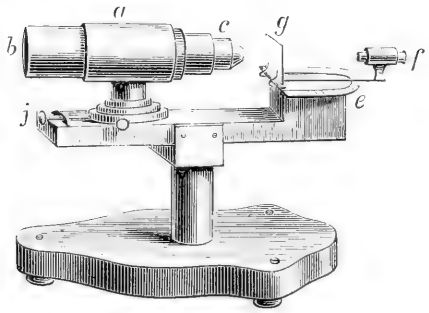



Fig 2

Fig 1

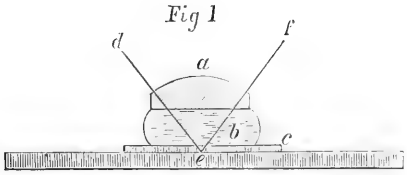



Fig 11

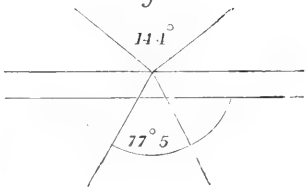



Fig 8

Fig 6

Fig 7


Fig 3 Fig 4 Fig 5

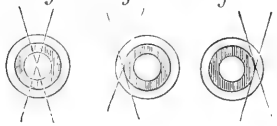
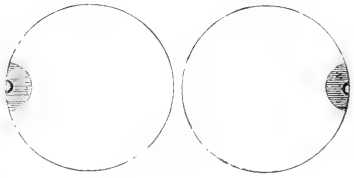


Fig 9 Fig 10



Apertometer.—H. L. Smith.

with glass, we could focus the objective as a dry lens; in doing this the plane surface of the lens will be brought nearer to *e* than it was when used as an immersion—this distance, with the 1-8th inch already alluded to, is about 1-50 of an inch, so that, if the base, of the little triangle whose apex is at *e* (Fig. 1) subtended an angle of 87°, when the objective was used as an immersion, it will now subtend 144° (the true air angle) when the objective is used dry; we have supposed the lines touching the flat surface of the lens at the same points, in each case.

It must be borne in mind that these rays, at an angle of 144° in air in front of the lens, will not enter the lens at that angle, but refracted at the plane surface, will now pursue paths, so that, if prolonged backwards, they will only include an angle of 77°.5; 10° less than before, when the objective was used as an immersion. I believe that the immersions of highest angles, like the oil-objectives of M. Zeiss, and certainly those of the Spencers, do not focus at all as dry lenses.

The apparatus which I use for measuring the true angle, in all cases, and which is shown in Plate XVII., Fig. 2, may, for angles in glass, or for immersions, be used precisely like Dr. Abbe's apertometer, and indeed, it seems to me has some advantages over that instrument, which will not give the direct air angle, but deduces it from the angle in glass; a separate graduation being required when it is to be read off directly. The 180 degrees are compressed into an arc of 82°, and the whole space on that arc between 60° and 80°, is not more than that between 0° and 10°; *i. e.*, the graduations are necessarily unequal, and the instrument is only graduated to every fifth degree. The cylindrical surface, though it may show a sliding edge with sufficient clearness, is not so good as the more easily made spherical surface which forms a part of the instrument I shall describe, and by means of which one may bisect a minute white circle with the greatest accuracy. Moreover, few would be able to graduate the "apertometer" correctly, and the process of computation, though easy enough, is not necessary.

*a* (Fig. 2) is a brass tube, say two inches long, supported on a pillar, into which another tube (*b*) slides easily, carrying at one end the objective (*c*). And for this purpose it is fitted with the Society screw; the other end (*b*) is open, except when a cap

with a small hole is put on for purposes of centering, and when it is used after the manner of Abbe's apertometer; *e* is an arc (a good protractor answers very well) graduated to degrees (any higher refinement is quite useless, as in the larger angles there will always be an uncertainty of at least a quarter of a degree, a space readily estimated). An arm moving freely on a pin at the center of the arc, carries at its end an eye lens, in a small sliding tube, and having a small eye hole (*f*), the lens having its focus over the central pin; *g* is an ordinary glass slide (3 by 1), which can be slipped in or out of place at will, and is held at right angles to the plane of the graduated arc by two springs which press it against two uprights, so that the front surface of the glass is exactly over the center of the arc, and therefore of the pin on which the movable arm turns. The glass slide is held by a separate brass holder, which can be pushed forward when the focal point of the objective is just over the pin, until the slide touches the front lens, and a black bar with a straight edge painted on the glass, can be made to cut off just half of the surface of the front lens by putting in the perforated cap at *b*, and looking through *f*, which is supposed to be standing over the middle of the arc. This is for using Mr. Wenham's method, and it gives very nearly the same results as my own. The apparent aperture of the uncovered half is measured (twice this will give an extravagant angle),* the whole aperture is then measured, but in the usual way, *i. e.*, until the light disappears; the angle of the half is now subtracted from that of the whole, and twice the remainder is the true angle; this method is only available when the front lens is flush with the surface.

The mode in which I prefer to use the instrument, however, and which gives the true air angle, is as follows: The front surface of the slide (*g*) is brought accurately over the center of the arc, by slipping the brass holder quite home; two fine cross lines, ruled with a diamond, on the glass, are, by sliding the glass laterally, brought directly over the center of the arc, or pin, on which the arm carrying *f* moves; their intersection is thus placed directly over the center of

* An objective which, when measured in the old way by the sector will show 180° as the air angle, will, measured the same way when half its front surface is covered, give 115° or so, *i. e.* 230° for the whole angle; for the explanation of this see Mr. Wenham's article *loc. cit.* The true angle is obtained thus, $180° - 115° = 65°$, and twice this or 130° is the true air angle.

motion; the objective is focused on these lines; it is not necessary to use an eye piece, unless the focal length be very long. Yet for true angle, independent of definite length of tube, it would be sufficient to simply focus upon the lines without an eye-piece; the screw (*j*) may be used for this purpose, or it may be effected by simply sliding the tube *b* in *a*. Suppose, now, the eye lens (*f*) to be over the middle of the arc; on looking through towards the objective, one will see something like Fig. 3, where the outer circle is the periphery of the front lens, the middle one is the image of the diaphragm at the back of the objective; or, if this diaphragm is sufficiently large, the margin of the posterior system; the inner circle is the image of the end of the tube (*b*), and within the area of this will be an inverted picture of external objects, crossed at the center by the lines on the glass; the objective (*c*), and the eye lens (*f*), forming a sort of miniature telescope, and having the lines as a common focal point: the smaller circle would disappear if the end of the tube (*b*) was large enough, and there would be but these two—the periphery of the front lens, and the image of the diaphragm or posterior system—and it is with this last we are to deal. A piece of tissue paper, or cap with ground glass, is now put on at *b*, and immediately a soft light fills the field, and the lines appear like cobwebs stretching across it. The sector arm carrying the lens (*f*) is now swung around until the intersection of the lines is tangent to the image of the margin of the posterior system or diaphragm, as in Figs. 4 and 5, which represent the circles, as they would appear with very small angles; with wide angles, they are foreshortened, as in Fig. 6, where the larger circle is, as before, the margin of the front lens; the next inner one, is the image of the diaphragm, and the smaller (partly obscure) is the bright field still visible, and which gives the exaggerated angle to measurements made in the old way. The sector arm may be swung many degrees farther on each side before this will disappear. I find that the old triple fronts, as made many years ago, by Powell & Leland and by Spencer, show much less difference between the true and false angle than do the modern systems, with more or less thick single fronts. When the fine lines are thus projected on the face of the front lens, they will, as in Fig. 7, mark the extremities of a diameter of the circle, which, if stopped out, would exclude all light from

passing through the objective, when used to form an image in the field of the eye-piece of the microscope.

So much for the air angle; for balsam, or what we will here consider as the same thing, angle in glass, the slide (*g*) is replaced by another (Fig. 8) of the same thickness, but with a small bull's eye—say 0.25 inch radius—cemented to it, and of such thickness that its center of curvature is in the front surface of the slide; fine lines are also ruled on this slide, passing through the center of curvature of the lens. When the bull's eye is properly adjusted, it will make no difference in the distinctness with which the images of external objects are exhibited, when using the objective and eye lens (*f*) as a little telescope, whether the glass slide and bull's eye are in position or whether they are removed, the rays pass through the slide and bull's eye, emerging without refraction at the convex surface; they will emerge, indeed, at a much smaller angle, as shown in Fig. 11, from the refraction at the front surface; and in this refraction, nearly all the rays which give the exaggerated angle disappear, and the angle of the emergent rays is the true angle in glass, from which the true air angle may be computed. To avoid this computation, M. Zeiss constructs the apertometer with another scale, upon which an arc of 82° corresponds to 180°, and one of 77°.5 to 144°, &c. No objective ever made, or that can be made to work as a dry lens, will pass rays through the slide and bull's eye at a greater angle than, say 82°, when air intervenes.

The 1-8th inch already alluded to, when the systems were closed and it was adjusted on the cross lines in the center of curvature of the hemispherical lens, transmitted rays making an angle of 77°.5. The natural sine of half this angle is .6259, and this, multiplied by 1.52, assumed as the index of refraction of glass, gives .9513, the natural sine of 72°.05, twice which, or 144°.1, is the air angle. [The degrees are here given in tenths.] Measured directly, using the glass slide (*g*) and the lines, as before described, I obtained 144°. Measured on the sector in the old way, I had no difficulty in getting 179° before the light disappeared.

A 1-6th inch Gundlach, which, measured in the old way, gave 141°, as the air angle, gave but 72°.75 with the bull's eye, from which the computed air angle is 128°.7; when measured, using the glass slip (*g*), I obtained 129°. It will be understood

that for immersion angle, or, as it is generally called, "balsam angle," all that is necessary is to introduce a drop of fluid (theoretically this should have the same refractive index as the glass) between the objective front and the glass slide, and to re-focus on the lines. The 1-8th inch, at the same closed point, which gave only 77°.5 from air into glass, will give 87° with glycerin interposed. There is very little difficulty in obtaining the true angle here; the proper point is when the circle of light, which is beautifully shown when the tissue paper covers the open end of the tube (*b*), is dichotomized, and the slightest movement will cause it to disappear; this action is even more prompt with the fluid interposed than when air intervenes. If the air intervenes in taking the glass angle with long focus glasses, *e. g.*, a 2-3d inch, I find it necessary to use the lines as described for getting the *air* angle directly; *e. g.*, a 2-3d inch "professional," of Spencer, marked 35°, actually gave with the bull's eye, before the light disappeared, 37° as angle in the glass. Computing the corresponding air angle we get nearly 58°!! Using the lines, however, bringing them to the edge of the illuminated field on either side, precisely as for the direct measurement of air angle, gave but 24°, from which the computed air angle comes out 36°.8+; and measured by using the glass slide (*g*), I obtained 37°.

These angles would be reduced when the objective was used, as such, on the tube of the microscope, as the focal point would then be somewhat more distant from the front lens; lengthening out the tube *b* to ten inches, and using an eye-piece for focusing, lessened the angle scarcely a degree, and so the makers, we may conclude, have really marked this objective within its true angle.

To convert the instrument substantially into Abbe's apertometer, it is only necessary to keep the slide and the bull's eye in place, focus on the lines, and then, putting on the cap with the small eyehole at *b*, look in there instead of at *f*; placing a sheet of paper in front of the graduated sector and allowing the light to shine through it we will get a distinct picture of the end of the tube *f*, and see a little spot of light (the eyehole) in the center; the lines ruled on the glass may interfere with perfect definition in the middle of the field, but when the sector arm is swung around, the little circle of light can be neatly bisected on each side of the field, as shown in

Figs. 9 and 10. A long-focus lens may be applied at the eye-hole if necessary, or the supplemental tube recommeded for Abbe's apertometer, but I find all that is required is my ordinary reading glasses, and I can make the bisection of the little bright circle as accurately as when using a compound microscope to view it, even with a 1-12th objective.

As already remarked, I think that in sharpness of the image the spherical surface will be found superior to the cylindrical. The results obtained with the instrument used in this way agree with those given when it is used as I have already described. The same exaggerated reading of low angled long-focus objectives is to be noticed as when using the bull's eye without the lines. The Spencer 2-3d inch gave, using the instrument as Abbe's apertometer, 36°.* With wide angles and high powers, the anomaly disappears, and the agreement between the two methods is as close as could be desired; the use of the lines with the bull's eye gives, however, a superiority to my own method of measuring, at least, for objectives of long focus, but there is certainly very great ease in reading the angle, using it after the manner of the apertometer of Abbe, though not more than in my own; the spot of light with wide angles and short foci disappears promptly or is readily brought to the intersection of the lines.

If we remove the bull's eye slide and focus on the lines on the plain slide, we can obtain the air angle with great accuracy by simply looking through the eye-hole in the cap applied at the end of the tube (*b*, Fig. 2), and observing, by aid of a long focus lens, when the image of the hole in *f* is neatly bisected on either side, as shown in figures 10 and 11. If, instead of a single lens, a short compound microscope with an objective of 4 inches focus is used, the eye-hole will not be necessary. I do not, except for higher amplification, see any need of this supplemental part. The highest air angle objective I have yet measured, is an old $\frac{1}{16}$th by Spencer, 163°. I do not doubt that some of the first-class modern dry objectives of recent date may reach perhaps 170° or more; but even with an angle of 163° the extreme rays strike with such obliquity that

*This is the glass angle, and 12° too much! As I have not by me one of Abbe's apertometers I cannot say whether that would give this exaggerated angle, 36° in glass, which my instrument gives when used after the manner of his apertometer, but I cannot see why it should not; the principle is the same; the use of the intersecting lines will, however, in my method, give, as already shown, 24° for the true angle of this objective in glass, or 37° as air angle.

more than half the light is reflected from the front surface, without entering the lens at all, and yet more at higher obliquities. I do not mean to say that there is not a gain worth striving for in passing from—say 160° to 170°, but an objective, whose real air angle is more than that last named, will have an inconveniently short working distance. I intend to investigate the cause of this enlarged angle of dry objectives observed in the Abbe apertometer fashion, with the bull's eye. I find that the Spencer Student $\frac{1}{4}$th inch, which measures 100° with the glass slide and lines, or by looking through the eye-hole at *b*, as above described, gives, by the latter mode, when the bull's eye is interposed, 63° as angle in glass, from which the computed air angle will be near 104°. Using the bull's eye, slide, and lines as directed, and looking through *b* the glass angle is 61°.5, from which the computed air angle is 100°. With objectives of shorter focal strength the agreement is closer.

I do not yet see any need of adopting Dr. Abbe's notation, which is, indeed, strictly correct in theory, but it would be very inconvenient for many microscopists, as it necessitates the use of tables that some might not have, or others understand. The fact is, no objective can be made to do equally as good work dry *and* immersion; it should be either dry *or* immersion simply. Why not mark the angle just what it is? If the objective is an immersion of 116°, everybody will understand it, and none but a simpleton would confound it with 116° marked on a dry lens, or suppose that it meant an objective of the same resolving power, or, indeed, excellence anyway. Knowing that 82° on an immersion would be equivalent to 180° on a dry, everyone would soon learn the comparative values of the same angles marked on each, and neither would ever come dangerously near 180°.

To compute rigidly the balsam or glass angle from the observed air angle, or *vice versa*, the objective must not only be acccurately focused, but the intersecting lines *must* be used; otherwise an exaggerated angle (varying very much in different objectives) to the extent of two to twelve degrees, may be obtained as the glass angle; and if, from this, we should compute the air angle, it might be ten or twenty degrees too much.

Carefully used, the instrument will give entirely concordant results. Moving to the right, the point of intersection will

travel in the same direction, as from Fig. 3 to Fig. 5, and to the left the change will be from Fig. 3 to Fig. 4; this is contrary to what one might at first suppose; a little reflection will show the reason for this.

GENEVA. N. Y.

## DUBIOUS CHARACTER OF SOME OF THE GENERA OF FRESH WATER ALGÆ.

BY REV. FRANCIS WOLLE.

(*Received February 24th, 1879.*)

Algologists have made a number of genera of unicellular plants, as *Glœocapsa*, *Microcystis*, *Glœothece*, *Protococcus*, and the like. My observations of these forms during the past few years induce me to question the place given them as plants, and to suggest that they are merely forms of gonidia or spores, or sporangia, various stages of development in the life history of filamentous plants. It has been observed by some authors, that forms of *Sirosiphon* are developed from cells similar to *Glœocapsa* cells, and that the two kinds of plants live together, also that the articles of the internal cellular structure of *Sirosiphon* filaments are often very similar to the cells of *Glœocapsa*, but that the one originates the other, and is in turn again reproduced by it, does not appear to have been entertained. This is not surprising, because each form appears to have a life of its own. The filaments develop and multiply, and the spores or gonidia develop and multiply; the latter not unlike some of the lower forms of animal life, as certain Infusoria. In the annexed plate I illustrate three genera of plants, and show how the plants are developed from spores, and how the spores are produced from the plants; and again, how spores reproduce spores often through three or more cycles. These spores represent as many different genera of the so-called unicellular plants. The changes continue through many generations, and sometimes the cells spread over extended surfaces before any of them prove fertile in reproducing the mother plant.

As an illustration, I represent in Plate XVIII., Fig. 1, first a fragment of an old filament (*A A*) of a common *Sirosiphon* (*alpinus*). The cells of the plant are usually subspherical and lamellate as in the end (*B*) of the figure. At the other end they

have undergone a change, both in color and in feature, from brown to olive-green and æruginous. These cells are filled, primarily, with a homogeneous endochrome; in this are formed very minute granules, the microgonidia. The cells slide out from the broken or decayed end of the filament (*d d*); then the microgonidia enlarge and the cells assume the character of sporangia, or spore bearers (*e e e e*). Next, the microgonidia are seen to sheath (*f f*); they enlarge still more (*g g*) and divide (*h*). Up to this period they are enclosed in an epidermis, or membranous tegument, which now breaks, and the enclosed cells are scattered (*i i*); these in turn also grow larger and larger, the internal cells divide, increase, and develop (*k l m*), often repeating this process many times; at last, from one of the latter form (*m*), *Glæocapsa*, here and there the young filaments of *Sirosiphon* (*n o*) are reproduced.

In this process we have a number of different forms of the dubious unicellular plants which would be respectively classed as *Microcystis* (*e e e*), *Glœocapsa* (*f f g g l n*), *Glœocystis* (*h*), and *Glœothece* (*i i*). These are often found in masses, sometimes the one and sometimes the other predominating. Under certain conditions the mother plant will be produced, and under other conditions only the spores will be repeatedly developed. In a deep mountain ravine in this vicinity, where the two forms abound, the more exposed rocks are covered with growths of *Sirosiphon* and a few of the *Glœocapsa* cells, while on other cliffs, which are shaded and dripping with moisture, the so-called *Glœocapsa* forms are the most abundant, with only occasional filaments of *Sirosiphon*, and may be drawn off by handfulls. They are evidently merely different conditions of the same plant.

Fig. 2 represents another form of *Sirosiphon*, found by Mr. Brandegee at a soda spring in Colorado. The specimen was scant, but the forms were very distinct, especially in the spores. *a* is a sporangium, a *Microcystis* form, and *b b b* the *Glœocapsa*

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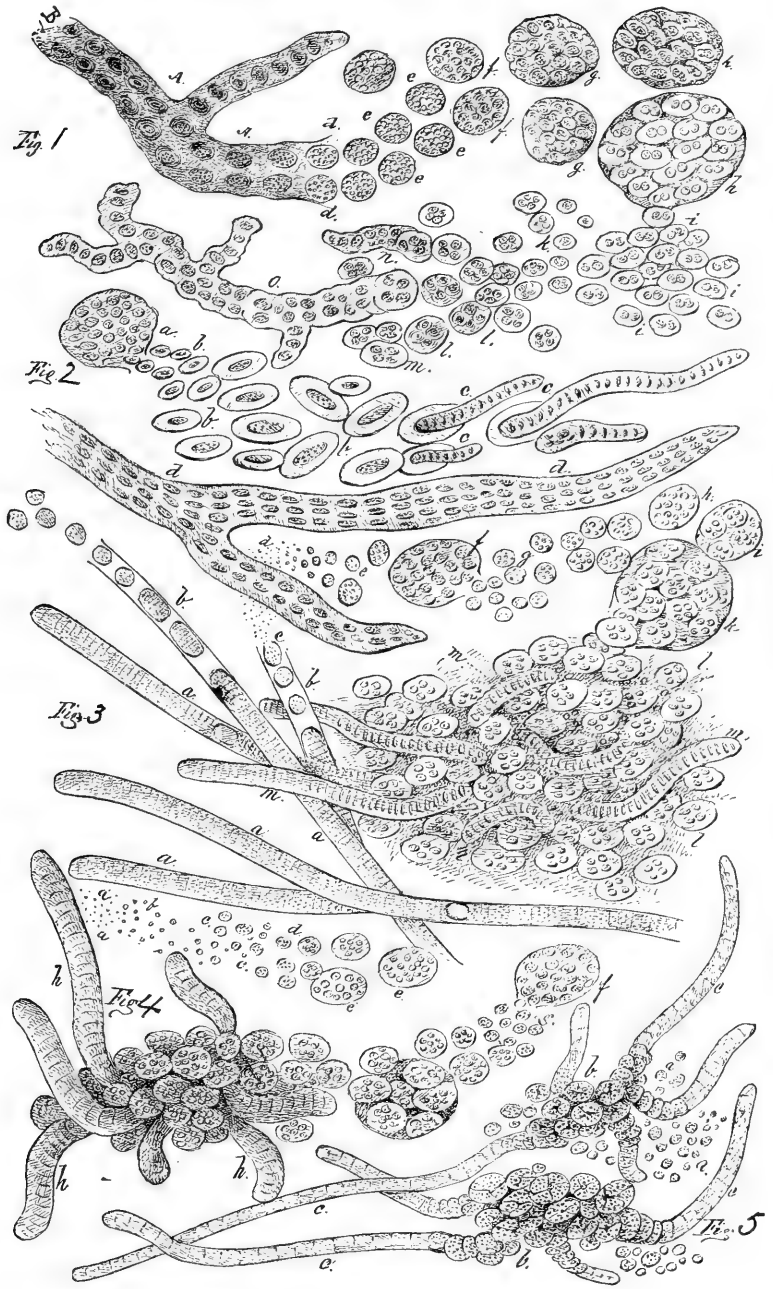
DESCRIPTION OF PLATE XVIII.

Fig. 1, Reproduction of *Sirosiphon Alpinus*.
Fig. 2. *Sirosiphon, n. sp.?*
Fig. 3. *Scytonema.*
Fig. 4. *Scytonema truncicola.*
Fig. 5. *Ulothrix.*




FRESH WATER ALGÆ.—FRANCIS WOLLE.

forms which have enlarged after being ejected from the former. These are singular in shape, and the process of development of the young forms of the mother plant is also unusual. They frequently germinate in the cysts (*c c*). There is likewise something distinct in the perfected plant (*d d*). It is probably a new species of *Sirosiphon*; but the specimens being few, I have not ventured to describe it.

Fig. 3 is a species of *Scytonema*, near *Sc. Castelli*, Massl. In its life history and general character it is not unlike *Sc. Cortex*, Wd. and *Sc. truncicola*, Rab. I found it growing in extended, bluish-green strata, on shelves, on flower pots, and on walls in a greenhouse in Harrisburgh, Pa. Omitting the *Glœocapsa* forms, the process of development is similar to that of *Sirosiphon*. I represent a few filaments (*a a*). The articulations are thin disks, two or four to a diameter; these separate, fall over and slide out of a broken end of the old plant (*b b b*); from these the microspores are evolved (*c*) and scattered; these enlarge by growth (*d*), and develop from one stage to another as figured (*e f g h i k l*); the latter (*l*) are *Glœothece* forms. Clusters of these are frequent without any filaments, but sometimes, by turning a mass over and over again, the young plants (*l m*) are seen intermingled with the cysts (*Glœothece*), and directly traceable from them.

Fig. 4 illustrates the early life of *Scytonema truncicola*, Rab. from a specimen found on an old pine board, by H. W. Ravenel, in S. Carolina. The microgonidia (*a a*) from an old filament, advance in size (*b c d e*); the younger are microcystis forms, the older are sporangia (*e f*), and emit small cells (*g*); these develop new cysts continually until favorable circumstances, moisture and warmth, cause them to cluster and to develop the young of the mother plant (*h h h*).

Fig. 5 shows the early development of forms of *Ulothrix*, as *U. flaccida* K., *U. nitens*, Mengh., and others. I add this as an example of rapid and extensive multiplication of gonidia or spores, before showing signs of fertility. There are green coatings low down on shaded fences, and on damp places on rocks, on trunks of trees, and sometimes on the ground. These may be seen at all seasons of the year. If examined in the spring, or summer months, they will usually be found to consist of masses of simple spherical cells (*a a*), rarely with signs of division; they are generally filled with very minute granules. These constitute

the *Protococcus*, *Pleurococcus*, and *Chlorococcum* of botanists. The larger cells are called sporangia, but they do not differ from the others except that they have become more matured; these eject the granules (microgonidia), which develop and reproduce. This process continues during the greater part of the summer, so that by the autumn months the strata have become quite extended, and the cells often crowd upon one another to form thick crusts. If we collect from these strata in the cooler months of October, or November, when there is more moisture in the atmosphere, we find that the *Protococcus* and the growths which were there in summer (*a a a*) are almost beyond recognition; they have conglomerated into irregular masses (*b b b*), the individual cells are breaking into parts, some elongate and add cell to cell, and here and there a long filament of *Ulothrix* (*c c*) has developed. We examine another mass; in this the filaments predominate.

Illustrations like the foregoing might be multiplied. They leave little doubt in my mind, that the many unicellular forms recognized as plants, are of a very doubtful character. To say that all of them should, at once, be wiped out from the catalogue of plants, might be too sweeping a demand. I merely call attention to the facts as they came under my observation.

Bethlehem, Pa.

## ON TWO FORMS OF COMPARATORS FOR MEASURES OF LENGTH.

BY PROF. W. A ROGERS.

(*Received March 29th, 1879.*)

The subdivision of a given unit into exactly equal parts, is a problem of extreme difficulty, and the difficulty rapidly increases with the length of the unit to be divided. The measurement of the subdivisions, presents almost equal difficulties, though of a somewhat different character.

Two methods offer themselves for the solution of the problem:

1. We may assume the smallest subdivision to be an aliquot part of the entire unit, and then obtain that unit by successive increments of this constant quantity. If the number of subdivisions is large, it will be found practically impossible to

measure and repeat this constant with sufficient accuracy to obtain the whole unit with the required precision. Suppose, for example, we require the meter—even granting that the true value of the millimeter could be found, it would still be impossible to get an exact value of the meter by 1000 repetitions.

An error of only one ten-thousandth of a millimeter in the assumed value will, in the whole meter, amount to one tenth of a millimeter .Through unavoidable accidental errors, the final deviation from an exact meter would doubtless exceed this amount. A fundamental objection to this method is found in the fact that so much time would be required to complete the measurements, that the changes introduced through a variation of the temperature could not be neglected.

2. We may assume the entire unit, and then obtain the subdivisions according to the following scheme:

($a$) Subdivision into 2 equal parts.
($b$) Subdivision into 4 equal parts.
($c$) Subdivision into 5 equal parts.
($d$) Subdivision into 10 equal parts.

The fundamental principle which must govern the construction of a comparator, is the requirement that these large subdivisions shall be easily made with great precision and within so short a time that the effect of a slight change of temperature can be neglected. As a check we have:

$$(b) = 2\ (a).$$
$$(c) = 2\tfrac{1}{2}\ (a).$$
$$(d) = 2\ (c).$$
$$(d) = 5\ (a).$$
$$(d) = 2\tfrac{1}{2}\ (b).$$

When the relations between the subdivisions into 10 equal parts have been found, each one of these tenths may be again subdivided as before, without danger of accumulating either accidental or systematic errors, or even errors which would be introduced through a change of temperature, if not more than ten or fifteen minutes is required for the entire operation. The writer has found that for air contact with a long bar of metal, whether of iron, brass, or steel, a change of several degrees in the temperature, as indicated by a thermometer in air, requires over thirty minutes to produce a perceptible change in the length.

When we reach those subdivisions which fall within one field

of the microscope it would seem better to modify, in some respects, the requirements which should govern the construction of a comparator.

The ordinary method of measuring short lengths is either by means of an eye-piece micrometer, in which the lines in the focus of the ocular are ruled on glass, or with the ordinary filar micrometer. There are quite a large number of micrometers of the latter class in use in this country. The one which I have used with great satisfaction was loaned to me for some experiments by Mr. F. Habirshaw, of New York. It was made by R. & J. Beck, and is excellent in every way. I believe Powel & Leland also make excellent micrometers of this class. I am not aware that any American maker has given attention to this important adjunct of the microscope.

These two methods of measuring short lengths are both open to two serious objections, both of which are inherent in the method of construction and use. First, even with a $\frac{1}{4}$ objective one is limited to a field not much exceeding $\frac{1}{4}$ mm., and secondly, in neither case can the contact of the lines of the eye-piece with the lines under the objective be made in the center of the field.

These two forms of micrometers for measurements of short lengths are, I think, the only kinds in use in this country. Abroad, however, a micrometer screw which carries the object to be measured in a plane perpendicular to the line of collimation of the microscope is in frequent use. The screw has a divided head, from which the magnitude of the space measured is read directly. The writer has seen only the form made by Merz & Son, of Munich.

The introduction into this country of this form of a comparator for short lengths is due to Mr. Leonard Waldo, assistant in Harvard College Observatory. During his visit to the continent, in the summer of 1877, he purchased of Merz & Son two of these comparators. One of them he attached to a grand stand by Crouch, constructed upon a special order, with reference to great stability. It is described in a paper on "Measures of Short Lengths," printed in the *Proceedings of the American Academy of Science and Art*, Vol. XIII., page 352. The other one was bought for the physical laboratory of Professor John Trowbridge, and was kindly loaned to me by him for some experiments. It was fitted to the Tolles stand, shown in Fig. 8. It is marked *A* in the drawing.

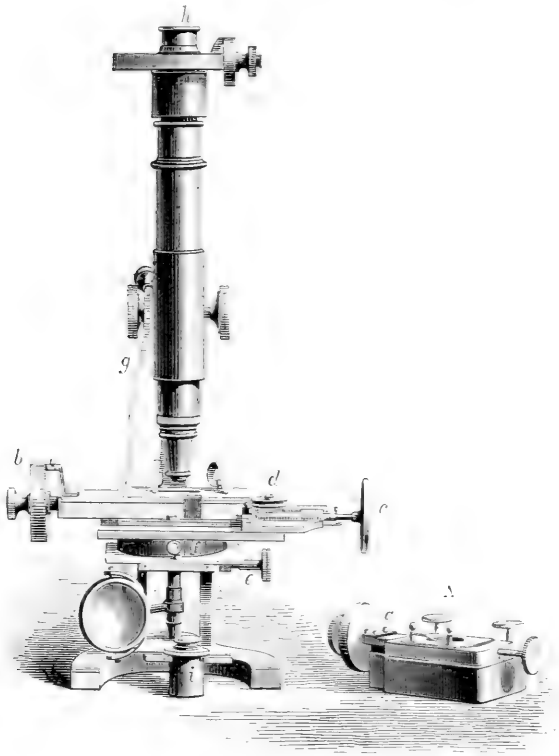



FIG. 8.

It was found, after a somewhat extended trial, that this comparator answered the purpose of its construction admirably, simply as a comparator, in which the same part of the screw was used to compare different spaces, but it was found inadequate to the measurement of absolute lengths in terms of the screw. It will be seen from the cut that the screw passes through a short nut (*a*). As the plate which carries the object to be measured is held against the oval end of the screw by parallel springs, which have a maximum tension of four pounds, the screw has an inevitable tendency to wabble, as the leverage becomes greater by running the screw out its entire length.

In order to remedy these defects, Mr. Geo. B. Clark, of the firm of Alvan Clark & Sons, constructed for me a comparator of the design shown in the accompanying illustration. The comparator proper consists of a bed-plate, within which is fitted a slide, carried by the precision screw *b*. The object

to be measured is held in position upon the moving plate by the clips shown in the cut. Instead of two parallel springs there is a single cord attached to the center of the moving slide, which runs on the guide pulley (*d*), and is attached to a spring, not shown in the cut, which is fastened to a pin on the back-side of the bed, a little to the right of and below *b*. The action of the spring, therefore, is wholly in the line of the screw, and as the direction of the cord falls a little below the motion of the slide, it has a slight tendency to keep the slide in contact with its seat without introducing friction. The screw (*c*) moves the whole bed-plate, including the precision screw (*b*). The whole comparator has a circular movement in the socket (*f*), attached to the original sub-stage (*e*) of the microscope. The Beck filar micrometer is shown at *h*, and an eye-piece with a micrometer, having some advantages over the usual form, is shown at *i*. Slow motion to the tube is given through the lever *g*.

The operation of using the comparator is as follows:

After the slide containing the graduations to be compared has been placed in proper position under the objective, with the right hand, the screw-head (*b*) is set at the zero of position; with the left hand, line 1 is brought in contact with a single line of the eye-piece micrometer; with screw *b*, line 2 is brought in contact with the fixed line of the eye-piece micrometer, and the number of revolutions and parts of a revolution are read off. Screw *b* is then brought back to zero, and the setting is made on line 2 by means of the screw *c*. In moving over the space from line 2 to line 3, with the screw *b*, it will be seen that *the same part of the screw is used as in going from line 1 to line 2*. Hence, the comparison of these two spaces is *independent of the errors of the comparing screw*.

The number of spaces which can be compared in this way is only limited by the length of the screw *c*, and the length of the opening through the bed-plate.

Again, suppose we measure the spaces 1, 2, 3, 4,..100, by a continuous forward motion of the screw. Such measures will involve all the errors of the screw itself. But if after the measures are made, we set the screw-*b* back at zero, turn the ruled plate around 180°, and set on line 100 with screw *c*, the continuous forward motion of the screw *b* from line 100 to line 1 will be over the same part of the screw as from line 1 to line 100. In the first case, the screw measures the accumulated

errors of the ruled plate from line 1 to any point up to line 100, but such measures involve the errors of the comparing screw. In the second case, the accumulated errors are measured in the same way from line 100 to line 1. But if we subtract the measures from line 1 to line 100 from the corresponding measures from line 100 to line 1, *the difference will give twice the accumulated errors at any point, independent of the errors of the comparing screw.* The only exception to this rule is found when the curve of errors takes a wave form. In a general way, this will be the case when the maximum error falls near line 25, and the minimum near line 75.

As an illustration of the character of the work which may be done with a comparator of this form, I give the measures of five standard micrometers, ruled at different times. As these micrometers are somewhat different in form from any with which the writer is acquainted, a brief description will be necessary.

I. A half inch is divided into 50 equal parts, the 1st, 25th, and 50th spaces being again subdivided into 10 equal parts. The length of the lines is about one-eighth of an inch, the 5th and 10th lines being a little longer.

II. After arranging the position of the ruling carriage, so that the lines of the second series of graduations should begin near the point where those of the first end, coincidence is made mechanically with the first line of the series already ruled. For a short distance the ruling point goes over the same ground twice. A centimeter is then subdivived into 10 equal parts. The 1st, 5th, and 10th spaces are again subdivided into 10 equal parts, and one of the middle subdivisions is still further subdivided, giving .01 mm. Near by is a band of 21 lines, each space being equal to .001 mm.

The first five columns of the following table give the number of divisions of the comparing screw corresponding to each space of .01 inch. The values for No. 7 are the mean of two readings. The remaining values represent single measures. The mean values given in the sixth column, without doubt, nearly represent the actual errors of ruling, the accidental errors of measuring being nearly eliminated in taking the mean of the corresponding measures of the separate plates.

The last column represents the accumulated errors at every point between line 1 and line 50, expressed in millionths of an inch. With the sign given, the values represent *corrections* to the corresponding spaces:

MEASURES OF 50 SPACES. EACH SPACE=.01 INCH.

| Spaces. | No. 7. | No. 8. | No. 10. | No. 11. | No. 12. | Mean. | Cor. in terms of screw-head. | Cor. in millionths of an inch. | Accumulated errors in millionths of an inch. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 79.95 | 80.02 | 80.02 | 80.00 | 80.03 | 80.00 | —.03 | —4 | —4 |
| 2 | 79.92 | 79 90 | 79.90 | 79.95 | 80.00 | 79.93 | +.05 | +6 | +2 |
| 3 | 79.88 | 80.00 | 79.98 | 80.00 | 79.83 | 79.94 | +.03 | +4 | +6 |
| 4 | 79.91 | 80.00 | 79.97 | 80.00 | 79 85 | 79 95 | +.03 | +4 | +10 |
| 5 | 80.02 | 80.00 | 80.03 | 80.05 | 80.00 | 80.02 | —.05 | —6 | +4 |
| 6 | 79.99 | 80.00 | 80.00 | 80 00 | 79.94 | 79.99 | —.01 | —1 | +3 |
| 7 | 79.90 | 79.90 | 79 98 | 79.92 | 80.00 | 79.94 | +.03 | +4 | +7 |
| 8 | 79.98 | 80.00 | 80.05 | 79.98 | 79.98 | 80.00 | —.02 | —2 | +5 |
| 9 | 79.99 | 80 05 | 80.00 | 79.97 | 80.00 | 80.00 | —.03 | —4 | +1 |
| 10 | 80.03 | 79.92 | 79.92 | 80 00 | 79 93 | 79.96 | +.02 | +2 | +3 |
| 11 | 79.95 | 79.89 | 79.97 | 79 90 | 79.99 | 79.94 | + 03 | +3 | +6 |
| 12 | 79.99 | 80.02 | 80.00 | 79.94 | 80.00 | 79.99 | —.01 | —1 | +5 |
| 13 | 79.99 | 79 90 | 80.00 | 79.98 | 79.94 | 79.96 | +.01 | +1 | +6 |
| 14 | 80.01 | 80.00 | 80.06 | 80.01 | 80.00 | 80.02 | —.04 | —4 | +2 |
| 15 | 80.00 | 79.92 | 80.00 | 79.97 | 79 90 | 79.96 | +.02 | +2 | +4 |
| 16 | 80.00 | 79 98 | 80 00 | 79.99 | 79.92 | 79.98 | —.01 | —1 | +3 |
| 17 | 79.98 | 80 00 | 79.96 | 80.00 | 80 01 | 79.99 | —.01 | —1 | +2 |
| 18 | 79.99 | 79.97 | 79.90 | 79 96 | 79.92 | 79.95 | +.03 | +4 | +6 |
| 19 | 79.90 | 79.97 | 80.00 | 79.96 | 80.00 | 79.95 | +.02 | +3 | +9 |
| 20 | 79.98 | 79 99 | 79.90 | 79.93 | 79.90 | 79.94 | +.04 | +5 | +14 |
| 21 | 80.06 | 79 92 | 80.00 | 80.00 | 79 98 | 79.99 | —.02 | —3 | +11 |
| 22 | 79.97 | 79.92 | 79 85 | 79.89 | 79 97 | 79 92 | +.06 | +7 | +18 |
| 23 | 79.91 | 79.90 | 79.92 | 79.90 | 79.96 | 79.92 | +.05 | +6 | +24 |
| 24 | 79.90 | 80.00 | 80.00 | 80.00 | 79.97 | 79.97 | +.01 | +1 | +25 |
| 25 | 80.04 | 80.03 | 80.00 | 79.93 | 80.00 | 80.00 | —.03 | —4 | +21 |
| 26 | 79.92 | 80.02 | 79.99 | 80 01 | 80.03 | 79.99 | —.01 | —1 | +20 |
| 27 | 80.01 | 79.98 | 79.98 | 80.00 | 80.00 | 79.99 | —.02 | —2 | +18 |
| 28 | 79.90 | 80.00 | 79.92 | 80.05 | 80.00 | 79.97 | +.01 | +1 | +19 |
| 29 | 80.00 | 80.04 | 80.00 | 79.95 | 80.03 | 80.00 | —.03 | —4 | +15 |
| 30 | 80.02 | 80.06 | 80.10 | 79.90 | 80.05 | 80.03 | —.05 | —6 | +9 |
| 31 | 79.98 | 80.00 | 79.96 | 79 95 | 79.96 | 79.97 | +.00 | +0 | +9 |
| 32 | 79.99 | 79.93 | 79.90 | 80 00 | 80.04 | 79 97 | +.01 | +1 | +10 |
| 33 | 80.02 | 79 97 | 80.02 | 80.03 | 80 00 | 80.01 | —.03 | —4 | +6 |
| 34 | 80.01 | 80.00 | 79.99 | 80.00 | 80.06 | 80.01 | —.03 | —3 | +3 |
| 35 | 79.98 | 80.05 | 80.00 | 79 97 | 79.88 | 79.98 | —.01 | —1 | +2 |
| 36 | 79.99 | 80.00 | 80.00 | 79.89 | 80.00 | 79.98 | +.00 | +0 | +2 |
| 37 | 79.98 | 80 02 | 79.90 | 79.96 | 80.00 | 79.97 | +.01 | +1 | +3 |
| 38 | 79.95 | 80.00 | 79.89 | 79.94 | 80.02 | 79.96 | +.02 | +3 | +6 |
| 39 | 80.00 | 80.10 | 80.03 | 79.93 | 80.03 | 80.04 | —.06 | —7 | —1 |
| 40 | 79.93 | 79 90 | 79.90 | 79.94 | 79 93 | 79.92 | +.05 | +6 | +5 |
| 41 | 80.00 | 80.03 | 80.02 | 80.00 | 80.00 | 80.01 | —.03 | —4 | +1 |
| 42 | 79.90 | 79 98 | 79.98 | 79.93 | 79.91 | 79.94 | +.03 | +4 | +5 |
| 43 | 79.98 | 79.96 | 80.03 | 80.00 | 80.00 | 79 99 | —.02 | —2 | +3 |
| 44 | 80.05 | 79.99 | 79.93 | 79.97 | 80 00 | 79.99 | —.01 | —1 | +2 |
| 45 | 80.01 | 80.00 | 80.00 | 79.98 | 79.98 | 79.99 | —.02 | —2 | +0 |
| 46 | 79.93 | 80 03 | 80.00 | 79.98 | 80.00 | 79.99 | —.01 | —1 | —1 |
| 47 | 79.99 | 80.07 | 79.98 | 79.98 | 79.98 | 80.00 | —.03 | —4 | —5 |
| 48 | 79.93 | 79.98 | 79.94 | 79.93 | 79.95 | 79.95 | +.02 | +2 | —3 |
| 49 | 79.98 | 79.93 | 79.95 | 79.95 | 80.00 | 79 96 | +.01 | +1 | —2 |
| 50 | 79.95 | 79.96 | 79.95 | 79.99 | 79.97 | 79.96 | +.01 | +1 | —1 |
| Means. | 79.97 | 79.99 | 79.98 | 79.97 | 79.98 | 79.98 | | | |

One division=.00012504 inch.

MEASURES OF MILLIMETER DIVISIONS.

| Spaces. | Divisions of Comparator. Number 7. | Number 8. | Number 10. | Number 11. | Number 12. | Mean. | Corr. in terms of Screw-head. | Corr. in hundredthousandths of a cm. | Accumulated error, in hundred thousandths of a cm. |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 314.87 | 314.98 | 314.90 | 315.00 | 315.03 | 314.96 | —.03 | —1 | —1 |
| 2 | 314.85 | 314.87 | 314.88 | 314.98 | 314.93 | 314.90 | +.03 | +1 | +0 |
| 3 | 314.90 | 314.85 | 314.95 | 315.00 | 315.02 | 314.94 | —.01 | —0 | +0 |
| 4 | 314.95 | 315.06 | 315.05 | 315.08 | 314.98 | 315.02 | —.09 | —3 | —3 |
| 5 | 314.92 | 314.83 | 314.85 | 314.90 | 314.97 | 314.89 | +.05 | +2 | —1 |
| 6 | 314.88 | 314.85 | 314.86 | 314.93 | 314.90 | 314 88 | +.05 | +2 | +1 |
| 7 | 314.93 | 314.92 | 314.93 | 314.90 | 314.98 | 314.93 | +.00 | +0 | +1 |
| 8 | 314.97 | 314.98 | 314.95 | 315.00 | 314.91 | 314.96 | —.03 | —1 | +0 |
| 9 | 314.86 | 314.85 | 315.00 | 314.98 | 314.92 | 314.92 | +.01 | +0 | +0 |
| 10 | 314.95 | 314.85 | 314.97 | 314.90 | 314.95 | 314.92 | +.01 | +1 | +1 |
| | 314.91 | 314.90 | 314.93 | 314.97 | 314.96 | 314.93 | | | |

One division=.0003175 cm.

It will be seen that the individual errors of graduation are practicably insensible. It is not supposed that the figures which represent millionths of an inch are reliable to the last unit. They are given in the sixth decimal place in order to make sure of the figure in the fifth place.

It is now to be noted that the errors thus obtained are entirely relative errors. They give no indication whatever of the absolute value of any of the spaces measured. If the entire length of the half inch is, *e.g.*, .001 inch too long, to each of the corrections given in the table, must be applied still further the correction, .00020 inch.

It is, therefore, necessary to make a careful investigation of the entire length of the half inch and of the centimeter.

This is done with a comparator adapted to the comparison of spaces, ranging from coincidence to an entire yard or an entire meter. Comparators of this class are usually constructed with two sliding plates, each carrying its own microscope. A fundamental objection to this form is found in the fact that the microscopes cannot be brought much nearer together than three inches, by any direct means. For lack of space and of illustrations, only a general description of the form which the writer has had constructed, can be given here. It consists

of an iron bed, 60 inches long and 14 inches wide. V-shaped grooves, 6 inches apart, run the entire length. In the center of the bed, a fine-toothed rack reaches from end to end. Two sliding plates are carried along the ways by means of a pinion set in the center of the plates, and working so loosely in the rack that the slides are free to follow the law of gravity. A microscope is attached to each plate, giving the form usually adopted. Instead of two microscopes, however, it is found better to use but one. The microscope plate is followed on either side by plates terminating in tempered steel stops, which are at will either made free or clamped firmly to the bed of the comparator. If one wishes to compare two meters, the method of proceeding is as follows:

(*a*) One stop is set at or near one end of the bed.

(*b*) The meter with which comparison is to be made is placed in position under the microscope, so that contact is made between the end line and the zero line of the eye-piece micrometer.

(*c*) The microscope plate is then moved by means of the rack and pinion till the other end line forms contact with the zero line of the micrometer.

(*d*) The second stop is then brought up against the other end of the plate and adjusted so that when contact takes place between the stops, contact also takes place between the end line and the zero line of the micrometer.

(*e*) Having made the adjustment of the stops perfect, the meter to be compared is then placed in position. When contact is made with the first stop, by mechanical adjustment, the end line is brought in contact with the zero line of the micrometer. The microscope plate is then brought into contact with the second stop. If the other end line is now in coincidence with the zero line of the micrometer, the two meters have the same length. By noting the number of divisions which the end line falls short of, or passes beyond the zero line of the micrometer, the difference in the entire length can be found; the only element yet unknown being the value of one division of the micrometer.

After the comparison has been made, it is better, or a matter of precaution, to again compare the standard with the distance between the stops. Since the stops can be set in actual contact with the microscope plate at either end, it is obvious that this method admits of a comparison of short spaces as well as

of long ones. The only criticism which I imagine will be urged against this form of construction, is that founded on a doubt whether the contact between the stops always indicates the same measured space. The arm of the pinion has a head of about 2½ inches in diameter. In my own case the sense of touch has been so far cultivated that I am able to make 100 successive contacts without a single deviation exceeding .000035 inch, and very few deviations reach .000010 inch. A comparator of this form possesses one decided advantage over all others, viz., that after the stops are once set, *any adjustment of the microscope may be made without interfering with the comparison.* The only condition required is that the relation between the stops and the bed shall remain unchanged during the short time required for the comparison. This does not usually take over 10 minutes.

In order to compare separate subdivisions of the same standard we proceed as follows:

The stops are set, *e. g.*, equal to 1 decimeter. After the reading of the first decimeter has been taken, as indicated above, the bar is then moved along till the first line of the second decimeter forms a contact with the zero of the eye-piece micrometer, when at the same time contact is formed with the first stop. Moving the plate to the second stop the reading for the second decimeter is taken. A comparison of the several values obtained with the mean value, will show how much each is in error, provided the entire length is correct.

For the present, all standards of length made by the writer will be referred to a line yard and meter bar, constructed by the U. S. Coast Survey for Stevens' Institute, Hoboken, and very kindly loaned to me by Professor Mayer. It is marked Y. & M., No. 2.

Professor J. E. Hilgard, Assistant in charge of the U. S. Coast Survey Office, has kindly communicated to me the statement that the yard is standard at 62° F. It was constructed from the yard known as "Bronze 11." The meter was constructed from the iron meter in the possession of the Coast Survey, which was one of four bars from which the platinum bar of the Archives was constructed. It is believed to be the only one of the originals now in existence. There is still some doubt about the exact temperature at which copies of this bar are standard. It is somewhere between 67° and 69° F. A careful

series of comparisons made at the Coast Survey Office during the Summer of 1878 gave 67.7°.

The bar which I have for the present adopted as a standard is of steel, and has the yard and its subdivisions on one side of the edge, and the meter and its subdivisions on the other. The bar is 40½ inches long, 1¾ inches deep, and ½ inch wide.

COMPARISON OF THE STEEL YARD WITH THE STANDARD.

Both the steel bar and the brass standard were placed in a wooden trough, with their graduated surfaces nearly in the same horizontal plane. The stops were set to correspond nearly to the end lines of the standard, after the trough had been filled with water having nearly the temperature of 62° F. The temperature of the room was then brought up to such a point that after several hours the thermometer immersed in water indicated 62°. The following comparisons were then made:

| Series. | Thermometer. | Steel Yard too Long. |
|---|---|---|
| I. | 61.0 | .00134 inch. |
| II. | 61.1 | .00146 |
| III. | 61.1 | .00132 |
| IV. | 64.1 | .00065 |
| V. | 66.8 | .00047 |
| VI. | 68.3 | .00025 |
| VII. | 68.5 | .00031 |

In order to get the error at 62° we may assume:

$$134 = a$$
$$146 = a + .1b$$
$$132 = a + .1b$$
$$65 = a + 2.1b$$
$$47 = a + 4.8b$$
$$25 = a + 6.3b$$
$$31 = a + 6.5b$$

Solving by least squares, we get:

$$a = +131$$
$$b = -17$$

For 62° we have for the error (E):

$$E = a + 1.06$$
$$= 131 - 17 = +114$$

At 62°, therefore, the steel yard is:

.00114 inch too long.

COMPARISON OF STEEL METER WITH THE STANDARD.

Series I. Steel meter was found to be .000050 cm. too long at 68.6°.

Series II. Steel meter was found to be .000008 cm. too short at 68.7°.

On account of the doubt still remaining with regard to the temperature at which the brass meter is standard, it will be assumed for the present that the two standards have the same length.

Comparison of decimeter divisions of steel bar:

| Spaces. | Corrections. |
|---|---|
| 1 | +000170 cm. |
| 2 | +000178 |
| 3 | —000050 |
| 4 | +000000 |
| 5 | +000050 |
| 6 | —000114 |
| 7 | +000093 |
| 8 | —000253 |
| 9 | +000040 |
| 10 | —000112 |

Since the fourth decimeter has no correction, this space was chosen for an examination of the centimeters composing it. The following errors were found:

| Cm. Spaces. | Corrections. |
|---|---|
| 1 | —.00029 cm. |
| 2 | —.00008 |
| 3 | —.00033 |
| 4 | +.00038 |
| 5 | +.00082 |
| 6 | —.00090 |
| 7 | +.00033 |
| 8 | +.00008 |
| 9 | —.00096 |
| 10 | +.00104 |

By applying these corrections, any one of these centimeters becomes a standard *with reference to the standard chosen.*

The steel bar is now replaced in the water-bath, and comparison is made directly with any centimeter whose value is desired. Comparing with space 2 and space 8, the error of No. 12 of the above series was found to be as follows:

Compared with space 2 at 68°, No. 12 is .000019 cm. too long.
Compared with space 8 at 61°, No. 12 is .000005 cm. too long.

When the last degree of precision is required, the stops should be set independently for each centimeter of the standard bar, with its proper correction applied, and the centimeter whose value is desired should then be compared with the distance between the stops in each case.

Finally, we have a severe test of the accuracy of the graduation in the value of the centimeter in terms of the inch. The end line of the centimeter falls between line 39 and line 40 of the inch. The following measures give the distances from line 39 to the end line of the centimeter:

| | Div. of Comparator. | In parts of Centimeter. |
|---|---|---|
| No. 7 | = 29.56 | = .003696 |
| 8 | = 29.74 | = .003719 |
| 10 | = 29.72 | = .003716 |
| 11 | = 29.56 | = .003696 |
| 12 | = 29.64 | = .003706 |
| | Mean, | .003707 |

The value of the centimeter in terms of the inch is

1 cm = .393707 inch.

The value generally given is

.393708

Since the value obtained involves the mechanical error of making a coincidence between the first lines, this agreement is rather more close than ought to be expected.

Harvard College Observatory.

## PRACTICAL HINTS ON PREPARING AND MOUNTING ANIMAL TISSUES.

BY CARL SEILER, M. D

(*Continued.*)

### STAINING.

After the section has been cut and placed in alcohol, it is ready for staining with one of the many preparations recommended in the books. It is not my intention to point out the merits and demerits of the various staining processes, but I

shall confine myself to giving the details of two processes which I have found to be so universally successful that I have discarded all others.

They are a simple carmine staining, and a double staining with carmine and indigo. The carmine solution which I use is one which was published several years ago by Dr. J. J. Woodward, in the *Lens*, and which is made as follows:

Best Carmine (No. 40), gr. xv.
Borax, - - ℥ i.
Water, - - fl. ℥ vss.
Alcohol (95%), - fl. ℥ xi

mix and filter, dissolve the crystals in 8 ounces of distilled water, and evaporate over a water bath to 4 ounces.

Sections placed in this fluid will become stained very evenly in a few seconds, and be of a violet red when removed. They are then immersed in a solution of

Hydro-chloric acid 1 part,
Alcohol - 4 parts,

until they assume a bright rose color, which appears in a very few seconds. The sections are then well washed in several changes of alcohol, after which they are ready for mounting.

A specimen thus treated exhibits only the nuclei with the granules stained, while the cell contents and fibrous tissue are not tinted. This is, in many cases, of great advantage, as a much clearer picture results than if the coloring matter is also seen in the non-nucleated structures, and the nuclei are marked only by a deeper staining. If, however, for purposes of diagnosis, it is desirable to stain the cell contents also, this can be accomplished by using a concentrated solution of oxalic acid, in alcohol, or, by employing a very weak solution of hydrochloric acid in alcohol after the specimen has been stained.

This may also be done, and in a much more beautiful and satisfactory manner, by double staining with carmine and indigo. Several years ago, when looking at some beautiful double stainings of vegetable tissues prepared by Dr. J. G. Hunt, it occurred to me that a similar effect might be produced in animal tissues, and I immediately commenced to experiment with various colors and dyes. These experiments were only partially successful, and I was about to give them up as impracticable, when a process was published by Drs. Norris and Shakespear, which promised all that I desired. On working

with it, however, and after many unsuccessful trials, I felt convinced that, although the materials employed were of the proper kind, the manner of using them was faulty.

After Mr. Bullock, of Bullock & Crenshaw, prepared for me a solution of sulphindigotate of soda, I again renewed my experiments, and they were crowned with success. This solution I use with uniform results, in connection with carmine, in the following manner:—The sections are first stained with carmine, as described above, care being taken to wash all traces of acid out of the tissues; they are then immersed in a solution of 2 drops of sulphindigotate of soda solution in 1 ounce of 95% alcohol, which should be filtered before using, and are left therein from 6–18 hours, according to the rapidity with which the elements take up the indigo. When sufficiently stained the sections are placed in strong alcohol, and are ready for mounting.

The sulphindigotate of soda solution is prepared, according to the process devised by Mr. Bullock, by first digesting best Bengal indigo with Nordhausen sulphuric acid. The excess of acid is then removed by washing, the coloring matter precipitated with chloride of sodium, and left standing for several days. The precipitate is then separated from the mother liquor by filtering through flannel, and the excess of chloride of sodium washed out by pouring cold water through the filter until the coloring matter begins to dissolve. The washing is then stopped and the precipitate dissolved in warm distilled water to saturation, which makes a solution of a deep, greenish blue color.

The effect of this mode of staining is to leave the nuclei bright red, while the formed material of the cell is slightly tinged with blue. The connective tissue fibers become stained with a deep blue color, while the blood vessels are purplish, and mapped out with surprising distinctness. Epithelium and hair take this staining in a very curious manner, inasmuch as the cells of different ages take different colors, ranging from a brilliant, emerald green, to purple, violet, and olive green, thus affording a valuable means of differentiation, especially in epitheliomas, where the so-called pearls are brought out with great distinctness, being of a different color from the rest of the cells.

This process seems somewhat troublesome, especially if the

microscopist attempts to make the indigo solution himself. But, even if it should prove so, the result obtained is well worth the pains taken, and fully repays the outlay of time and patience bestowed upon it.

### Mounting.

The question as to the best material for permanently mounting and preserving microscopical preparations is one of great mportance, which fact is best illustrated by the existing controversy between eminent microscopists as to the merits of Canada balsam and glycerin as preserving media. My experience has taught me that, in most cases, pure Canada balsam, dissolved in absolute alcohol, is to be preferred to any other mounting material, but for a few tissues, and for special purposes, glycerin is better. I do not intend, however, to discuss this point here, but will give merely a short description of the simplest methods of mounting in Canada balsam and glycerin.

Balsam.—The specimen to be mounted is placed in Squibb's absolute alcohol, so as to extract all traces of water which might have been left in it from the staining fluid. It is then removed, drained of surplus alcohol on the back of the hand, and transferred to a shallow glass cup filled with pure benzol (not benzine), which will speedily make it transparent. I prefer benzol to oil of cloves or turpentine, for several reasons: 1, a specimen cleared in oil of cloves and then mounted in balsam does not improve in distinctness by age as much as one cleared in benzol, because the balsam cannot penetrate into the interstices of the tissue perfectly and thus bring out its details; 2, because the oil causes the balsam to harden very slowly, and 3, because the method of quickly mounting large and thin sections, as described below, can not be employed as well with the oil of cloves.

Sections which need but little arranging on the slide, and very young fœtal preparations, are better placed in the alcoholic balsam solution without first clearing them, as the balsam will make them transparent, provided all water has been extracted. After they have become transparent the objects are placed on a clean slide with sufficient balsam to cover them, and the thin cover is laid on and pressed down.

The Canada balsam solution mentioned above is prepared according to Dr. J. J. Woodward's formula, as follows: A clear

sample of Canada balsam is evaporated, either in a water bath by artificial heat, or better, by placing it in a shallow dish, and exposing it to the heat of the sun until it becomes hard and brittle throughout when cold, and until all odor of turpentine has disappeared when warm. This resinous balsam is then dissolved in warm, absolute alcohol to the consistency of thin syrup, and filtered through flannel. If, by accident, the balsam has become brown during evaporation, the alcoholic solution may be bleached by exposure to sunlight. I am in the habit of keeping a bottle of this balsam on a window shelf for the purpose of bleaching it.

The advantages of this mounting material are, that it soon becomes hard around the edges of the cover, and can be scraped off to finish the slide; that it never crystallizes as other resinous, mounting media frequently do, and, as has already been remarked, it improves the appearance of the object by age.

I found large and thin sections very difficult to mount in the ordinary way; viz., by spreading them on the slide with needles or a brush, and therefore devised a plan which simplifies mounting very much, and saves a great deal of time and vexation. The sections, when transferred from the alcohol to the benzol, spread themselves open and float on the surface until all the alcohol evaporates and the benzol takes its place, when they sink to the bottom. They can then be floated on to a cover glass held near the bottom of the dish by means of a pair of forceps, the ends of which are bent at right angles, or nearly so, and lifted out, already arranged on the cover glass. A drop of balsam is then placed on the section, and the cover, together with the tissue and balsam, is laid on the slide and pressed down.

If glycerin is to be used as the mounting medium, this same method may be employed with advantage.

The great difficulty in mounting in glycerin consists in getting rid of the surplus, and in cementing the cover glass to the slide in such a way that the glycerin can not leak out. Both of these obstacles may be overcome in the following manner: After the specimen has been stained and made transparent, as directed in Beale's latest work, it is placed on the slide with sufficient glycerin to cover it, the cover laid on, and held in position by a spring clip. All excess of glycerin is then washed off with a gentle stream of water from a syringe or tap, and the

slide is set up to dry. When all the water on it is evaporated, the clip is removed, the slide placed on a turn table, and a ring of glycerin-proof cement applied around the edge of the cover.

The following cement is the best that I have found for this purpose:

Cox's Gelatin, ℥ ii.
Acetic Acid, fl. ℥ i.
Gum Ammoniac, gr. x.

Dissolve in a water bath and filter through cotton while warm.

This cement remains fluid when cold, and dries quickly. After the ring has become set, or stiff, the whole slide is immersed for a minute or so in a 10-grain aqueous solution of Bichromate of Potash, and is then allowed to dry exposed to light. The action of light makes the bichromated gelatin perfectly insoluble, even in boiling water, and thoroughly prevents any escape of glycerin. After the ring has become hard, rings of other cements may be applied to suit the fancy of the preparer.

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## THE SIMPLEST FORMS OF LIFE.

BY B. EYFERTH.

(*Translated from the German for this Journal, with additions.*)

(*Continued.*)

*H. utriculatum*, Roth. In stagnant water; appears seldom, but at times in abundance.

[Each swarm-spore grows to only a single cell, forming one side of the mesh; it never increases by sub-division forming two or more cells. The nets may grow to the length of 30 cm.]

6. Gen. *Scenedesmus*, M. Cells elliptical, [often] with points on the ends, in simple or parenchymous series. Common in standing water and aquaria. [Cells polymorphous.]

[*a*. Cells armed.]

*Sc. quadricauda*, Bréb. Cells 0.02, egg-shaped. Terminal cells with straight or bent spines.

[2-4-8 joined in a single straight series or double alternating one, all straight, the median unarmed or some of them with the apex furnished with a curved spine.

*Sc. polymorphus*, Wood. Cells fusiform, or oval, or elliptic, or globose, single or 2-7 conjoined, furnished in most cases with a single spine, sometimes 2, at each end; spines exceedingly slender and acute, straight, moderately long, inclined.

*Sc. rotundatus*, Wood. Cells globose or sub-globose, armed with 3-5 very long, slender, acute, straight spines, single or in pairs, or 3-4 closely conjoined in a two-fold rank (Wood).]

[*b.* Cells unarmed.]

*Sc. acutus*, M. Cells spindle-shaped, the outer ones crescent-shaped. [2-4 times longer than broad.]

*Sc. obtusus*, M. Cells elliptic, obtuse.

7. Gen. *Pediastrum*, Meyen. Cells smooth, lobed, connected into disk-like rosettes, often perforated. Swarm-spores produced by repeated division of the contents, make their exit and arrange themselves into new rosettes. [Cells polygonal.]

*P. Boryanum*, Mengh. Cells of disk polygonal, connected without any gaps. Outer cells with two lobes, horned.

*P. pertusum*, Ktz. Cells four-cornered with carved borders; disk therefore perforate. Outer cells deeply bi-lobed, lobes horned. In turf-bogs.

*P. Ehrenbergii*, A. Br. Cells connected without gaps. Outer cells club-shaped, but deeply indented, lobes two-pointed.

*P. rotula*, A. Br. Cells all bi-lobed, family perforate. Outer cells growing together only at the base, deeply cleft, lobes two-toothed.

[*P. Selenæa*, Ktz. Cells crescent shaped, arranged in one or more circles round one or two central ones, connecting medium colored (Wood).

*P. constrictum*, Hass. Cells varying in number and arrangement; outer cells suddenly contracted into two short, cylindrical, obtuse processes (Wood).

*P. simplex*, Meyen. Peripheral cells, ovate-cuspid, 8-10-16 joined at bases.

8. Gen. *Protococcus*, Ag. Spheroidal cells, swimming free, or out of water in thin pulverulent stratum. Protoplasm first green, homogeneous, later granular, green, or reddish.

*P.* nov. sp.? Green cells, globose or angular, accumulated in a pulverulent stratum, often closely united into families, cytioderm mostly not distinct; resting-spores round with 2 or 3 thick coats; zoöspores oval or roundish, or somewhat elliptical, with two cilia (Wood).

*Chlorococcum*, Fries, is a genus given by Wood, as follows: "Cells spheroidal, single, free, furnished with a chlorophyllous vescicle and a

paler lateral (hollow?) spot, with a hyaline nimbus, and surrounded by wide coat; mostly accumulated into strata or little heaps. Propagation by means of zoöspores." This is not the same as *C.* Grev. Probably gonidia of lichens.]

The three remaining genera are not widely distributed.

*Sorastrum spinulosum*, Ng., lives in moor-water, *Cœlastrum cubicum*, and C. *Sphæricum*, Ng., in swamps and ditches. *Staurogenia rectangularis*, Ktz., in swamps.

## II. FAMILY. PALMELLEÆ.

Small, generally roundish cells, living single or in communities, which increase by binary division, and only produce swarm-spores in the last generation.

Cells 2 or 4, connected by gelatinous, stalk-like stolons,
- roundish, in pairs, — *Mischococcus*, Ng.
- oval, in pairs, — *Cosmocladium*, Bréb.

Cells without stolons, in series in gelatinous layers, division in only one direction,
- cylindrical families, combined in series, — *Hormosphora*, Bréb.
- single, gelatinous layer branched, feathery [fixed, cells in parallel gelatinous tubes ranged longitudinally in frond, and surrounded by common gelatinous envelope], — *Hydrurus*, Ag.

Cells combined in several rows, or not at all

Division in 2 or 3 directions, in families with hyaline bladder-like covering,
- which later bursts; 2-4 cells, — *Schizochlamis*, A. Br.
- which does not burst;
  - bladders oval or kidney-shaped, cells kidney-shaped 2-16 — *Nephrocytium*, Ng.
  - bladders cylindrical, tube-shaped, — *Palmodactylon*, Ng.
  - " pear-shaped, fixed, — *Apiocystis*, Ng.
  - " round, — *Glœocystis*, Ng.
- in families in unstratified gelatin, without outer coat,
  - family like a hollow ball [cells united by very fine, dichotomous filaments], — *Dictyosphærium*, Ng
  - family massive, spherical, — *Glœococcus*, A. Br.
  - family filamentous, branching and reticulated, — *Palmodyction*, Ktz.
  - family spread out flat,
    - single layer, generally 4 cells in a square, — *Tetraspora*, Lk.
    - several layers,

| | |
|---|---|
| cells green, | *Palmella*, Lgb. |
| cells pale red, | *Porphrydium*, Ng. |
| in families or isolated, without gelatin, | |
| cells spindle-shaped, in sheaves, | *Raphidium*, Ktz. |
| cells spherical, | |
| in grape-like families, | *Dimorphococcus*, A. Br. |
| single, or in spherical families, | *Pleurococcus*, Mgh. |

The family of Palmelleæ includes the smallest forms of chlorophyllaceous Algæ, which, in their mode of increase and occurrence, are allied to the lowest of the *Phycochromaceæ* (Chroococceæ). The green color is rarely replaced by red (Erythrophyll or red oil). Those species living in water—with the exception of *Pleurococcus*—are rarely especially noticeable; others form green coatings in moist places out of water. Only a few are particularly important; most of them are sparingly distributed.

Many are doubtless stages of development of other Algæ or Lichens.

[Indeed, many of the genera here given are not recognized as distinct by other writers; *e.g.*, *Nephrocytium*, *Glœocystis*, *Palmodactylon;* and among those mentioned below, only the ones marked * seem to have been identified in this country.]

*Mischococcus confervicola*, Ng., lives on filamentous Algæ in swamps.

*Cosmocladium pulchellum*, Bréb., appears very rarely in marshes.

*Hormosphora mutabilis*, Bréb. Rare in forest marshes.

**Hydrurus penicillatus*, Ag. In mountain streams and brooks.

[Var. *occidentalis*, Harv. Frond 1-2 feet long, much branched; branches worm-like, tapering to a fine point, naked, or with villous ramuli; cells pear-shaped, twice as long as broad. Found in strong currents.]

*Schizochlamys gelatinosa*, A. Br. In marshes.

*Nephrocytium Agardhianum*, Ng. Rare in marshes and ditches.

*Palmodactylon varium* and *P. semplex*, Ng. The same.

*Apiocystis Brauniana*, Ng. On filamentous Algæ, not common.

*Glœocystis ampla*, *G. vesiculosa* and *G. botryoides*, form green coatings under water.

**Dictyosphœrium Ehrenbergianum*, Ng. Tolerably wide-spread.

[**D. pulchellum*, Wood. "Thallus sub-globose, sometimes indistinctly lobate, sometimes almost wanting; cells globose, mostly scattered, but sometimes crowded."]

*Glœococcus* is rare.

*Palmodictyon viride*, Ktz. Not common.

**Tetraspora gelatinosa*, Ag. Common.

[**T. lubrica*, Ag. Thallus tubular or expanded, simple or branched, often perforated, cells globose, bright green, single, in pairs or fours, probably the same as *T. gelatinosa*.

**T. bullosa*, Ag. Thallus saccate or expanded, obovate, 1-6 inches long, verrucose, cells in twos or fours, crowded, granular.]

*Palmella uvæformis*, Ktz., and *P. mucosa*, Ktz. Fixed, upon objects under water; *P. botryoides*, Lgb., and *P. heterospora*, Rb., form green coatings on window panes; *P. mirifica*, Rbh., peach-blossom colored patches upon milk, meat, etc.; *P. prodigiosa*, Bréb. (*Monas prodigiosa*, Eh.), on boiled potatoes, rice, bread, etc.

[**P. Jesenii*, Wood. Thallus indefinitely expanded, first soft and pellucid, then tubercular, deep olive-green; cells globose or elliptical.

**P. dura*, Wood. Thallus irregularly sub-globose, irregularly minutely lobate or warty, bluish-black, crustaceous, minute.

**P. hyalina*, Lgb. Fronds ¼-1 inch in diameter, globose, ovate or cylindrical; gelatinous, pellucid, watery, granules numerous, globose, green.]

**Porphyridium cruentum*, Ng., blood colored gelatin upon moist ground.

[The occurrence of this species in this country is doubtful.

**P. magnificum*, Wood. Cells globose or sub-globose, often polygonal and conjoined into indefinite mass; purple, granulated, cell wall thick, not laminate.]

**Raphidium polymorphum*, Ktz. Sheave-like, or radiating bundles of needle-shaped cells, in ditches, swamps, and particularly in aquaria.

*Dimorphococcus lunatus*, A. Br. In swamps.

*Pleurococcus vulgaris*, Mengh. Forms green, crusty coatings on moist objects; *P. roseo-persicinus*, Rh., red coatings.

[**P. seriatus*, Wood. Grows on bark; reddish brown, powdery mass.

**P. pulvereus*, Wood. Cells very small bluish-green, oval or angular, in families; pulverulent, bright green.

Genus. *Pagerogalia*, Wood. Thallus solid, indefinite, gelatinous, whitish, pellucid, composed of closely aggregated modules, often indistinct. Cells globose, crowded. Families surrounded by a thin membranous coat and placed in the center of the gelatinous nodule.

**P. stillio*, Wood. Frond ⅓ inch. Cells 4-3000—1-2000.]

The Palmellaceæ are, by many algologists, placed as a third family of the Volvocineæ, which I have placed among the Flagellata (Infusoria), according to Stein, Carus, and others.

Their spherical forms and chlorophyll-green color make them closely resemble the unicellular Algæ. They possess, like the swarm-spores of the latter, two or more moving filaments in front, but besides these they have one or more contractile, slowly pulsating vacuoles, and generally a red pigment spot. Single, or in families, surrounded with a gelatinous investment, they are in voluntary motion during the greater part of their life, only coming to rest for the purpose of propagation. The alga spore, on the contrary, after a short period of activity, soon comes to rest and grows into the original form, and can never again return to the moving condition. However, we find also motion in some Phycochromaceæ and Diatomaceæ during the greater part of their lives, but very rarely.

If the Volvocineæ are to be regarded as Algæ, however, the Flagellata may also be placed with them according to A. Braun and v. Siebold, while still others would place the Volvocineæ among the Algæ but not the Euglenæ and Peridinæ.

## ORDER IV. CONJUGATÆ.

Cells single, or in filamentous families, without terminal growth, and not branching; multiplication and propagation by simple cell division, and resting-spores which form as the result of copulation of two cells, by the union of their entire contents (Zygospores).

No swarm-spores. [Endochrome usually arranged in patterns.]

Cells cylindrical, not constricted in the middle, in families, copulating filaments. ZYGNEMACEÆ, Endl

Cells of varying form, usually divided by a constriction in the middle, copulation only between isolated cells. DESMIDIACEÆ, Ktz

### I. FAMILY. ZYGNEMACEÆ.

Cells cylindrical, in filaments, swimming free, forming loose, green masses. Nucleus often very prominent in the center of the cell, surrounded by star-like radiating strings of plasma reaching the walls; chlorophyll in plasma lining the cell-walls, often arranged in ornamental bands, or groups, with distinct, large, starch-grains.

Copulation between two neighboring cells of the same filament; chlorophyll in spiral bands. *Rhynchonema*, Ktz.

Copulation between two cells of different filaments,
ladder-like, from numerous cell-unions.
Spore in one of the copulating cells,
chlorophyll in spiral bands. *Spirogyra*, Link.

| | |
|---|---|
| chlorophyll in two star-like groups. | *Zygnema*, Ktz. |
| Spore in the connecting tube. | *Zygogonium*, Kt. |
| lateral and knee-shaped, on the same filament. Spore in the connecting tube. | *Pleurocarpus*, A. Br. |
| geniculate, never lateral. | |
| Spore in one of the copulating cells. | *Sirogonium*, Ktz. |
| Spore in connecting tube, | |
| which is turgid, | *Mesocarpus*, Hass. |
| which is constricted, | |
| spore cruciform, | *Staurospermum*, Ktz. |
| spore spherical, | *Craterospermum*, A. Br. |

1. Gen. *Rhynchonema*, Ktz. Chlorophyll in 1 or 2 spiral bands. Copulation between two cells of the same filament, not direct, but through external continuations growing out and meeting, through which, after absorption of the separating walls, the entire contents of one cell passes over into the other, and there unites with its plasma to form a single spore. Numerous species.

*R. vesicata*, Ktz. Cells 0.018—0.022 d.; l.=3–4 d. Cell-ends forced inward. One chlorophyll band with 1½–2 turns. Spore egg-shaped, in turgid cell.

*R. Hassallii*, Ktz. Cells 0.028—0.035 d.; l.=3½—7 d. Two bands.

[Owing to the fact that some species copulate in two ways, partaking of the characters of both *Spirogyra* and *Rhynchonema*, as here distinguished, some authors have discarded the latter genus and place the species under *Spirogyra*. The two following are examples, found in this country:

**Sp.* (*R.*) *elongata*, Wood. Sterile joints, much longer than broad; fertile joints, much shorter, greatly swollen; cell-wall at each end, produced or folded in, one chlorophyll filament, spiral lax, generally 7 turns.

**Sp.* (*R.*) *pulchella*, Wood. Sterile joints 2–3 times longer than broad, fertile joints somewhat swollen, single chlorophyll band 3–4 turns; cell-wall at each end produced or folded in.]

2. Gen. *Spirogyra*, Link. In appearance very similar to the preceding, only to be distinguished while fruiting. In this condition ladder-like from the copulation of two opposite cells of neighboring filaments which extend continuations toward each other. By the disappearance of the separating wall, when these come in contact, a cylindrical combining tube is formed between the two cells,

through which the contents of one cell pass over into the other. Spores spherical or elliptical. Spore-cells turgid. Numerous species.

a. One band of chlorophyll in each cell.

*a.* Cell-ends folded in.

*Sp. tennissima*, Ktz. Cells 0.007—0.008 d.; l.=5—8 d. Chlorophyll band with 4–5 turns. Spores elliptical. Common.

*Sp. ventricosa*, Ktz. Cells 0.02 d.; bands with 3–6 turns.

[**Sp. Weberi*, Ktz. Sterile joints 3-20 times longer than broad, fertile joints not swollen, band usually single, 3-8 turns.

**Sp. protecta*, Wood. Spore-wall very thick, 6 turns. Sterile joints 6 times longer than broad.]

*β.* Cell-ends not folded in.

**Sp. quinina*, Ag. Cells 0.03—0.04 d ; l.=1 to 2 d.; band with about 3 turns.

**Sp. longata*, Ktz. Cells 0.02—0.025 d.; l.=2–8 d.; band with 2–4½ turns.

b. Several chlorophyll bands in each cell, often crossed.

*a.* Cell-ends folded in.

**Sp. insignis*, Ktz. Cells 0.027—0.03 d.; l.=4-6 d.; 3 very attenuate bands with 1—1½ turns. [rarely 3.]

*β.* Cell-ends not folded in.

**Sp. decimina*, Ktz. Cells 0.03–0.036 d.; l.=2–4 d. Bands with 2–2½ turns.

**Sp. setiformis*, Ktz. Cells 0.08–0.1 d.; l.=d., drawn in somewhat at the ends. Bands very closely wound. [3–8 bands.]

**Sp. nitida*, Ktz. Cells 0.055–0.07 d.; l.=1–2 d.; 4–5 steeply-wound bands. Outer membrane mucilaginous.

**Sp. crassa*, Ktz. Cells 0.12–0.13 d. (and over); l.=½–2 d.; 4 bands slightly constricted at the ends.

[**Sp. diluta*, Wood. Chlorophyll bands 5, very narrow, more resembling nodules with fine connecting threads, ½–1 turn.

**Sp. dubia*, Ktz. Sterile joints ½–2½ times longer than broad; 2-3 very narrow bands, nodose, 1-2 turns. Zygospores polymorphous.

**Sp. parvispora*, Wood. Sterile joints 2–4 times, and fertile 1–2½ times longer than broad; 4 bands, narrow, nodose, many turns.

**Sp. majuscula*, Ktz. Pale green, fuscescent while fruiting, 3–4–5–7 bands, partly straightish and longitudinal, nodose.]

3. Gen. *Zygnema*, Ktz. Cells with two star-shaped plates of chlorophyll, each with a starch grain, copulation as in

Spirogyra. Spores spherical; on drying, the filaments become brown.

**Z. cruciatum*, Ag. Cells 0.04–0.044 d.; l.=1–2 d. Common in standing water as floating, yellowish-green masses. [Spore-coat minutely punctate.]

*Z. stellimum*, Ag. Cells 0.024–0.033 d.; l.=1–3 d. Common.

[**Z. insigne*, Ktz. Deep green or yellowish-green, conjugation scalariform, sometimes lateral, spore-coat smooth.]

4. Gen. *Zygogonium*, Ktz. Cells with two irregular chlorophyll plates, enclosing starch grains. Copulation as in Zygnema, but the spore forms in the connecting tube. The species live mostly out of water on moist ground. All have a purple-violet coloring matter which predominates in many during life, but always when dried.

*Z. Agardhii*, Rh. (*Z. ericetorum*, Ktz.). Common almost everywhere.

5. Gen. *Pleurocarpus*, A. Br. (*Mougeotia*, Ag.). Chlorophyll in fine grains, equally distributed, often contracted to a longitudinal band. Copulation geniculate, often unfruitful, or lateral as in *Rhynchonema*, but with spores formed in the connecting tube.

**P. mirabilis*, A. Br. (*Mougeotia genuflexa*, Ag.). Cells 0.03–0.036 d.; l.=2–4 d. Forms light-green masses in standing water.

6. Gen. *Sirogonium*, Ktz. Chlorophyll in longitudinal, pearly strings. Copulation geniculate without connecting tube. Spore in one of the two cells.

*S. sticticum*, Ktz. Cells 0.037–0.05 d.; l.=4–5 d. Two to four slightly bent bands. Dirty-green, intricate masses in standing water.

[**S. retroversum*, Wood. Chlorophyll band 1, in spiral 1–9 turns, fertile cells very tumid, retroverted.]

7. Gen. *Mesocarpus*, Hass. Cells similar to Pleurocarpus. Copulation geniculate (often growing ladder-shaped later). Spore in turgid, connecting tube. Filaments generally live single among other Algæ in standing water.

**M. scalaris*, Hass. Cells 0.016–0.002 d.; l.=2–8 d.

**M. parvulus*, Hass. Cells 0.007–0.009 d.; l.=1.5½–12 d. [Spores fuscous.]

8. Gen. *Staurospermum*, Hass. Chlorophyll evenly distributed, often contracted into a longitudinal band. Copulation

cruciform. Spore four-cornered at the combining place, with lengthened corners sticking into the cells.

*St. gracillimum*, Hass. Cells about 0.006 d.; l.=8–15 d. Spore verrucose (warty). Filaments separated, especially in peat bogs.

9. Gen. *Craterospermum*, A. Br. Chlorophyll, as in the preceding genus, with starch grains. Copulation spore in the middle of the constricted, connecting piece, spherical with cubical covering.

*C. lætevirens*, A. Br. Cells 0.02–0.037 d.; l.=3–8 d. Forms light-green masses in swamps.

# Editorial.

## A NATURAL SYSTEM OF THE THALLOPHYTES.

Dr. George Winter has published* a most excellent article "On a Natural System of the Thallophytes," which we would be glad to translate in full if space would permit. After briefly reviewing and criticising the systems of Cohn and Sachs, he admits that "Both are in a certain degree natural, but the adherence to a single characteristic—the sexual reproductive phenomena—has made them, at the same time, too artificial; and, in fact, it is at present very difficult, indeed partly impossible, to devise a natural system of the thallophytes." "The two main branches are Fungi and Algæ; but the special building up of each series is indeed difficult."

In this respect the author opposes all those systems in which the Fungi are regarded as having their origin in the corresponding types of the Algæ. He considers, with Fischer, that the Algæ and Fungi are "Two parallel developed groups, which have not reached the same stages of perfection, either in morphological or histological characters; of which the Fungi terminate in the *Ascomycetes*, while the Algæ are united with the mosses through the Characeæ. Indeed, it may be that the Fungi as a whole occupy a lower stage of development than the algæ." However this may be, Dr. Winter has certainly pointed out some evident inconsistencies in the systems

* Hedwigia, Notizblatt für kryptogamische Studien, etc., January, 1879.

of Cohn and Sachs, from which it appears that a system that is purely natural, regarding special phenomena, may lead us astray.

The article of Dr. Winter deserves careful attention from students of cryptogamic botany.

## MICROMETRY.

A large gathering of microscopists is expected at Buffalo this coming summer, when the American Society of Microscopists assembles. It is to be hoped that some action will be taken to give this organization a permanent existence, for, if properly conducted, its meetings will be of no little value for discussing questions of national importance.

The Society will probably meet on Tuesday morning, August 19th, and continue four days, thus leaving ample time for members to attend the meeting of the A. A. A. S., at Saratoga, on the 27th instant.

At the Buffalo meeting the subject of adopting a standard micrometric division is to be discussed.

Owing to the timely and well-directed efforts of the Troy Scientific Association, the subject has been brought before the country in a manner that has secured the coöperation and support of almost every microscopical society in the country. Only two societies, we believe, have failed to respond favorably to the circular from Troy. The New York Microscopical Society is one of these, but we believe that this arose from a misconception of the meaning and intent of the circular, on the part of the committee to which the matter was referred.

It is to be regretted that the tone of some of the articles already published has been such as to induce Prof. Rogers to withdraw his liberal offer, made through the writer at the Indianapolis meeting, already noticed on page 48. He is still willing, we are informed, to give all the aid in his power to any suitable body having the matter in charge. We hope to see this subject treated at Buffalo as it deserves, and in furtherance of this desire, invite attention to a few remarks regarding a micrometric unit.

It appears to us of comparatively little importance, and in this respect we do not take the same view of the matter as our

worthy co-laborer, Dr. Ward, of Troy, whether our 1-1000 of an inch, or 1-100 of a millimeter, or any space whatever, that may be adopted as a standard micrometric division, is precisely the quoted fraction of the original standard, although it is desirable to have it so if practicable. In our view of the matter, any given space upon a stage micrometer might serve the purpose. Micrometric measures are not to be compared to the meter or even the centimeter. They will be expressed in terms of a given unit, and compared together by means of the same unit. The real advantage, therefore, of a standard micrometric division will not be that it is an aliquot part of a larger measure in use. Its value lies in the fact that this particular division has been declared standard by a competent and duly authorized body, and that all standard micrometers must agree with it. It is certainly desirable, for convenience, that it should be an aliquot part of some standard in daily use. We assume, however, and not without reason, that such a subdivision of a given standard is possible, and that the standard for division finally adopted will be the meter.

The term unit, in this connection, means the smallest whole number used in giving dimensions. Now, when the 1-100 mm. unit was proposed it met with the, perhaps too hasty, approval of the Congress, and since then has been subjected to criticism on the ground of its being too small for the maker to work from. The intention was not to adopt a unit for the maker of micrometers to subdivide, but rather one which would serve as a basis for the comparison of all future rulings. We are still inclined to the belief, after carefully reviewing the subject, that the most appropriate division for our standard micrometer is the 1-100 mm., and for the following reasons :

1. Assuming the metric system to be adopted, the 1-100 mm. will be the division most frequently in practical use.

2. A larger division would be seldom employed, and if such a one were adopted, makers could rule these large divisions quite accurately, and leave us no assurance that its subdivisions were as true as they should be.

3. A smaller division, as the 1-1000 mm., *e. g.*, would be seldom required on stage micrometers.

Let makers work from any division they may deem it advisable, whether it be the meter, centimeter, or decimeter, the values we want are the 1-10 and 1-100 mm., and it is the value

of these, in our opinion, that should be determined by our standard micrometer. But, as we have defined the term unit, either of these values would be too large for convenience. The 1-1000 mm., the so-called micro-millimeter, or *micra*, of the French (designated $\mu$), appears to us more suitable for our unit. A few examples of its application may serve to support this view.

The diameter of a human blood-corpuscle is about 7.7 $\mu$ (.0077 mm.). In birds, the corpuscles measure from 12 to 14 $\mu$ in one direction, and from 6 to 8 $\mu$ in the other (.012–.014 mm. $\times$.006–.008 mm.). The corpuscles of *Proteus anguinus* measure 58 $\mu$, and still larger are those of *Amphiuma tridactylum* 175 $\mu$ (.058 and .175 mm.).

If the reader will assume some other unit, as the cm., or mm., or even the 1-100 mm., and endeavor to express the same dimensions in these terms, the advantage of the micra will, we think, be obvious. We would prefer this unit to the hundredth of a mm., already proposed, and urge its consideration by the American Society of Microscopists. Thus, although much has been said against the 1-100 mm. unit as being too small, and although the New York Society has deemed it necessary to reconsider and retract the resolutions passed at first commending the action of the Congress in adopting it, we are decidedly of the opinion that the still smaller unit of 1-1000 mm. is the more desirable, and it has the prestige of actual use in France, and is generally known.

The reader will observe the distinction we have made above between the *standard division* of the micrometer, and the *unit*.

The former constitutes the accurate scale of reference; the latter a subdivision of that scale, obtained by an eyepiece micrometer. The distinction is made because the most convenient rulings on a stage micrometer are the 1-100 mm., while the adoption of the same divisions as a unit would involve the use of longer decimals. With the micra, a single decimal is sufficient for ordinary purposes.

## A SHOWER OF POLLEN IN PENNSYLVANIA.

We are indebted to two correspondents for specimens of the pollen which is described in the following abstract from Mr.

Silliman's letter. Mr. Wolle, of Bethlehem, states that it was accompanied by a slight fall of snow.

"A remarkable shower of 'yellow snow' fell in the northeastern part of Pennsylvania, on the morning of March 17th, covering an area of twenty-five hundred square miles or more.

"The coloring matter was so strikingly like sulphur that the country people decided that we had been visited by a shower of brimstone, and their olfactories, being excited to the condition of strong expectancy, soon corroborated the evidence of the eyes by announcing a decidedly sulphurous odor in the atmosphere.

"Under the microscope the yellow substance was found to consist of three-celled bodies (two cells of granules, attached to opposite sides of an empty one), which, when dry, are nearly circular in outline, but when wet assume an oval form. After remaining in water some time many of the cells become so distended as to burst and discharge their contents.

"These grains have been compared with pollen of the yellow pine (*Pinus australis*) of the Southern States, from blossoms in the college herbarium, gathered in North Carolina in the month of March, and are found to agree in every particular, in the dry condition as well as when placed in water, thus removing all doubt as to their identity. I enclose herewith samples of the 'yellow snow' and pine pollen from the blossoms referred to.

"This pollen must have been carried by the winds a distance of at least five hundred miles, and sown broadcast over thousands of square miles." J. M. SILLIMAN.

LAFAYETTE COLLEGE, EASTON, PA., March 20th 1879.

## NUCLEUS IN BLOOD-CORPUSCLES.

(*Received March* 8, 1879.)

*To the Editor:*

Upon reading, some months ago, Böttcher's demonstration of a nucleus in the mammalian blood-corpuscle, after bleaching by corrosive sublimate and alcohol, it occurred to me that the asserted nucleus might be artificial, due to coagulation of albumen and extraction of water by the re-agents used. It seemed that if bleaching alone were to be accomplished, the same results should follow bleaching by other methods.

With this idea I procured specimens of fresh blood from man, the dog, rat aud turtle; exposed the corpuscles to the action of various bleaching agents—chlorine, sulphurous acid, acetic acid, a freezing temperature—then, when the coloring matter had been removed, I immersed them in weak solutions of anilin and carmine, and mounted them in distilled water. I was careful to produce, as nearly as possi-

ble, identical effects upon all the specimens treated by each re-agent, using the same solutions for the same periods upon them all. By each method nuclei were clearly demonstrated in the turtle's blood, but in no other specimen was there any differentiation of color. It is true that some mammalian corpuscles, after prolonged immersion in the coloring fluid, showed staining, but that staining was invariably uniform from center to circumference, proving conclusively the absence of a nucleus so far as carmine staining can prove anything.

On these observations I base a strong suspicion that the alcohol and corrosive sublimate used are responsible for the appearance of nuclei in corpuscles treated by Böttcher's method. This suspicion receives support from recent discoveries as to the structure of nuclei. In the July number of the *Quarterly Journal of Microscopy* Dr. Klein relates a series of observations, as a result of which he affirms the nucleus to consist of a fibrillar network, imbedded in which is a ground substance; that this intranuclear network is continuous with a similar intracellular network; that nucleoli are merely the thickenings and shrivelings of these fibrils. The natural shriveling effect of alcohol might readily produce a pseudo-nucleus in a blood-corpuscle from condensation of this intracellular network.

PHYSIOLOGICAL LABORATORY, W. T. BELFIELD, M. D.
RUSH COLLEGE, CHICAGO, March 4, 1879.

## NOTES ON DR. ABBE'S LETTER.

(*Received January 29th.*)

I am truly sorry that Dr. Abbe has so far misunderstood my remarks upon the Zeiss ⅛-inch, as to suppose that I intended to question M Zeiss's veracity when I said that "so far as could be judged from outside appearance, it is a 'three system' objective." I did not mean to say dogmatically that it was a "three system." Though I had no copy of M. Zeiss's circular, I was aware that, when the new oil immersions were first announced, they were mentioned as four systems, but then they were also mentioned as having a balsam angle of 115° to 116°, and as the objective in my hands, as measured by the Spencers and myself, and by Mr. Tolles and the owner of the objective, as I am informed by the latter, was barely 102°, I might be pardoned for supposing that, possibly, this particular ⅛-inch was from a new formula of Dr. Abbe, and a "three system." I did not mean to say positively that it was not what is called a four system. Certainly if it had been a three system, there would have been far more credit to be given to the distinguished mathematician and to the optician, whose combined skill had produced so perfect an objective, inasmuch as a four system is the more easily corrected. However, I beg to disclaim any thought of questioning M. Zeiss's assertion that the new objectives are four systems, and I am truly sorry that Dr. Abbe has so understood me.

If my language will bear this construction, I offer whatever apology may be necessary. The question after all is one of performance, and I can hardly believe that Dr. Abbe, when he acknowledges that the objective I examined is below the standard angle, 116°, and, as he says, only 107° to 109°, really means what he does say (p. 158), that this increase of angle, 7° or more, would not make any notable difference in the performance of the objective. Such is not my experience; other things being equal, each degree of gain in angle is a positive advantage, and certainly 7° would show a superiority in resolving power, and, indeed, a general superiority which no careful observer could overlook. Why parade conspicuously this large angle, if an objective of 107°, or for that matter 100°, will perform so nearly equal that no notable difference can be perceived? But I do not think this is really Dr. Abbe's unqualified opinion. He has taken too much pains to elaborate the formula to obtain this large angle, and M. Zeiss has expended too much skill in the construction to insist upon such a statement. I, for one, am exceedingly indebted to these gentlemen for the demonstration of the fact that so large a balsam-angle *can* be obtained, and I have reason to believe that two objectives, a $\frac{1}{8}$-inch and a $\frac{1}{12}$-inch, now in the hands of my distinguished friend, Lt. Col. J. J. Woodward, at Washington, are both, and notably the latter, superior to the objective that I examined, and because they *are* "standard" objectives of 116° balsam-angle, or 1.27 according to Prof. Abbe's notation.

As I had not the "circular" by me when I examined the $\frac{1}{8}$-inch Zeiss "Oil Immersion," I did not pay so much attention to the length of tube as I ought to have done. It is quite evident that a non-adjustable glass, of very wide angle like this is rigidly confined (or within narrow limits) to a definite ratio for the conjugate foci for its best performance, and the tube I used was, perhaps, half an inch too short, if I remember rightly the distance named on the circular, which I had seen long before. How far this affected the performance of the $\frac{1}{8}$-inch, I cannot now judge; I do not imagine that it would make a very great difference. Whatever this would have been would be so much in M. Zeiss's favor.

H. L. Smith.

## NOTES.

—Dr. H. Lenz, of Lubeck, has devised a means of ærating the water in aquaria, which has given great satisfaction. A tube conducting the air to the bottom is expanded at the end and stuffed with fine sponge. This causes the air to rise through the water in very minute bubbles.

—Maxime Cornu has made some experiments on the germination of the spermatia of Ascomycetes, and succeeded in causing the spermatia

of *Diplodia acerina*, *D. vulgaris*, several *Valsa*, *Massaria Platani* and others to germinate by employing a nutritive fluid. The spermatia should, therefore, be considered as a particular kind of very minute spores, which do not generally germinate in pure water but only in nutritive media which they find in the crevices of the bark of old trees. The identity of certain conidia with the spermatia, and of other conidia with stylospores, appears to have been recognized. This would only make two kinds of asexual spores for the Ascomycetes, the stylospores and spermatia. The author states that further experiments are necessary to prove the generality of these facts.

—An exceedingly simple method of sexual reproduction has been noticed by M. Cornu in a species of *Ulothrix* which he names *U. Seriata*. Besides the asexual formation of swarm-spores, two masses of protoplasm, destitute of chlorophyll, occupy at first the two ends of one cell. They approach each other and unite in the middle, forming a sphere, which becomes surrounded with a membrane.

—Mr. W. R. Gerard recently described before the Torrey Botanical Club, a species of truffle found on Staten Island. It is interesting as being one of the first recorded in this country.

—It is said that a solution of potassic bichromate in water will preserve all the lower gelatinous animals, such as Polypes, Medusæ, Salpæ, Ctenophora, etc.; also small Crustacea and Bryozoa.

—A new species of *Tinea* has been found in China, differing very much from *Tinea circinata*. There are but few spores and considerble mycelium. It has not been fully described.

—Prof. Leidy finds that the black or smoky color sometimes found upon old walls in narrow, shaded streets is caused by an alga closely resembling *Protococcus viridis*. It may be this plant in a particular stage, but he calls it, provisionally, *P. lugubris*.

The cells are round or oval, .006–.009 mm. in diameter, isolated or in pairs or fours, brownish or olive-brown.

—The most common and conspicuous shell of the New Jersey coast, according to Prof. Leidy, is that of the beach-clam *Mactra solidissima*. These are frequently found perforated, probably by *Natica heros*. Numerous genera and species of diatoms are found in the intestines of *Mactra*, and the mollusk appears to subsist upon such food and infusoria. *Amphiprora constricta* is a diatom which he found covering the sand, between tides, in a remarkable state of activity. On examining the shore sands of Atlantic City and Cape May for Foraminifera he found them all to be of the species *Nonionina polypora*, Ehr. In the former locality there were about 19,000 shells to the ounce of sand, in the latter about 38,000. The above notes of Prof. Leidy were communicated to the Philadelphia Academy of Sciences.

—We regret to notice that our friend, Mr. G. S. Woolman, suffered some loss by a fire in the upper part of the building in which his store

is located. The fire occurred during the night of March 28th, and was quite destructive to the upper floors; but Mr. Woolman's business will not be interfered with.

—It is proposed to form a Cryptogamic Society in New York City, and measures have already been taken to interest gentlemen well known in this branch of study. Such a society could do much to advance the knowledge of the cryptogamic flora of the country. We wish the undertaking great success.

## LABORATORY NOTES AND QUERIES.

1. Dr. A. Lang makes use of the following new staining mixture in cases where a general coloration is desired along with some selective staining: Fifty parts one *per cent.* picro-carmine, with fifty parts two *per cent.* rosein (in aqueous solution). In four days, or less, the staining is completed, and the picrin is removed by seventy *per cent.* alcohol, which must be often changed, after which ninety *per cent.* and absolute alcohol are used.

2. Dr. C. Wedl gives the following process for staining animal tissues: French orseille extract, from which the excess of ammonia has been removed by heating on a sand bath, is added to a mixture of 20 cc. absolute alcohol, 5 cc. acetic acid (Sp. gr. 1.070), and 40 cc. distilled water, until a dark-red, saturated solution is obtained, which is filtered. The sections, hardened in Müller's fluid, alcohol, or chromic acid, are washed with distilled water, and this removed with filter paper A few drops of the above fluid will now stain the protoplasm instantly, while nucleous and nucleolus remain uncolored.

3. Dr. Paul Mayer, of Naples, has found an alcoholic solution of cochineal valuable for staining tissues.

Mr. E. B. Stuart writes us that he finds the ordinary dropping bottles with capillary points, used by pharmacists, very convenient for holding Canada balsam for mounting, especially for those who mount but little. By tying a piece of sheet rubber over the tube, where the finger is applied, the flow of balsam can be well controlled.

## DIGEST OF CURRENT LITERATURE.

### JOURNAL OF THE ROYAL MICROSCOPICAL SOCIETY.

*February*, 1879.

On Œcistes Umbella and Other Rotifers.—C. T. Hudson.—This new species is described with the aid of a plate. *Conochilus Volvox* is also figured, and some remarks are made on *Notommata aurita* and *Melicerta ringens.*

A Further Inquiry into the Limits of Microscopic Vision, and the Delusive Application of Fraunhofer's Optical Law of Vision.—Dr. Royston-Pigott.—Dr. Pigott does not believe that the formulæ of Abbe & Helmholtz have fully determined the limit of visibility of fine lines, and in this paper he gives the results of some investigations, by means of minute miniatures, which show that it is possible to distinguish a bright space between black lines not greater than 1-230,000 or even 1-300,000 of an inch.

On Some Recent Forms of Camera Lucida.—Frank Crisp.—Several forms of this instrument are described and illustrated without any attempt at criticism or comparison. The forms described are those devised by Hofmann, Pellerin, Swift, and Russel.

Description of a New Form of Camera Lucida.—J. C. Russel.—The image formed by the objective of the microscope is reflected through a short tube at a right angle to the axis, and then into the field of the eye-lens of a telescope. The paper and pencil are viewed through this telescope, properly inclined, at the same time.

Immersion Illuminators.—J. Mayall, Jr.—Mr. Mayall reviews this subject and briefly mentions various appliances which have been used as immersion illuminators.

Note on a Revolver Immersion Prism for Sub-Stage Illumination.—James Edmunds.—This is a prism of special construction, having four surfaces normal to light incident, at 30°, 41°, 60°, and 49° from the optical axis of the objective.

A Catoptric Immersion Illuminator.—J. W. Stevenson.—This was devised in 1877, and consists of a plano-convex lens, "worked on a 1-inch tool, and having a diameter of 1.2 inches, which is then 'edged' down to 1 inch. The upper, or convex side of the lens is cut down or flattened so as to give a surface $\frac{4}{10}$ of an inch in diameter, with which the slide is to be connected, when in use, by a drop of oil or water." The convex surface is silvered. Directly beneath the flattened part an opaque stop of corresponding size is placed. Incident rays, normal to the plane surface, impinge on the curved, silvered surface, and are thrown back upon the plane surface, from which they suffer total reflection, and converge to a focus, giving a numerical angle of 1.30=120° in balsam.

The Thallus of the Diatomaceæ.—F. Kitton.—From a paper by Dr. M. Lanzi, elsewhere noticed.

## JOURNAL DE MICROGRAPHIE.

*December*, 1878.

Under the "Review" we find a reproduction of a note on the Germination of the Spores of Volvox Dioicus, from F. Henneguy.

Having previously communicated a note to the *Academie des Sciences* relative to the sexuality of *Volvox dioïcus*, Cohn, the male appearing

before the female, he now goes on to show that the spores from the fecundated oöspheres fall to the bottom of the water and remain there for some time. Cohn thought these spores required to be dried before germinating. Cienkowski watched the division of the spore contents, and believed that a cœnobium was ultimately produced. About the beginning of last June, however, Mr. Henneguy was able to follow the developement of these spores, and now asserts that they pass the winter in the water. Those which he studied had been preserved in a tolerably deep vessel, in the *Jardin des Plantes*, constantly full of water.

The spores were orange-yellow in color, and possessed two enveloping membranes, exospore, and endospore. At the moment of germination the exospore ruptures and the endospore escapes. The cell-contents, separated from the wall by a clear space, divide into 2, 4, 6, 8 cellules, and when this sub-division is complete the cellules form a spherical layer analogous to the blastoderm of an holoblastic egg; each element acquires two cilia, the endospore disappears, and the young volvox is set free. The cellules, at first very close together, separate by the interposition of gelatinous matter. An interesting fact to notice is the presence of elements larger than the others among the cellules within the endospore. These finally give birth to daughter colonies, by a mode of division similar to that observed in the spore.

Lymphatic Hearts.—Prof. Ranvier.—Continued.

Preliminary Note on the Intimate Structure of the Tongue of Parrots.—Prof. C. V. Ciaccio.

Angular Aperture of Objectives.—Dr. Geo. E. Blackham—Continued.

Studies on Foreign Microscopes.—Continued.—A description of Bulloch's A B diatom stand.

Organization and Nature of Hygrocrocis Arsenicus.—Dr. Leon Marchand.—This fungus grows in the arsenical liquid well known as Fowler's solution. Its growth is quite fully described and also some points in its reproduction. It belongs to the Dematiei.

Process for Arranging Diatoms Dry.—G. Marmod.—By exposing a slide to the vapors of heated oil of cloves, numerous minute drops are formed upon the surface, which will not evaporate for an hour or two. By arranging the diatoms upon such a slide they will be held securely in place after the liquid has entirely evaporated.

Diatoms of the East Indian Archipelago.—Dr. P. T. Cleve.—The full list of the species found in some collections, together with descriptions of a few new species. First part, illustrated.

The Thallus of Diatoms.—Dr. Matteo Lanzi.—Thallus, in this connection, refers to the gelatinous stipes or *mucus matricalis* of diatoms. It is produced by the accumulation of plasma within the cells, which takes place to such an extent as to issue from the frustules.

It merely plays the part of an organ of vegetation, and does not properly afford, by its presence or absence, any distinction of species. It may furnish nutriment to the young diatoms, or serve to distribute the species by dividing into parts which are carried off by the water.

All genera founded upon the character of the thallus, form, consistence, etc., should be abolished.

The entire subject is well treated, and should be read by those interested in the study of diatoms.

On the Termination of Nerves in the Striated Muscles.—From *Comptes Rendus*. Vol. LXXXVII.

The Oil-Immersion of C. Zeiss, &c.—Prof. H. L. Smith.—Translated from this journal.

Microscopical Technic.—A chapter from a prize thesis by Mr. A. Hénocque, on the termination of the nerves in the unstriated muscles, relating to the application of the gold method in histology. This method has been used by the author since 1870.

*January*, 1879.

The Muscles of the Œsophagus.—Prof. Ranvier.

Researches on Spermatogenesis.—Dr. Mathias Duval. These studies were carried on in some pulmonary gasteropods. The article begins with some general considerations, and closes with the study of spermatogenesis in *Helix*. It is illustrated with a plate.

The spermatozoids originate in this way: During December, the walls of a *cul de sac* of the hermaphrodite gland of a helix is lined with epithelial cells, among which larger, distinctly nucleated, cells are to be seen. These are called the mother cells. Soon the nucleus becomes opaque and granular, loses its spherical shape, and numerous smaller nuclei form in the protoplasm. By a process very similar to budding, these nuclei become centers to numerous smaller cells, which remain attached to the mother cell. It is from these that the spermatozoids are formed. The article is not completed in this number.

Angular Aperture of Objectives.—Dr. George E. Blackham. Continued.

Diatoms of the East Indian Archipelago.—Continued, with plate.

Histological Microscope.—Description of a Stand of Ch. Collins.

Researches of Van Tieghem on Mucorines.—A bibliographical note.

## THE AMERICAN JOURNAL OF MICROSCOPY.

*December.*

What can be done with a Cheap Microscope.—From *Young Scientist*. The Microscope in Medicine.—Dr. S. M. Mouser. Read before the San Francisco Microscopical Society. The Use of the Microscope.—Dr. Geo. E. Blackham. The Microscopical Ex-

AMINATION OF YEAST POPULARLY EXPLAINED.—From *London Brewer's Journal.* OUTLINES OF A PROCESS FOR THE EXAMINATION OF URINE FOR MEDICAL PURPOSES.—Arranged by R. Hitchcock. ON BIOTITE AS A PSEUDOMORPH AFTER OLIVINE.—Prof. A. A. Julien. This paper, apart from the value of the facts it relates, is important as showing the great practical value of the microscope in the study of rocks, and the alterations they have undergone. Microscopical lithology is fast becoming recognized as an important study. RECENT PROGRESS IN THE STUDY OF THE LOWER CRYPTOGAMS.—Abstract of Sir Joseph Hooker's address before the Royal Society, published in *Nature.*

*January,* 1879.

STRUCTURE OF COLORED BLOOD CORPUSCLES.—Dr. Elsberg.—Abstract of a paper read before the New York Academy of Sciences. ARTIFICIAL CRYSTALS OF GOLD AND SILVER.—Albert H. Chester.—Prof. Chester has been working upon this subject for a long time, and his contribution is quite interesting, giving some processes for making the crystals and describing their several forms. TRICHINÆ IN PORK.—The results of experiments of Dr. Belfield and Mr. Atwood, of Chicago, referred to in our last issue. THE MICROSCOPE IN MEDICAL JURISPRUDENCE.—H. C. Hyde.—Read before the San Francisco Microscopical Society. NOTES ON DIATOMACEÆ FROM SANTA MONICA, CALIFORNIA.—Charles Stodder.—This deposit contains several quite rare and beautiful forms of diatoms, which are briefly noticed. The paper was read before the San Francisco Microscopical Society. MICROSCOPIC SOIREES—AN IMPROVED METHOD OF EXHIBITING OBJECTS.—George E. Fell. A NEW FORM OF COLLECTING CANE. MICROSCOPIC POND LIFE.—Paper read by Mr. T. S. Wilkins, before the North Staffordshire Naturalists' Field Club, England. A NEW ROTIFER.—D. S. Kellicott.—This is a rotifer well known to all who have examined the water of Lake Erie, and we are sure it is not uncommon in Lake Michigan. Although now described as a new species, it has been familiar to observers for at least ten years. It is named *Anuræa longispina,* and a full description, accompanied with a wood cut, is given. VOLVOX GLOBATOR.—From *Young Scientist.*

## BULLETIN DE LA SOCIÉTÉ BELGE DE MICROSCOPIE.

*Séance, November 28th.*

Mr. Renard gave some results of his microscopical examinations of thin sections of FULGERITE, and of some products of the FUSION OF QUARTZOSE MINERALS, and compared the results with the products of artificial fusion. In a second note Mr. Renard described the METEORITE of Tourinnes-la-Grosse. The President, Mr. Ledeganck, presented a communication relative to some matters in OPHTHALMOLOGY. A plate accompanies this. Mr. F. Kitton contributes NOTES ON SOME DIATOMS, which is also illustrated.

CHESAPEAKE ZOÖLOGICAL LABORATORY. SCIENTIFIC RESULTS OF

THE SESSION OF 1878. We are indebted to Mr. W. K. Brooks for this valuable contribution. We have already referred to some of the excellent scientific work done during the past summer. In this volume the results are published in detail, with excellent illustrations, occupying 170 pages. The contents are as follows: "Introductory," by W. K. Brooks, Associate in Biology. "Partial List of Land Plants found at Fort Wool," by N. B. Webster. "List of Animals observed at Fort Wool," by P. R. Uhler. "The development of *Lingula* and the Systematic Position of the Brachiopoda," by W. K. Brooks; illustrated by six plates. "Description of *Lucifer Typhus*," by Walter Faxon; one plate. "Preliminary Observations upon the Development of the Marine Prosobranchiate Gasteropods," by W. K. Brooks; one plate. "The Larval Stages of *Squilla Empusa*, Say;" by W. K. Brooks; with five plates. The energy and foresight which have led to the equipment of the Summer Laboratory are amply rewarded by this record of the work of the first year. An extended notice of the monographs mentioned would occupy more space than our limits will allow.

*The Medical Record*, on page 187, gives the main conclusions of C. F. W. Bodecker, who has been studying the STRUCTURE OF TEETH in Dr. Heitzmann's laboratory. Several new discoveries are claimed, but as the "new methods" of preparing the specimens are not described, further comment is not necessary. On page 205 is found a note on the STRUCTURE AND FORMATION OF THE GIANT CELLS OF TUBERCLE, from the *Gazette Medicale de Paris*.

*Science Gossip* for January has an illustrated article describing some FUNGI from Epping Forest; and a brief account of the development of the HOUSE FLY, and its parasite. The February number contains a contribution from A. M. McAldowis, on the COLORS OF ANIMALS AND THE ARRANGEMENT OF PIGMENT IN THE LEPIDOPTERA. In the March number Mr. G. R. Vine continues his instructive contributions on POLYZOA, with a paper entitled "Physiological Character of *Fenestella*."

*The New York Medical Journal* for January contains an article by A. M. Hurlbutt on the STRUCTURE OF THE BLOOD CORPUSCLES OF THE OYSTER.

*The Cincinnati Medical News*, for February, contains several short papers under "Microscopy," among others is one by Prof. J. Edwards Smith, on the "Illumination with High Powers by Reflected Light." In this article he speaks of Beck's Illuminator, used with wide-angled objectives. Among other things he claims to have seen the nucleus of the red blood-corpuscles of mammalia in this way, about three years ago. The appearance of a nucleus, when the corpuscles are viewed in this manner, has long been familiar to observers, and it is safe to assert that no true nucleus can be thus demonstrated.

## MICROSCOPICAL SOCIETIES.

Space does not permit us to publish the proceedings of societies in full. We are only able to notice the papers read and matters of general interest. We would consider it a favor if secretaries of societies would send us reports of meetings regularly.

## RECEPTION OF THE BIOLOGICAL AND MICROSCOPICAL SECTION OF THE PHILADELPHIA ACADEMY OF SCIENCES.

The building of the Academy of Sciences in Philadelphia was the scene of a large and interesting exhibition of microscopes and objects, on the evening of Monday, April 7th.

It is rarely that we find so many exhibitors and so much real enthusiasm as was manifested on this occasion at such an exhibition. To be sure, there was the usual lack of system in the arrangements for the convenience and comfort of visitors, but we are accustomed to this. It will probably require another score of such exhibitions before our Philadelphia friends will realize that it is desirable and quite possible to accommodate as large a gathering as was present on that evening, without the confusion caused by crowding and moving in opposite directions.

The dealers were well represented. Mr. Walmsley, of R. and J. Beck, occupied two tables at one end of the library and furnished 23 stands. Mr. J. Zentmayer came next with 12 stands, and J. W. Queen & Co. followed with 17. Further on, Mr. W. Y. McAllister had a table with 9 microscopes. Some of these instruments will be noticed on another page.

At one table the Westchester and the Camden Microscopical Societies were represented.

By actual count there were 140 stands on exhibition in the library and adjoining rooms. We give below a list of the objects shown, which we believe to be quite complete, and also the names of the persons who furnished them. It will be seen that, as a rule, the objects are familiar to all who use the microscope, but many of them deserve special mention, for which, however, we have not the space.

Prof. D. S. Holman afforded very instructive entertainment by means of his "life" and "current" slides.

Dr. J. G. Hunt had several objects of interest, among which may be named the tongue of a fly entrapped by the sensitive organ of *Stapelia asterias*, the tongue and the two pollen masses being shown in a beautiful manner. Dr. Hunt also showed a transverse section of the small intestine of a cat, and he claimed to be able to demonstrate that the villi were ciliated. The preparation was not shown under a sufficient magnifying power to enable us to judge as to the presence of true cilia.

A very interesting object was the blackberry leaf with fungus spores.

There were quite a number of histological preparations exhibited, which, taken as a whole, were of the very best order. Only a few were of the well-known German type of work, which shows no structural detail. Among those which were especially good, Dr. C. Seiler's double stained preparations must be mentioned first. This gentleman exhibited a transverse section of a fœtal larynx under a 5-inch Zentmayer lens; a section of fœtal trachea, showing the mucous glands; a lip of a fœtus, in which the epithelial cells were shown with remarkable distinctness, and a section of skin from the sole of the foot, which, in color, was perhaps the most brilliant specimen. He also showed some large sections of the adult human larynx through the vocal cords, measuring 30×34 mm. (about 1¼ inch square); a section of the kidney of a cat, and a section of the foot and leg of a 5 month fœtus, measuring 47 mm. (nearly 2 inches) in length. These sections were remarkable for their size, thinness and evenness, and were samples of the work done by Dr. Seiler's mechanical microtome, which he also exhibited.

Mr. Zentmayer exhibited a very pretty specimen of the papillæ of the cat's tongue; Mr. Walmsley, an exquisite injection of the small intestine of the rat, and a specimen of *Trichina spiralis*, also injected.

Messrs. Queen & Co. had, among their exhibits, a section of bone which ranks among the best that we ever saw.

Dr. Charles Turnbull exhibited eye preparations, among which a silver staining of the cornea, and a gold preparation of the rods and cones of the retina must be mentioned as being exceptionally fine.

The circulation of the blood in the living animal was shown by various gentlemen, both in the web of the frog's foot and in the tail of the salamander, and these exhibits attracted considerable attention.

As no exhibition can be considered complete without the frog, we feel bound to remind our readers that the barbarous cruelty sometimes shown in arranging this animal is quite unnecessary, and deserves severe condemnation.

We have not a full list of the stands and objects exhibited by Mr. Joseph Zentmayer, but among them were several deserving special notice. The "Centennial" stand was prominent, and, as now made, embodies several improvements over the original form. The workmanship upon this stand is certainly the most perfect we have ever seen. The sub-stage is in two parts, the upper part having an arrangement for centering that is much superior in design and appearance to the old plan. The lower part, which is independent of the other, does not possess centering screws, and can be entirely removed.

The "Histological" stand made into a binocular was shown, and the makers claim that it is the cheapest binocular made; but as R.

and J. Beck now have an "Economic" binocular at about the same price, we believe a few dollars cheaper, this claim will probably be disputed. The base of the "Histological" stand appears too light, and certainly is not attractive; but this is the only homely thing about any of the stands of this maker.

The Messrs. Beck have produced a large stand which they believe is superior to any other yet made, but for certain reasons it was not shown at the reception. We hope to describe it for our readers in future. Mr. Walmsley's exhibit was as follows:—

STANDS, &c.—2 Large Best Binoculars; 1 Small Best Binocular; 2 Small Best Monoculars; 1 Popular Binocular; 4 National Binoculars; 4 National Monoculars; 4 Economic Monoculars; 1 Economic Binocular; 1 Holman's Class Microscope; 1 Best Dissecting Microscope; 1 Small Dissecting Microscope; 1 Histological Dissecting Microscope; 1 School Dissecting Microscope; 1 Ether Spray Freezing Microtome; 1 Dr. Seiler's Knife and Carrier.

OBJECTS.—Franklin's letter, photograph; section of leaf of *Nymphea odorata*, double stained; cornea of frog, gold staining; human lung, double injection; small intestine of mouse and of rat, injected; liver of rabbit, double injection; sections of Echinus spines; Foraminifera from the Levant; Polycystina, Barbadoes, grouped; *Drapernaldia plumosa; Licmophora in situ* on Algæ; tongue of cat, injected; *Trichina spiralis* in muscle of rabbit, injected; spicules of sponge; anchors and plates of Synapta, arranged; stems of *Vites vulpina, Bignonia,* Smilax, and ovary of *Calla Ethiopia,* double stained; Möller's plate with 100 diatoms, with name of each photographed beneath.

*With parabola.*—Flower, Bishop's cap; leaf of *Sphagnum.*

*Opaque.*—Bouquet of butterfly and beetle scales; Dr. Watt's gold crystals; grouped diatoms; small human intestine, injected; crystals of berberine.

*With polariscope.*—Quinate of quinine; Amygdalin; toe of white mouse.

The exhibit of Messrs. J. W. Queen & Co. was very attractive, and embraced the following:

STANDS.—1 Crouch "Large Best" binocular; 1 "Centennial" binocular, and 1 "Grand American," by Zentmayer; 1 new Jackson model binocular, by Ross; 8 "Students" binoculars, by Crouch; 3 "Educational," by Crouch; 2 "Students," by Queen.

OBJECTS.—Trachea of silk worm; "the wicked flea"; section of petiole of *Nuphar advena,* double stained; *Trichina spiralis;* Microphotograph of Dr. Carpenter; sections of Ivy stem, root stalk of fern, human cerebellum, stained, and human scalp, injected.

*With polariscope.*—Asparagine; chlorate of barium; kinate (?) of quinine; scales from fern stalk, *Elaphoglossum squamosum.*

*By reflected light.*—Wings of *Sangala gloriosa, Papilio,* and *Morpho*

*anexbia; Isthmia nervosa;* corallines; echinoderm spines; sponge spicules; shells, etc., from Bermuda; seeds of *Hypericum perforatum* and *Silene noctiflora.*

*With paraboloid.*—Sulphate of iron and ammonia; *Pleurosigma angulatum;* scales of *Vanessa Atalanta;* section of coal showing Stigmaria; spicules of *Euplectella.*

WESTCHESTER MICROSCOPICAL SOCIETY.

Dr. J. C. Green.—Natural Crystallized Copper.
J. F. Rothrock.—Hairs on Croton leaf. Polar.
A. May.—Lichens.
Henry C. Wood.—*Trichea pyriformis* (Fungus), on oak.

CAMDEN MICROSCOPICAL SOCIETY.

Harry S. Fortiner.—Chloride of Cobalt.
A. P. Brown.—*Polypodium aureum.*
Geo. F. Robinson.—Vinegar Eels.
J. L. De La Cour.—Fossil Diatoms.

PRIVATE EXHIBITS.

W. Y. McAllister.—Diatoms; Lung of Rat; Copper Acetate; Blood of Frog; Trichina in Pork; Skin of Spider; Muscular Fiber; Section of Human Bone; Blood of Rabbit.

Dr. W. L. Atlee, Jr.—Photograph, Descent from the Cross (Rembrandt).

Dr. Chas. Schäffer.—Platino-Cyanide of Magnesia; Wing Case of Beetle; Stomach of Frog.

Northern Dispensary.—Sweat Glands of Skin, Sole of Foot.
Dr. R. J. Hess.—Thrombosis of the Middle Cerebral Artery.
Geo. B. Dixon.—*Trichina Spiralis* in Tongue of Cat, stained.
Chas. Bullock.—Lip of Fœtus.
Dr. Kirkhide.—Polycystina.
Dr. Crane.—Trachea of Male Child.
J. T. Pennepacker.—Synapta.
C. N. Pierce.—Polycystina.
Dr. Horace Y. Evans.—Eye of Fly.
Otto Luthey.—Section of a Lilly.
Dr. T. G. Morton.—Eye of a Bee.
Dr. W. W. Keen.—Spiculæ of Sponge.
Dr. C. S. Baker.—Section of a Tooth; Polyonas Seed.
Mrs. C. L. Pierce.—Section of a Quill.
Dr. Hollingworth Neill.—Tongue of Butterfly.
C. S. Bement.—Photograph, The Orphans.
Henry Liffman, M. D.—Atlantic Soundings.
E. T. Darby.—Circulation of Blood in Tail of Salamander.

Dr. L. Ashley Faught.—Human Tongue; Anchors of Synapta, Polar; Platino-Cyanide of Barium, Polar; *Trichina Spiralis;* Stomach of Cat, Injected.

Uselma C. Smith.—*Volvox Globator.*

W. M. James.—Section of Elephant's Hair.

Dr. Albert H. Smith.—Cochineal Insect.

Spencer Trotter.—Cornea of Fly.

C. Shaffner, M. D.—*Aspergillus flavescens.*

W. C. Stevenson, Jr.—Potato Bug.

John T. Morris.—Measuring Worm.

Dr. C. S. Turnbull.—Bloodvessels in coat of the eye of a Rabbit; Human Retina, showing Rods and Cones.

——— ———.—Thin section of Quartzite, Polar.

Academy of Natural Science.—Sections of Coal, Lower Carboniferous, Ind; eye of a Beetle.

R. S. Kenderdine.—Corallines.

Mrs. R. S. Kenderdine.—*Candia holacantha.*

Dr. Kenderdine.—Mexican Soap Plant.

Miss Gerty Kenderdine Bolles.—Photograph of Cathedral of Milan.

Jno. A. Ryder.—Section of Intestine.

D. S. Holman.—Circulation in Plant; *Branchipus stagnalis;* Circulation of blood in Salamander.

Chas. Bowden.—Vinegar Eels; Verbena Flower.

C. Henry Kain.—Circulation of blood in Salamander; *Oscillatoria,* creeping plant.

Mr. Morris.—Yellow Snow, Bethlemen, Pa., Mar. 16th, '79; Seed Vessel, Water Lilly.

Edmund Lewis.—Bell Animalcule.

Theo. D. Raus.—Mica—Chester Co.

——— ———.—*Sertularia.*

Dr. J. F. Holt.—Circulation of blood in foot of Frog.

H. S. Hitchcock.—Fly's Foot.

Benj. Sharp.—Frondlet of Fern, Spores.

L. Brewer Hall.—Conifers, Stained.

Isaac C. Martingdale.—Circulation of Sap in *Anacharis Canadense.*

Wm. G. Davis, M. D.—Circulation in Frog.

Geo. B. Cresson.—Frond of Fern.

——— ———.—*Hemitrichia clavata* (*fungus*); Section of leaf of Blackberry, showing brand spores (*Phragmidium incrassatum*).

Dr. J. G. Hunt.—Pistillidia of Moss.

J. O. Schimmel.—Anthers, Stigmas, and buds of Flowers, arranged on a revolving disk, around the margin of which was inscribed "Solomon in all his glory was not arrayed like one of these."

## WELLESLEY COLLEGE MICROSCOPICAL SOCIETY.

This society, composed of teachers and students, has been in successful operation for two years. There are now about twenty-five active members and ten microscopes—Zentmayer's Centennial, and Army Hospital; besides stands from Beck, Tolles, Zeiss and others. There are also, available for special occasions, twenty other student stands, by Crouch and Beck, from the botanical and biological laboratories. There is also an excellent working library, including complete sets of the English *Quarterly* and *Monthly Microscopical Journals*; a good line of objectives and accessory mounting apparatus, and some hundred slides have been prepared for the cabinet by the members. The meetings have been of continually increasing interest, and papers have been presented covering a wide range of subjects.

The regular meeting of the Society was held in the Physical Lecture Room, February 8, Miss Fairbank, the President, in the chair. Beside the members of the Society, some fifty visitors were present. A paper was presented by Miss Metcalf on "The Application of the Microscope to the Study of Rocks." This was the second paper on the subject; the first dwelling upon the uses of polarized light. Free use of the blackboard was made in illustration, and, after the paper, some thirty specimens, loaned by Mr. A. L. Dickerman, of Boston, were exhibited upon the screen, by means of the oxhydrogen light and polarizing attachment. The first of a series of papers on "Spectrum Analysis, as applied to the Microscope" was next given by Miss Whiting, and illustrated by lantern projections. The company then adjourned to the adjoining laboratory, where there were exhibited, under some fifteen microscopes, with various powers, specimens of thin rock sections. Granite, showing liquid inclusion, with moving bubble; Dolerite, showing good augite crystals; Pitch-stone, showing fluctation structure; Hornblende, breaking up into microlites; Quartz, containing needle-shaped microlites, and others. Also, under the microspectroscope, were exhibited some specimens of crystals. Miss Hunn also exhibited some living sea anemones, which were intended for microscopical dissection the coming week.

The Corresponding Secretary is Miss Marion Metcalf.

The regular monthly meeting was held the evening of March 15, Miss Cook, the President, in the chair. Miss Whiting called the attention of the Society to the receipt of fifty selected slides of Diatomaceæ, prepared by Prof. Smith, and of a splendidly illustrated monograph by Häkel, entitled "Die Radiolaren."

Miss Dickinson then read a paper upon "Animal and Vegetable Hairs; their Differences, Growth, and Uses," detailing many experiments which she had performed. The paper was illustrated by blackboard drawings, and by eight or ten slides.

Miss Beattie spoke for nearly an hour on Bacteria. She gave, somewhat in detail, the present state of the discussion in reference to spontaneous generation—the experiments performed, and deductions drawn; also as to their nature, plant or animal; their connection with putrefaction and infection. She spoke of forms which she had observed in various infusions, animal and vegetable. Bacteria from sheep's blood were exhibited.

Miss Whipple, with all needed apparatus on the table, gave a demonstration of the method of cutting, preparing, and double staining vegetable sections.

A cross section near the tip of the root of an air orchid, showing fibro-vascular bundles and fissure-like markings, on cells of epidermal tissue was noticeable; also a vertical section of a stalk of corn, showing reticulated and annular vessels in fibro-vascular bundles; and a cross section of stem of cypress, showing intercellular spaces.

After the more formal meeting the company adjourned to the adjoining laboratory to inspect the specimens under the microscopes and discuss the topics of the evening.

Adjourned for two months.

MARION METCALF, Cor. Sec.

### MICROSCOPICAL SOCIETY OF CAMDEN, N. J.

This Society held its first public reception on the evening of March 14th, which was well attended, and appears to have been highly satisfactory to all concerned. Mr. C. Zentmayer, of Philadelphia, was present as an exhibitor.

### SAN FRANCISCO MICROSCOPICAL SOCIETY.

On December 5th, a paper from Mr. Charles Stodder was presented, describing some diatoms from Santa Monica, Cal., among which were some very beautiful and rare forms. At the next meeting a letter was read from Mr. T. P. Woodward, stating that the specimen from which the Santa Monica slides were prepared was discovered in tidal refuse several miles from Santa Monica.

At the meeting of January 2d, the circular letter from the Troy Scientific Association, regarding a micrometric standard, was read, and on motion it was decided that it is expedient to adopt a standard now, and that the metric system should be employed. The other propositions were referred to a committee. The committee reported, January 16th, in favor of a standard in the metric system, and recommended the millimeter as the unit.

The annual meeting was held February 13th, at which President Hyde delivered an interesting address, in which he briefly reviewed the progress of microscopical discovery and invention for the past year.

## STATE MICROSCOPICAL SOCIETY OF ILLINOIS.

The regular meeting of the State Microscopical Society of Illinois was held at the Academy of Sciences, Chicago, January 24, 1879. President Fuller in the chair. After the election of members and the transaction of some routine business, the Secretary read a communication from a committee of the microscopical section of the Troy Scientific Association in regard to the adoption of a unit of micrometric measures, with reference to action of the American Microscopical Society at its next meeting. After an expression of views by various members, the matter was referred to a committee consisting of Professors H. A. Johnson, M. D., Lester Curtis, M. D., H. H. Babcock and Mr. H. W. Fuller, to consider the subject, and report their recommendations at the next meeting.

Dr. W. T. Belfield read a paper entitled "Have the Mammalian Blood-Corpuscles a Nucleus?" After recounting his own experiments, he referred, in closing, to the so-called claim of the late Dr. Freer, of Chicago, to the discovery of a nucleus in the human blood-corpuscle by the use of reflected light, as employed by Dr. H. A. Johnson He stated that Dr. Freer suggested that the peculiar appearance of the corpuscle, when thus examined, *might* be due to the presence of a nucleus. This suggestion, however, was not indorsed by eminent medical gentlemen in England and Germany, and on his return from abroad he had quite abandoned that theory.

## BOOK NOTICES.

INDEX MEDICUS. A MONTHLY CLASSIFIED RECORD OF THE CURRENT MEDICAL LITERATURE OF THE WORLD. F. Leypoldt, Publisher, New York. Although this journal does not come strictly within our field, it is still of such sterling value that we feel bound to bring it prominently before our medical readers. The first two numbers are issued and bear evidence of careful editorial work, and the style is unexceptionable. Its scope is fully set forth in the title, and we can only add that the undertaking, although involving a vast amount of labor, bids fair to be carried out to the fullest extent.

Periodicals are divided into several classes and arranged alphabetically under their respective heads. We find: "I. Journals and transactions exclusively medical. II. Scientific Journals and transactions. III. Journals and transactions devoted to collateral subjects, special theories, and popular medicine." Among the latter we find the subdivisions of "Eclectic," "Homœopathic," and "Veterinary." It seems to us that an index of this high character should be above all distinctions of schools. A contribution to medical literature, especially such as relates to surgery, pathology, or, in fact, to anything but mere physic is, *prima facie*, as valuable from one school as another, and deserves the same recognition in an index "of the current literature of the world." Not being doctors ourselves we cannot sympathize with the distinctions here made, for we are assured that if occasion required us to look up the literature upon any medical subject, no one school of doctrine would serve our purpose or

bias our judgment. We think the value of the index is weakened by this separation, in that contributions from able writers outside of the "regular" school are liable to be overlooked.

A COURSE OF PRACTICAL HISTOLOGY, BEING AN INTRODUCTION TO THE USE OF THE MICROSCOPE By Edward Albert Schäfer, Assistant Professor of Physiology in University College, London. Philadelphia: Henry C. Lea, 1877. This is a useful little volume, evidently prepared to be of real assistance in laboratory work. All descriptions of tissues have been left out, and very little is said about selecting a microscope and its construction. Some useful general directions are given, but the body of the work is divided into chapters, each one treating of special subjects as blood, epithelial tissue, connective tissue, cartilage, &c. Under each chapter several methods of preparing the objects are given. The arrangement is systematic, and the directions are plain and concise.

MANUEL DE HISTOLOGIE NORMALE. By Dr. J. Pelletan. With 200 illustrations. Paris: H. Lauwereyns. 1878. Pp. 322. The author of this work, well known as the director of the *Journal de Micrographie*, has shown himself well fitted for the task of producing a book that is clear, concise, and fully up to its time. It is an admirable work throughout, and we can recommend it as an excellent manual for students in this line of work.

A STUDY OF WHEAT. By Mrs. Lou Reed Stowell. Chicago: Blakely, Brown & Marsh, Printers. 1879. This little pamphlet is a re-print from the *American Miller*. It is quite an interesting and valuable contribution, with a number of cuts illustrating the microscopical structure of the coats and tissues, both of the straw and the berry.

## PUBLICATIONS RECEIVED.

THE NORTH AMERICAN REVIEW.—THE LIBRARY TABLE.—PROCEEDINGS OF THE MEDICAL SOCIETY OF THE COUNTY OF KINGS.—THE MEDICAL RECORD.—NEW YORK MEDICAL JOURNAL.—THE ST. LOUIS ECLECTIC MEDICAL JOURNAL.—THE AMERICAN BOOKSELLER.—THE NEW YORK ECLECTIC MEDICAL AND SURGICAL JOURNAL.—NEW REMEDIES.—THE HOSPITAL GAZETTE.—THE CANADIAN JOURNAL OF MEDICAL SCIENCE.—ZEITSCHRIFT FUR MIKROSKOPIE.—THE JOURNAL OF THE FRANKLIN INSTITUTE.—THE AMERICAN JOURNAL OF MICROSCOPY AND POPULAR SCIENCE.—FARM AND FIRESIDE.—THE UNIVERSITY COURANT.—BULLETIN DE LA SOCIETE BELGE DE MICROSCOPIE.—SCIENCE GOSSIP.—THE POPULAR SCIENCE REVIEW.—THE POPULAR SCIENCE MONTHLY.—JOURNAL DE MICROGRAPHIE.—THE VALLEY NATURALIST.—THE AMERICAN MEDICAL JOURNAL.—THE KANSAS CITY REVIEW OF SCIENCE AND INDUSTRY.—VAN NOSTRAND'S MAGAZINE.—BULLETIN TORREY BOTANICAL CLUB.—THE BUFFALO MEDICAL AND SURGICAL JOURNAL.—THE JOURNAL OF THE QUEKETT MICROSCOPICAL CLUB.—THE AMERICAN JOURNAL OF SCIENCE AND ARTS.—SCIENCE NEWS.—HISTOLOGY AND THE MICROSCOPE. By E. A. Schäfer. Pp. 300. H. C. Lea, Philadelphia.—INDEX MEDICUS.—FAMILIAR SCIENCE AND FANCIERS' JOURNAL.—MANUEL D' HISTOLOGIE NORMALE. By Dr. J. Pelletan. H. Lauwereyns. Paris, 1878.—ZOOLOGISCHER ANZEIGER.—WELLESLEY COLLEGE CALENDAR. 1878 9 —A STUDY OF WHEAT. By Mrs. Lou Reed Stowell. Pamphlet, pp. 29. Reprint from the *American Miller*.—THE PRINCETON REVIEW.—THE CINCINNATI MEDICAL NEWS.—A CASE OF PROGRESSIVE MUSCULAR ATROPHY WITH SCLEROSIS OF THE LATERAL COLUMNS. By Dr. J. C. Shaw. Pamphlet, pp. 9. Reprinted from *Journal of Nervous and Mental Diseases*.—TENTH ANNUAL REPORT OF THE MICROSCOPICAL SOCIETY OF LIVERPOOL. Pamphlet, pp. 26 —THE MIDLAND NATURALIST. Vols. I., and II., to date.—PROCEEDINGS OF THE DAVENPORT ACADEMY OF NATURAL SCIENCES. Vol. II., part 1.—CONTRIBUTIONS TO AMERICAN HELMINTHOLOGY, No. 1. By R. Ramsey Wright. Pamphlet, pp. 23. From the *Proceedings of the Canadian Institute*.—HEDWIGIA.—A NEW MICROTOME. By S. W. Fletcher. Pepperell, Mass. Pamphlet, pp. 4.

THE

# American Quarterly Microscopical Journal.

"Go forth, under the open sky, and list
To Nature's teachings."—*Bryant.*

VOL. I. NEW YORK, JULY, 1879. No. 4.

## ON SOME SENSORY STRUCTURES OF YOUNG DOG-FISHES.

BY PROFESSOR S. A. FORBES.

(*Received June 2d, 1879.*)

Clusters of cells, similar to those of the lateral line of larval amphibia, appear in the skin of the head of many young fishes. Small cat-fishes furnish good examples of these, the barbels, especially, being richly provided with them. In the young dog-fish (*Amia calva*, L.) of the Mississippi Valley they are unusually well developed; and, as they have not hitherto been studied in this fish, nor, as far as I can learn, in any of its allies, a description of their structure may have some value, as they present peculiarities which I have not noticed elsewhere.

The material studied was derived from the smallest specimens of this genus of which I have any knowledge, taken in the Illinois River, at Peoria, in June, 1878, and ranging from $17^{mm.}$ to $25^{mm.}$ in length. These specimens were carefully preserved in 87 *per cent.* alcohol, but without special reference to histological work.

As the young *Amia* has not been figured, a sketch of it is given herewith (Plate XIX., Fig. 1). In specimens of this size, the skin of the front, top and sides of the head (including the lower jaw) is closely dotted with minute white specks, which extend backward to the posterior border of the opercle and downward to the branchiostegal membrane, but are wanting on this membrane, on the throat and between the rami of the mandible. In other words, they were distributed over those parts of the integument most exposed to first contact with objects, as the fish swims about. (See the dotting of the head of the figure.) They are largest and

thickest in front, but very minute everywhere, rarely exceeding .025$^{mm.}$ in diameter, and are so thickly placed that I counted twenty-five on a surface of the maxillary measuring but .5$^{mm.}$ in each direction. They are destitute of pigment cells, which thickly star the skin elsewhere. The surface is very slightly elevated over each cluster, but no cilia or external processes of any sort could be demonstrated. (On the barbel of the cat-fish, it should be noted that these clusters form evident small tubercles.) When a piece of the epidermis is detached from the corium, these bodies commonly remain imbedded in it, but can easily be picked out from the under side, leaving circular openings in the epidermis. These openings are, however, sometimes more or less completely covered by a delicate, granular film (Fig. 6), which is probably only the coagulated slime of the skin. When the clusters themselves are examined they are seen to differ considerably in shape (Figs. 2–5), but the outer end is always the smaller, as if the cells were crowded more closely together at their distal extremities.

Various methods of macerating these bodies were tried for separating their cells, but, owing probably to the previous action of the alcohol, without satisfactory results. Fragments of the epidermis were usually stained with Beale's carmine and placed in clean glycerin ; the sensory bodies were then picked out and transferred on a needle point to fresh glycerin, where they were care-

DESCRIPTION OF PLATE XIX.

Fig. 1. *Amia calva*, L., young form. Showing distribution of sensory bodies.

Fig. 2. One of the sensory bodies from the skin of the head ; the upper end is the distal. Drawn with the eye-piece micrometer, and slightly idealized.

Fig. 3. Same as 2, but accurately drawn with camera-lucida. Logwood staining, dammar mount.

Figs. 4 and 5. Outlines of sensory bodies. Camera-lucida drawing.

Fig. 6. Fragment of epidermis from which a cluster has been removed. The opening is partly covered by the granular film mentioned in the text.

Fig. 7. Sheathing cells from the outer layer.

Fig. 8. One of the outer cells of a cluster.

Fig. 6. Group of the same.

Figs. 10 and 11. Columnar cells of a cluster.

Figs. 12, 13 and 15. Modified columnar cells.

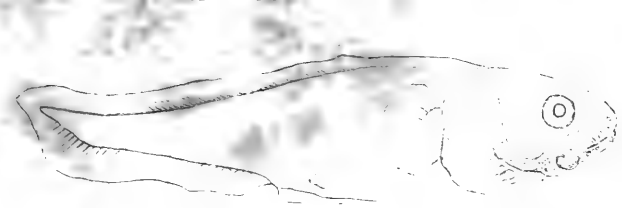
Fig. 14. Group of fusiform cells, with a filamentous columnar cell.

Figs. 16 and 18. Other intermediate forms.

Figs. 17 and 19. Rod-cells.

Fig. 20. Group of epidermal cells.

Figs. 21, 22 and 23. Cells from deeper layer of epidermis.



fully teased with needles or bristles, and mounted as they lay. Other methods gave substantially identical results, but the above was found the most convenient.

These clusters consist essentially of two kinds of cells, with various intermediate varieties, all intermingled to form a compact mass, shaped something like a cask with one end smaller than the other, resting on the corium by the larger end, the smaller filling a circular opening in the epidermis.

The most conspicuous of the component cells (all of which are perpendicular to the surface) are cylindrical, slender, about .04$^{mm.}$ to .05$^{mm.}$ in length and from .003$^{mm.}$ to .006$^{mm.}$ in breadth, each with a large, oval nucleus about .008$^{mm.}$ long, and commonly from one to three nucleoli (Figs. 2, 10 and 11). The cell-contents are pale, slightly granular, and usually stain more deeply in the proximal part of the cell, so that the distal half of a cluster is much the paler after staining with carmine or logwood.

The deeper end of these cylindrical cells is frequently slightly flattened and expanded, where it rests on the corium, while the exact limit of the other end is often difficult to make out. Many of these columnar cells are more or less constricted at some point, as if by pressure, and some part of the length of the cell may be reduced to a mere filament (Figs. 12 to 17). The part containing the nucleus seems to resist compression, and the cell may thus be reduced to a fusiform body with a filament at either end, as in Fig. 17. We are thus led directly to rod-cells, not unlike those of other sensory structures (Figs. 14 and 19). In a single specimen, first seen floating free, the filament was distinctly varicose—possibly an indication of its relation to a nerve fibril (Fig. 19).

No serious attempt was made to determine the nervous supply of these bodies. It was noticed, however, that the deeper end of a detached cluster often presented an appearance of a tangled pubescence, as if from the projecting ends of the filaments of the fusiform cells. Something of the mode of arrangement of these elements is shown by Fig. 14. It evidently presents no definite plan, except that the outer portion of each mass is composed exclusively of the columnar cells.

Sheathing the outer end of each cluster, were flattened scales, evidently modified forms of the superficial cells of the epidermis. The appearance of those nearest the clusters is shown by Figs. 3 and 9, while Fig. 7 represents the form of those of the outer layer of this sheath.

For an understanding of the relations of these clusters, and for a hint of their possible origin, a glance at the unmodified epidermis will be desirable. The deeper layer of this consists of columnar cells, much wider, but shorter, than those of the sensory bodies. Figs. 21, 22 and 23 are examples, the first being the commonest form. More or less oval or spherical cells (represented by Figs. 6 and 20) intervene between these and the superficial layer, and among them the irregular masses of pigment are distributed.

It is evident that any unusual developmental stimulus applied to the columnar epidermal cells at a given point, determining their elongation and more rapid multiplication, would gradually crowd away and flatten, by compression, the more superficial cells, resulting, if continued, in the protrusion of the columnar cluster through these layers, and that, at the same time, the columnar cells themselves would be forced, by mutual pressure, at least in the interior of the mass, into forms similar to those delineated in the plate.

The advantage of these compact little masses as a sensory apparatus over the adjacent epidermis, presenting, as they do, a medium anatomically continuous between the outer force and the seat of the inner impression, is very evident, especially when they form distinct elevations of the surface. It is not impossible that, through their rod-like cells, they may even transmit vibrations, and so minister to a more delicate sense than that of touch. Just what this sense may be, of course, we cannot tell, and we can probably do no better than to follow Leydig in regarding these and similar structures as the organs of a sixth sense, of whose character we must remain forever ignorant.

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## SPORES, WITH A SPORE GLOSSARY.

BY C. L. ANDERSON, M. D.

(*Received February 17th, 1879.*)

The history of a spore would be the history of a life—a life in its dealings with matter. It may be the longest or shortest life, and the smallest or greatest quantity of matter. The actual life of a spore may be limited to a single moment, for in the act of birth it dies. That is, in freeing itself from the matrix in which

it may have lain for thousands of years, and before it can reproduce itself, it becomes dead, or passive matter; for a spore is a cell, changed for the purpose of reproduction, and when that purpose is accomplished, its life, as an independent being, enters into new conditions. It is no longer a spore, but a part of the new organism, as a grain of wheat that has entered into the brain structure of an animal is no longer a grain of wheat, but nerve tissue.

A spore is the starting point of cell growth, although a simple cell may, in many cases, answer the same purpose without passing into the spore transformation. However, the spore structure is better adapted for the preservation and the continuance of life. It is a more securely sealed package, often containing many little packages in one enclosure. It is sealed, that it may better preserve and favor the transportation of life. Whilst a cell, or other organism, endowed with life would quickly perish by exposure to heat, cold, moisture, dryness or other unfavorable surroundings, a spore has greater persistence, as oft and well-tested experiments of Pasteur, Tyndall and others have shown. "It is a grave error to confuse the germs of infusions," (turnip, cucumber, &c.) says Tyndall "with the adult forms. Heat destroyed the adult organisms, but the germs from which they sprang were comparatively indestructible."

I may say here that the word spore is used in this paper in its most comprehensive sense, as applied to all organisms synonymous with germ or seed. A spore may be a germ without protoplasm, without a nucleus or a cell-wall. According to Lionel Beale, it may be a bit of "bioplasm" or "living matter." But we cannot conceive of "bioplasm" without a seed, or sowing. Every spore presupposes a parent body, or as Rudolph Virchow expresses it: "Where a cell arises, there a cell must have previously existed (*Omnis cellula e cellula*), just as an animal can spring only from an animal, a plant only from a plant." Furthermore, this seed in bioplasm, which is the life of the plasm, will produce an organism like the parent. It may be a simple cell—nothing more, or the most complex structure of plant or animal.

The simplest form of life, then, is a cell; and the simplest manifestations of life is the action of the matter in that cell.

And when I assert that a cell, which we can all see, with or without the aid of the microscope, has the two essentials of continuous growth, a *nervous* and a *secretory* system, I assert nothing

but what I believe can be demonstrated. The nucleus is the nerve-center, and must exist at some period of cell growth. From it nerve-force proceeds to superintend the building of the cell-walls, the storing of protoplasm, the establishment of new nerve-centers, and the keeping up of communication with these outposts, until they are independent. The cell-wall is the secretory apparatus. Osmosis goes on here as in the tissues of all the secretory bodies. The "cell-contents" are various and uncertain. They may be effete or formed matters, as chlorophyll, which is nutrient; or nucleoli, around which protective material is thrown, thus forming spores.

A spore is a cell in a general sense, but it differs from a large majority of what we call cells, in this: that it is endowed with the power of growth, but does not grow itself; for it has no nucleus or cell-wall. It is a center of growth, and forms organs out of inorganic matter; but it can do nothing until freed of the protective matter that the parent cell threw about it, and this disinthrallment is brought about by conditions needless to mention here. As a grain of wheat cannot grow unless the matter that surrounds the embryo is dissolved, so the spore cannot germinate until set free from its case, or bindings, by the application of some external force. It then manufactures the machinery by which the structure is to be built, sets it in motion; and, having served this purpose of its existence, dies. And so with each cell that succeeds it—they serve their place and office, pass through the stages of nucleolus, nucleus, and cell-walls, and are built into the structure, or cast aside as *débris*.

We speak of nerve-centers or nerve fibers, and say that a nerve is subjected to "excitability" on the application of a "stimulus." A nerve-center is a ganglion, or little brain, for receiving and sending out nerve energy. Here the nervous force accumulates, and on demand, is sent out along the fibers to the tissues where motion is required. It is simply an apparatus, then, for generating motion and telegraphing it from one point to another. Nerve force is thus conveyed by "a wave of stimulation" along the fiber to any distance.

May we not, appropriately, call a spore a nerve ganglion, consisting perhaps of a single cell, and ready, when it falls into a proper medium, to establish other centers and lines between them? A glance at some of the swarm-spores of Algæ and Fungi, with their actively vibrating cilia and swift movements in the water

would seem to warrant such an expression. Dilation and contraction, we say, explain these movements, and the stimulus is supplied by the fluid in which they are suddenly cast. But other fibers do not, under similar circumstances, contract and expand in this way. We think there is a little brain work here, and that we have the beginning of a nerve. The force that was sealed up, and has traversed water or air for an indefinite length of time, falls at last upon suitable soil, and we have the beginning of one of Lionel Beale's "bioblasts"—"a minute mass of clear, transparent, structureless, living matter, possessing formative power of the most remarkable kind."

But in that "clear, transparent, structureless mass," furnishing the motive power, is a minute, organized structure—a *nerve-cell*—so small that with our best microscope we cannot, in all cases, see it. It may be a form of nerve-cell different from those we already know. I think Beale recognizes this as a fact when he says: "There is a great difference between the bacterium and the minute germ particle from which it springs. This little body is often less than the $\frac{1}{100000}$ of an inch in diameter, and there are probably few living things in existence which will retain their vitality for so long a period, under such very different adverse circumstances. * * * These germ particles, each one probably protected by an envelope, may remain dormant, passive, and undergo but little change, for a great length of time. Such particles exist everywhere, and retain their life under conditions which would not only infallibly destroy the growing, multiplying bacteria, but every other living organism known to us."

We should recognize this fact, then, that there is, and should always be understood, a difference between the germ-cell or spore, and the cells or propagations that it originates.

This difference has been well demonstated by the patient experiments of Dallinger, Drysdale, Pasteur, Tyndall, *etc.*, and yet some writers on the subject evince ignorance of this matter, apparently so well established as a fact. Confusion has arisen from our having failed to distinguish between the growing organism and its seed or spore.

Similarity of form and structure in some bodies may have but little significance. It may not indicate similarity of function and use. But the similarity of the nerve-cells and zoöspores, especially in the beginnings or simplest stages of developement, is very striking.

The well-directed and patient observations, on some of the microscopic plants, begin to throw light upon subjects of vast importance to the human race. In the first number of this journal is the commencement of a paper by Mr. Frank B. Hine, on some forms of Saprolegnieæ. The illustrations show, in a beautiful manner, something of their life-history. This is a large, and doubtless much varied, family of plants. They are all microscopic. The much-talked of and little known Bacteria, for the present, I presume, may be included among the Saprolegnieæ. They are connecting links between the Algæ and Fungi. They contain in their cells no protoplasm, but feed upon living or dead animals. They have the habit of moulds and the fructification of Algæ. They are great enemies to fish and other animals in our aquaria; and there is good reason for the belief that the terrible fatality among fish in some of our waters, at times, may be owing to the spread or propagation of some of these plants. Favoring conditions would disseminate the spores with wonderful rapidity. Their growth, according to Mr. Hine's observations, required thirty hours from the sowing of zoöspores to the maturity of the sporangium or the discharge of the new crop of zoöspores. This is the slowest mode of reproduction. Other modes which, in other plants are very rapid, are probably no less so in this.

But it is not the rapid growing and propagation of these germs, or microscopic organisms, that is directly fatal. The air and water, and much of the food we eat, are full of them; and so long as our bodies are free from septic matters that may be associated with the growth of these organisms, we have no occasion to fear them. We may breathe, eat, and drink them in myriads. They may pass through the lacteals and lymphatics, course through the whole extent of the circulation and pass out with the excretions, as it has been demonstrated by experiment, and our bodies do not suffer nor feel their presence. Bacteria, or any other form of the Saprolegnieæe, are not poisonous while in active growth and separated from decomposing matter. They have been injected into the blood with impunity.

Decomposing animal, and possibly vegetable, matters may develop a virulent poison. This is not an organism with life, but a chemical compound. Dr. Burdon-Sanderson has named it *pyrogen*. When bacteria and decomposing tissues produce chemical changes then is life endangered.

I have kept animals and plants in the same water for months,

until the water was burdened with growing, propagating cells, spores of Protophytes and Protozoans, desmids, diatoms, and infusoria, together with larger plants and animals in the greatest abundance. It was a mass of living, healthy matter, in a very little water. But by the introduction of a decomposing animal, or neglect for a little while to remove one that had died, my aquarium would suddenly be changed to a putrescent, infecting, offensive mass, and all the plants and animals would die, except a few of such as feed on decomposing matter.

Decomposition having commenced, it spreads with rapidity. Even the spores that are propagated and the cells that feed on this "*pyrogenic*" virus, are capable of communicating the poison to other bodies. Possibly, or even probably, these protophytes themselves become diseased, and their genetic qualities changed or rendered abnormal by a surfeit of decomposing, poisonous matter. So that, wherever they find a suitable lodgement, they act directly as irritants, exciting inflammation and decomposition.

Thus, I have but little doubt, epidemics spread. Each body becomes a center of infection. Even the air, in close proximity, will contain germ particles, and clothing or other material may be the means of conveying spores, which, as I have said, are "sealed packages," containing not only the life-endowed seed of a bacterium or other organism, but a chemical compound of the most poisonous character.

From this cause millions of human beings have perished in past ages, and millions will perish in time to come, unless we act with knowledge and in concert to stop the spread and prevent the dissemination of this "living contagion," which carries so sure a cause of "black death."

Quite recently, Dr. B. W. Richardson, of London, eminent as a physiologist and lecturer, opposed what has been termed the "germ theory of disease." He stated, perhaps with more zeal than knowledge of the subject, that it was a hypothesis, and it would be false even to call it a theory. His theory substitutes "a poisonous, glandular secretion under special atmospheric conditions," &c. "An extreme nervous impression made on the glandular nervous supply." "The impression of disease made on a nervous center is transmitted;" and so on. In order to take all supports from the hypothesis, he propounds the following questions: "Why do the germs, after a certain time, cease to multiply, and allow the sick person to recover?" "Why do they not go on

multiplying until the person is infected in every part and fatally stricken?" "Who would escape fertilization if the hypothesis were true?" "Who would get well from a disease due to living, self-propagating, contagions?"

An exact answer to such questions might be very difficult; but a reply is very easy. What is a "poisonous, glandular secretion," or a "nervous impression," but the abnormal action of a living organism—a cell, or collection of cells, in the human body; and who could recover from a poisonous secretion generated by the cells; or, who could escape the "secretion" or "impression?" One question is as logical as the other. In either case, atmospherical or other conditions, the limited circle of life, and environment of the organisms, would doubtless stay the spread.

There are many vegetable parasitic diseases of the human body, "self-propagating contagions," that Dr. Tilbury Fox and others have described. What prevents their universal dissemination; and why should a person ever recover from their attack? To use a more tangible illustration, what but the environment of the grasshoppers prevents them from spreading and eating all the succulent plants of the United States of America? I fear that Dr. Richardson has not fully comprehended the advance that has been made in a knowledge of these organisms within the last few years.

That they are agents, in some way, in the dissemination of septic matters, and not the direct cause of decomposition, is probable. That they may appropriate material of live bodies, upon which they grow, to their own use, and thus produce a chemical change in the material supplies, or in the nervous centers, is also probable. But before we can make positive assertions, one way or the other, further experiments and investigations are necessary.

At this stage our subject opens into such a wide field,—not only for discussion, which to a certain extent is profitable, but for very patient and systematic research,—that we have not more than glanced at a few of the seemingly important points. At some future time, possibly not very distant, our attention may be directed this way again.

## Spore Glossary.

For convenience of study I have compiled a glossary of terms, in pretty general use, on the subject of Spores. The list might

be considerably increased, for each writer seems anxious to invent new words, sometimes without necessity. In a subject so intricate, the multiplicity of terms often grows burdensome, especially to young students. Yet the great variety of ways that nature has for the accomplishment of a single object, must lead to the use of many terms for expressing this variety with exactness. The short definition of some of these words may be difficult to understand and may occasionally lead to confusion; for this, however, I am not altogether accountable.

AGAMOSPORE, spore formed without conjugation.
ANTHERIDIUM, anther-like, or male spores.
ANTHEROZOIDS, (see spermatozoid).
APOTHECIUM, a cluster of spore cells.
ASCUS, plural ASCI, spore cases, or fruit-bearing cells.
BASIDIOSPORE, spores on tips of little stems, or supports.
BASIDIUM, a stem or base supporting spores.
CARPOSPORE, a central cell, with 2 or 4 spores surrounding.
CERAMIDIA, ovate, conical, or globose capsules, holding spores.
CONCEPTACLE, a follicle or sac, holding loose spores.
CONIDIA, spores formed without sexual action.
CYSTOCARP, a cyst, holding a great many spores.
ENDOSPORE, inside covering of a spore cell.
EPISPORE, outside of a spore cell.
FAVILLA, a single cell capsule holding many spores.
FAVILLIDIUM, a group of fertile cells or favilla.
GONOSPHERE, a globular cell, made reproductive by the piercing of an antheridium.
OCTOSPORE, an eight-spored cell.
OÖGONIUM, an ovary-like spore. "Resting-spore."
OÖSPORE, a fertilized spore.
OÖSPORANGIUM, a large kind of reproductive spore.
PROTOSPORES, tubes issuing from primary or apparent spores, bearing true spores.
PERITHECIUM, a cyst or capsule containing spore cases.
PYCNIDIUM, same as perithecium.
PSEUDOSPORES, spore-like bodies from which spores grow; spores that engender reproductive spores.
RESTING-SPORE, ovary-like spore; oögonium; "winter spore."
SPORE, a germ cell. The word has a varied and extensive meaning in its common use. It is applied to the fruiting

of cryptogamic plants in contradistinction to phænogamic seeds. Some cells contain a great many spores, and yet the cell itself is called a spore. In its primary sense it means a *seed*, whether applied to plants or animals. It is the cell, however large or small, however changed in form, or wherever found, that reproduces from a sowing.

SPERMOGONIA, cavities in Lichens and Fungi, containing—

SPEMATIA, granules within spores, without motile power.

SPORULE, generally in the sense of small spores.

SPORANGIUM, a case in which spores are formed, or body containing spores.

SPORIDIA, two or more germ cells in one case.

SPOROCYST, the spore case of Algeæ, and same as—

SPOROCARP, any spore case.

SPORIDIOLA, same as spermatia.

STYLOSPORES, spores on tips of threads enclosed in a perithecium.

SPERMATOZOID, the moving spore of an antheridium, analagous to the spermatozoa of animals.

TELEUTOSPORE, same as protospore.

TETRASPORE, a four-spored cell.

TRICHOSPORES, spores on slender threads, like conidia, but jointed, each cell producing zoöspores.

WINTER SPORES, spores that remain dormant for some time.

ZOÖSPORE, moving spore, like Infusoria. It has, at some period of its existence, ciliary appendages.

ZYGOSPORE, the conjunction of two cells forming a spore.

## THE OBLIQUE ILLUMINATOR; AN APPARATUS FOR OBTAINING OBLIQUE ILLUMINATION AT DEFINITE ANGLES.

BY J. J. WOODWARD, SURGEON AND BVT. LT. COL., U. S. A.

(*Received May 19th, 1879.*)

The radial arm for carrying the substage of the microscope, as made for some years in this country by Tolles, Bulloch and Zentmayer, and recently adopted in England by Ross & Co., affords a very satisfactory means of obtaining oblique illumination at known angles. I have, however, been unable to make use of this excellent device for the purposes of photo-micrography,

because it has, as yet, only been applied to instruments made on the Jackson model, and it has never been my good fortune to find one constructed on that plan, which was suitable for my work. The reason of this is twofold; first, because, when I use the objective alone (without eye-piece or amplifier) to project the image upon the screen, I frequently desire to remove the microscope body, leaving the objective in place, which cannot be done with stands constructed on the Jackson model; and second, because I have never yet met with a stand of that model in which, when the image was projected to a distance of nine or ten feet with a high power, the fine adjustment did not introduce an embarrassing degree of lateral displacement. I have, therefore, for some time, used a little piece of apparatus which enables me, on my large Powell and Lealand stand, or any similarly constructed instrument, to obtain with certainty any desired obliquity of illumination. It has been suggested to me that others, possessed of instruments of like pattern, would find it useful, and hence this brief memorandum.

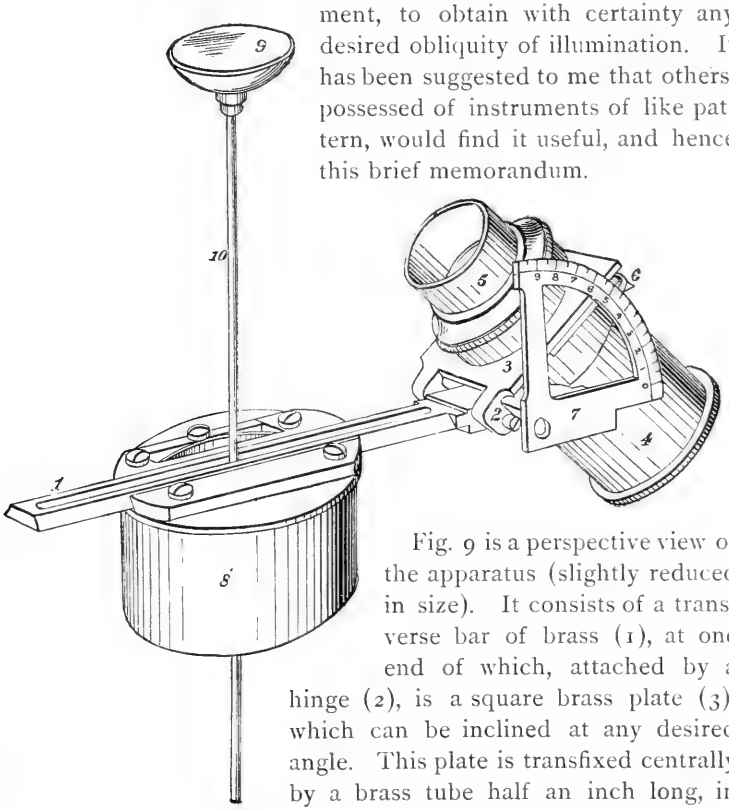



Fig. 9.

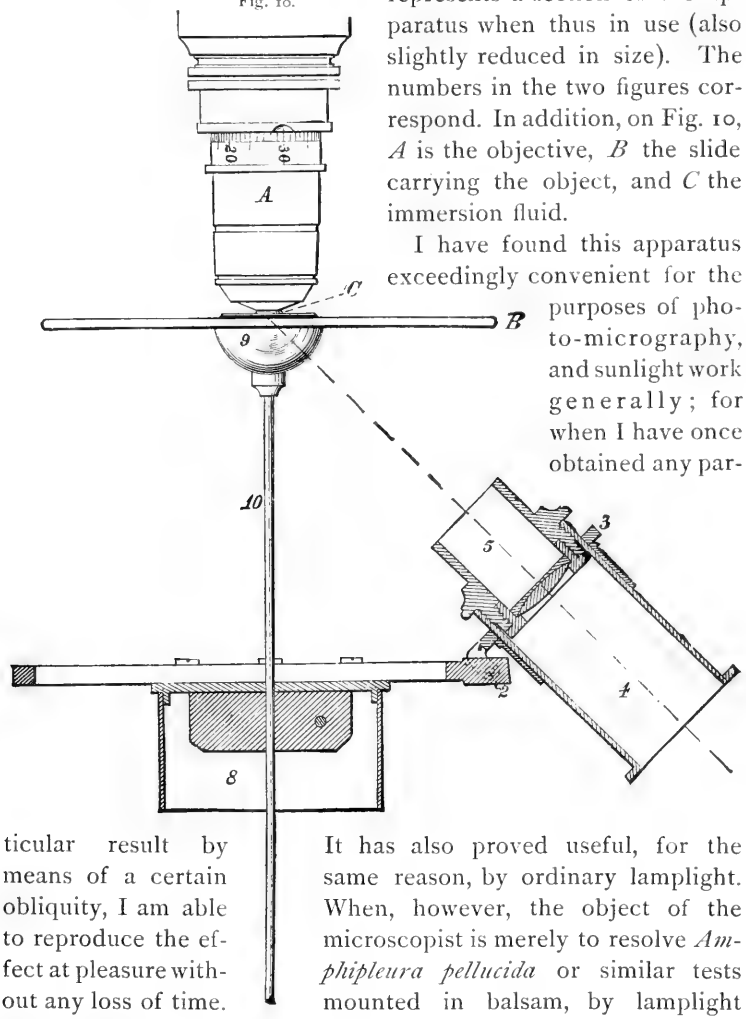
Fig. 9 is a perspective view of the apparatus (slightly reduced in size). It consists of a transverse bar of brass (1), at one end of which, attached by a hinge (2), is a square brass plate (3), which can be inclined at any desired angle. This plate is transfixed centrally by a brass tube half an inch long, in which a second tube (4) an inch and a

half long, slips easily. The slip-tube (4) is provided at one end with the Society's screw, by which a three inch objective (5), or any other preferred for the purpose, can be attached. The movable square plate is provided with a spring catch (6) which fits into any one of a series of notches in the edge of a brass quadrant (7), and thus serves both to hold the plate in position and to register the angle of obliquity. The transverse bar (1) slips in a groove on the upper surface of a strong brass tube (8) fitted to the substage of the microscope. The bar itself has a longitudinal slot running nearly its whole length, so that it can be pushed to any desired position without disturbing the position of a central steel rod (10) at the upper end of which a lens (9) is fastened. The lens (9) is such a segment of a hemisphere of crown-glass that, when brought into optical contact (by oil of cloves) with the under surface of an ordinary glass object-slip, the object to be studied will be as nearly as possible at its center of curvature; and the rod (10) slips freely in the top of the substage tube (8), so that the lens may be pushed into position or withdrawn at pleasure.

In using this apparatus with monochromatic sunlight, I first set the square brass-plate (3) at the desired angle, as read on the quadrant, and then slip the transverse bar (1) backwards or forwards, as may be necessary, until the pencil of monochromatic sunlight (to which the desired degree of obliquity has been previously given by means of a prism) falls centrally through the slip-tube (4) and illuminating objective (5) upon the face of the lens with which the object is viewed. By means of the slip-tube, the illuminating objective (5) is then brought to the proper focal position. Ordinary illumination is thus obtained, of any desired obliquity from about 30° to the limit of the thickness of the stage. When I desire still greater obliquity, I use Powell and Lealand's extra stage, and slip the transverse bar into the groove at the upper end of the holder which those makers provide with it to carry the small bull's-eye they furnish for the examination of *Amphipleura pellucida*. In this manner I can get more oblique illumination up to 80° or even 85°; but, of course, the oblique pencils thus obtained are refracted at the under surface of the glass slip that carries the object, and cannot possibly reach the object itself at an obliquity greater than 41°. To obtain greater obliquity than this, I make use of the hemispherical lens (9). The illuminating objective is set at the desired angle, say 45°, and the

object illuminated as described above. When this is satisfactorily done, a drop of oil of cloves is placed on the flat surface of the hemispherical lens, which is then pushed up into contact with the under surface of the slide on which the object is mounted. The light now enters in the line of a radius of the hemisphere, at the angle registered on the quadrant (7). Fig. 10 represents a section of the apparatus when thus in use (also slightly reduced in size). The numbers in the two figures correspond. In addition, on Fig. 10, *A* is the objective, *B* the slide carrying the object, and *C* the immersion fluid.

Fig. 10.




I have found this apparatus exceedingly convenient for the purposes of photo-micrography, and sunlight work generally; for when I have once obtained any particular result by means of a certain obliquity, I am able to reproduce the effect at pleasure without any loss of time. It has also proved useful, for the same reason, by ordinary lamplight. When, however, the object of the microscopist is merely to resolve *Amphipleura pellucida* or similar tests mounted in balsam, by lamplight with suitable objectives, I still give preference to the simple substage prism I described last year (see *Journal of the Royal*

*Microscopical Society*, November, 1878, p. 246), through which I can throw the light at once at an angle of 45° by means of the concave mirror or a small bull's-eye, and thus obtain for this particular purpose equally good effects, with less expenditure of time, in making the adjustments.

## DESCRIPTION OF A NEW APERTOMETER.

BY J. J. WOODWARD, SURGEON AND BVT. LT. COL., U. S. A.

(*Received June 4th, 1879.*)

The interesting paper of my friend, Professor H. L. Smith, accompanying a description of his "Universal Apertometer" (this journal, April, 1879, p. 194), suggests to me that your readers would probably be interested by a description of the instrument I have been using for some time for the same purpose. My apertometer is really a combination of the apertometer of Professor Abbe, of Jena, with the well-known sector, and has, I think, certain advantages over both the instrument of Abbe and the later device of Professor Smith.

Abbe's apertometer is essentially a modification of the instrument described and figured by Mr. R. B. Tolles, of Boston, in 1873. ("An Apparatus for obtaining the 'Balsam' Angle of any Objective." *Monthly Microscopical Journal*, Vol. IX., 1873, p. 212, and Plate XV., lower portion.) This apparatus consists of a semicylinder of crown-glass placed in front of the microscope objective, and the course of the most oblique rays, in this semicylinder, that can pass from it into the objective, or from the objective into it, is measured by means of a shutter, sliding on its convex surface. In practice, a thin glass cover is cemented with Canada balsam over the center of the flat surface of the semicylinder, and the objective is brought into optical contact with this by means of the immersion fluid. The flame of a candle occupies the position of the eye-piece of the microscope, and the light from this source, after passing through the tube of the microscope and the objective, diverges into the semicylinder in which the course of the extreme rays can be measured by means of the shutter. Or, with the same apparatus, if an eye-piece be used, and the objective focussed upon a diatom or other transparent object mounted beneath the thin glass cover, the course of the most oblique rays of light thrown through the semicylinder upon the diatom, with which

resolution is possible, can also be measured with the shutter, and gives, substantially, the same angular value as is obtained in the other way.

Now, Professor Abbe has made one modification in this apparatus which I certainly think is an improvement. He attaches an achromatic convex lens of suitable focal length to the draw-tube of the microscope, and slides it into the proper position to convert the microscope into a terrestrial telescope, by which erect (but quite small) images of distant objects are sharply defined. With this he looks through the central point of the flat surface of a semicylinder of crown-glass at surrounding objects, and measures, by two shutters or indices (which slip on the curved surface of the semicylinder), the extreme angular limits of the telescopic field. This represents, as in the case of the Tolles apparatus, the angle formed by the most oblique rays that can pass through the semicylinder of crown-glass and enter the objective; but it has the advantage that the reading is sharper, and no reasonable person can dispute that the rays thus measured are "image-forming," since it is precisely the position of the images formed that is measured.

But Professor Abbe has made two further modifications of the Tolles apparatus, the advantages of which are doubtful. In the first place he has cut away the surface that corresponds to the diameter of his semicylinder at an angle of 45°. The object of this was to enable the apparatus to be used on the stage of an ordinary microscope, placed vertically after the German fashion. This rendered it necessary to fix the point on the upper surface of the semicylinder, by a silvered cover glass, with a clear circular spot in its center, which should correspond to a path of the rays to the oblique surface, and thence by reflection upwards just equal to the radius of curvature. It is clear that an error in selecting this point will render the reading inaccurate, and I am in doubt whether the increased convenience in using the apparatus compensates for this; unless, indeed, one is to be content with readings which, on each side, may vary a degree or two from the true measurements.

In the second place, instead of dividing his semicylinder into degrees, and so reading at once the aperture in the crown-glass, Professor Abbe has graduated it into divisions corresponding to an arbitrary scale of his own invention; each number engraved on the glass representing the product of the

sine of half the aperture, observed when the shutter rests on that point, by the index of refraction of crown-glass. By this method a calculation, or the use of a specially constructed table, is always necessary to translate the reading into degrees, not merely to obtain the aperture in air or water, but also to obtain it in crown-glass, the medium through which it is actually measured. Moreover, the divisions of his arbitrary scale are so far apart that, for example, the distance from 1.10 to 1.15, the next higher division, corresponds to the difference between the half apertures 46° 3′ and 48° 56′, making a difference of 5° 46′ between the two apertures indicated, supposing the semicylinder to be made of crown-glass of an index of refraction of 1.525 ; and in the case of the higher readings of his scale the differences will be still greater. There is no means of measuring the intermediate points on his apparatus, they can only be estimated ; that is, guessed at. As a consequence, we have the strange anomaly offered in his paper (*op. cit.*, p. 21) of a balsam angle computed at ninety-four degrees and thirty minutes, from the reading of a scale the units of which are upwards of five degrees each. Moreover, even should

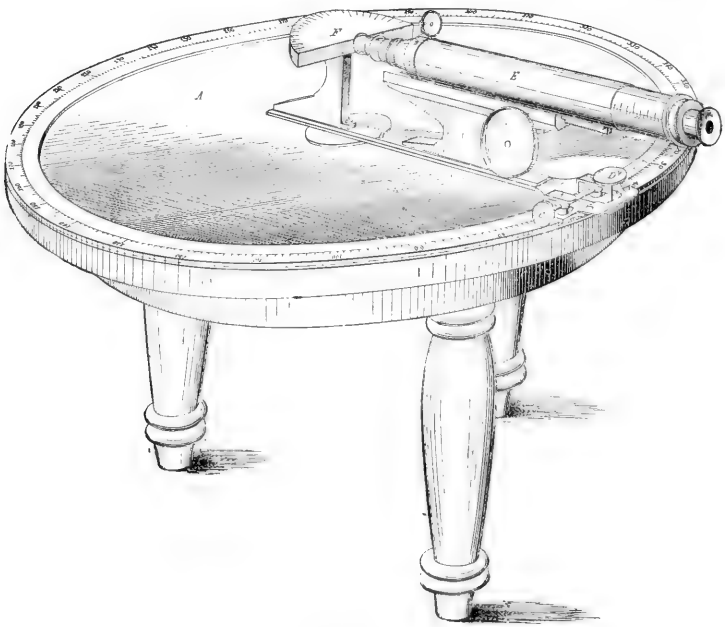


FIG. 11.

we accept these serious inconveniences, the microscopist who uses this apparatus has no convenient means of verifying the correctness of the scale as ruled by the maker, but must always accept it as correct.

These considerations induced me to modify, for my own use, the apparatus of Abbe, and I have accordingly constructed the instrument shown in Fig. 11.

*A* is a circular disc of brass of about 10 inches radius, inlaid near its circumference with a silver circle divided to sixths of a degree. It is mounted for convenience on a heavy three-legged stool of black walnut. I had this graduated disc made a full circle, because I intended to use it for another purpose also. Of course a graduated semicircle of the same size would have answered equally well. Into a hole in the center of this brass disc a pin is fitted on which swings the radial arm (*B*) which carries, on one side of the center of rotation, the body of a microscope (*E*), while its extremity is provided with a vernier, clamp (*D*) and tangent screw (*C*). On the other side of the central pin the radial arm carries a table, on which is mounted a semicircle of crown-glass (*F*) of about two inches radius and half an inch thick. This is so mounted that the edge, which corresponds to the diameter of the semicircle, is directly over the center of rotation, and the microscope objective can be focussed exactly upon the center of the semicircle. At this spot a thin glass cover, silvered except at a central circular hole (or vertical slit) about $\frac{1}{20}$ of an inch in diameter, is cemented with Canada balsam, the central hole (or slit) being fitted precisely over the center of the semicircle. A suitable achromatic convex lens (a four-inch objective answers very well) is screwed at the end of the draw-tube of the microscope body, and serves to convert it into a telescope, precisely as in the apparatus of Abbe; and, indeed, this apparatus can be used precisely like his. For this purpose I have had the semicircle engraved to degrees, and two shutters or indices provided, so that I can use it in this way when so disposed; but it is not in this manner that I prefer to employ it.

The particular method for which the apparatus was constructed, and by which exact measurements can be made, is as follows: Using the microscope as a telescope, I view some distant object so small that it only occupies an extremely minute portion of the field, and so bright that it can easily be discerned. For this purpose I prefer the slit of a spectroscope placed at

about ten feet distance and illuminated by monochromatic (blue) sunlight. This appears, when the adjustments are rightly made, as an extremely minute blue star in the center of the field. The radial arm is then swung until the star comes to the extreme margin of the field, the adjustment is made as exact as possible with the tangent screw, and the vernier read. The radial arm is then swung till the star comes to the opposite margin of the field, where the same process is repeated. The difference between the two readings is the aperture of the objective for any medium of the same index of refraction as the crown-glass semicircle employed. My apparatus reads to half-minutes, which is closer than is at all necessary, and, indeed, closer than the observations can be accurately made. In fact, after the star comes to the edge of the field it usually begins to fade just before it entirely disappears, and a motion of several minutes is necessary to effect the change. My plan is to adjust the instrument as exactly as possible at the point at which the star begins to fade, and then read to the next lowest sixth of a degree, neglecting the small fractional remainder. The same instrument answers very well to measure the glass angle corresponding to the actual air angle of dry objectives of any power; or, the semicircle of glass being removed, and the microscope still used as a telescope to view the blue illuminated slit, as before, air angles may be directly read with a degree of precision not attainable when the sector is used in the ordinary way.

From the angles of aperture measured in the semicircle of crown-glass, it is quite as easy to compute air angles, water angles, glycerin angles, balsam angles, *etc.*, as from the numerical scale of Abbe. It is only necessary to subtract the logarithm of the index of refraction of the rarer medium, in which the aperture is to be expressed, from that of the index of the glass semicircle, and to preserve the difference as a constant, for use whenever the aperture in the selected medium is to be computed from the angle observed with the semicircle. Then, to perform the computation, it will only be necessary to add this constant to the logarithmic sine of half the observed angle, and take from the table of logarithmic sines the angle corresponding to the sum, which will be half the angle required.

It will readily be understood that if the crown-glass semicircle of the apparatus is of precisely the same index of refraction as the crown-glass front of the objective, the rays of light passing into the objective from the semicircle will, after more or less

refraction, as they enter and leave the immersion fluid, resume in the crown-glass front precisely the same course they had in the semicircle. In this case, the angle measured in the semicircle would be precisely equal to the aperture of the pencil passing through the crown-glass front, and might be called the *first interior angle of aperture*, or briefly, the *interior aperture* of the objective. As this is the angle which, after all, determines the resolving power of the objective (provided its aberrations are properly corrected), I think it would be better hereafter to express the angle of objectives in degrees of interior aperture instead of speaking of air, water or balsam angles, or using the numerical scale of Abbe. This end will be obtained with sufficient exactness if the crown-glass semicircle has an index of refraction of 1.525. In this case, the angles read by the apparatus with each objective will be its interior aperture, and no computation will be necessary. But equally exact results can be obtained from a glass semicircle of higher or lower index, provided only its index of refraction is known ; in this case it is simply necessary to compute the corresponding angle in a medium of 1.525 from the observed angle, by the method already explained. I have ordered a semicircle of the desired index to be constructed for my own apparatus, but as it has not yet reached me, I am still using the one I originally had constructed from the first material that came to hand. This is a piece of dense crown-glass of the index 1.534, and, of course, all the observed angles must be correspondingly corrected.

The index of refraction of the glass semicircle may be exactly determined, in the ordinary way, by measuring the angular deviation produced by a prism cut from the same piece of glass. But in the absence of conveniences for this determination, it is one of the advantages of this apertometer that it affords the means of measuring the index of the glass semicircle with sufficient accuracy ; for, if the angle of any immersion objective that exceeds 90° of interior aperture be measured by it, and then the immersion fluid wiped away, and the angle measured with a very thin film of air between the front of the objective and the semicircle, the observed angle will be reduced to a figure which is constant for all objectives of the same or greater aperture, and which is independent of variations in the angles of such objectives, representing, in fact, double the angle of total reflection from the glass of the semicircle to air. If the sine of half this constant angle be divided

into unity, the quotient will be, of course, the index of refraction of the glass semicircle.

Provided the glass semicircle is nicely centered, the silvering of the glass cover, which prevents vision from taking place except through the small hole or slit directly over the center of the semicircle, would be unnecessary with the highest powers; for the diameter of the circular spot through which rays can pass into the objective is so small, as compared with the diameter of the semicircle, that the greatest possible chance of error from this source will be very small indeed. But with dry lenses of low power, this is not the case; the greater the transverse diameter of the objective, the more readily would those rays enter it, which, having passed through the semicircle, but not through its center, would indicate a greater aperture than the objective actually possessed. This is, I suppose, the source of the erroneous readings which Professor Smith obtained (*loc. cit.* p. 203) when he attempted to use his apparatus after the method of Abbe with low-power objectives. He did not use the opaque cover with a small central hole, which is indispensable in this case. On the other hand, his apparatus gave substantially the same results with high-power objectives, whether used after Abbe's method or his own, and for reasons obvious, I trust, from the above remarks.

I append a list of the angles of several objectives, as actually measured by my apparatus in the crown-glass semicircle of 1.534 index, together with the corresponding angles computed for an index of 1.5, the so-called "balsam angle," and for an index of 1.525, which will be what I propose to call the "interior angle."

| NAME OF OBJECTIVE. | Angle measured in medium with an index of 1.534. | "Balsam angle," or angle in a medium with index of 1.5. | "Interior aperture," or angle in a medium with index of 1.525. |
|---|---|---|---|
| $\frac{1}{8}$ in. oil immersion by Zeiss, . . . | 111° 10′ | 115° 2′ | 112° 8′ |
| $\frac{1}{12}$ " " " " " . . . | 110° 20′ | 114° 8′ | 111° 18′ |
| $\frac{1}{10}$ " " " " Tolles, . . . | 118° 20′ | 122° 50′ | 119° 28′ |
| $\frac{1}{18}$ " water " " " . . . | 89° 10′ | 91° 44′ | 89° 50′ |
| $\frac{1}{10}$ " glycerin im. " Spencer, . . . | 102° 20′ | 105° 36′ | 103° 10′ |
| $\frac{1}{8}$ " water im. by Powell & Lealand, | 101° 50′ | 105° 4′ | 102° 40′ |
| $\frac{1}{16}$ " " " " " " | 100° 10′ | 103° 18′ | 100° 58′ |
| $\frac{1}{25}$ " " " " " " | 89° 00′ | 91° 34′ | 89° 40′ |

To illustrate the performance of these objectives, I send herewith photographs, by each, of a frustule of *Amphipleura pellucida*,

mounted in Canada balsam. It is a finely marked specimen with 102 striæ to the thousandth of an inch. The magnifying powers were intended to be made approximately equal, but in fact vary from 2700 to 2830 diameters. I have also added a photograph of the same frustule by a Spencer glycerin immersion $\frac{1}{6}$ inch, magnified 1900 diameters, and an enlargement from this negative to 2760 diameters. The angle of this objective was not determined in my new apertometer, but measured in another way 106°, in a medium of 1.5 index. The pictures, numbered from 1 to 11, were all taken with the illuminating pencil inclined but 45° to the optical axis of the microscope, and without any immersion substage contrivance. They open a number of questions which I will discuss elsewhere. I will only call attention here to the fact that while, in a general way, they show the superiority of glycerin and oil over water immersion objectives, the great superiority of the performance of the glycerin objectives over water objectives of very nearly the same aperture, indicates that other advantages are possessed by the denser immersion media besides the mere possibility of increased angle. The nature of these advantages has been correctly discussed by Professor Abbe (see *Journal of the Royal Microscopical Society*, May, 1879, p. 256), in the case of the oil objectives, and the glycerin objectives share them, though not to the same degree.

I have added to the series two photographs, numbered 12 and 13, taken by the Zeiss oil $\frac{1}{12}$ inch and the Tolles oil $\frac{1}{10}$ inch, with the greatest obliquity in the illuminating pencil that could be given by means of an immersion illuminator, and in each case without distorting the image. A comparison of these pictures with those of the same frustule, taken with the same objectives and with the obliquity used in the other pictures, will serve to indicate that with monochromatic sunlight the greatest possible obliquity in the illuminating pencil is, by no means, essential to secure the advantages resulting from excessive aperture. I will elsewhere take occasion to discuss the meaning of this phenomenon and its relations to lamplight illumination. Finally, I send another photograph of an exceedingly delicate frustule of *Amphipleura pellucida*, mounted dry, by the Zeiss $\frac{1}{12}$ inch, to illustrate the superb performance of objectives of great angle on dry objects also, provided these are adherent to the covering glass. This frustule has 105 striæ to the thousandth of an inch, and is magnified 3400 diameters.

## ON PROFESSOR H. L. SMITH'S APERTOMETER.

BY F. H. WENHAM.

(*Received June 4th, 1879.*)

I have read with much interest Professor Smith's paper on "Angular Aperture, and an Universal Apertometer," published in the last number of the AMERICAN QUARTERLY MICROSCOPICAL JOURNAL. The essay contains the most practical series of experiments yet made, with results that must lead to a more correct knowledge of the meaning of angular aperture, and to a sure method of measuring it. After perusing Professor Smith's paper, any one must be convinced that he is unbiassed and free from prejudice.

I admire Professor Smith's courage in taking up a subject that may give rise to acrimonious strictures, and which has been announced as "finally decided" by some who have complacently agreed amongst themselves upon a verdict that mine is a "lost cause," forgetting that up to the present time we have possessed no instrument for measuring aperture satisfactorily, or with sufficient accuracy to enable us to finally decide the question.

Professor Abbe's apertometer is held by some as the only one to be relied upon, but with it we take the angle of field instead of the angle of aperture, for the outermost rays that extend to the margin of the field render the index pointers visible through the glass of this instrument, precisely as they would two diatoms or other objects at the edges of the field of view, when mounted in balsam. I have tested this apertometer; using the intermediate or examining lens supplied with it according to instructions. I measured a very fine recent oil-immersion $\frac{1}{8}$ inch by Zeiss, professing to have a balsam angle of 113°: with a short microscope body and the A eye-piece, the indices may be seen at that angle in glass; with the B eye-piece the indices will be out of range, invisible at that angle; with the C eye-piece, 90° is indicated on the inner scale, on which are degrees for air angles only; with the D eye-piece the air angle is 65°; with the E it is 45°, and with the F it is the absurd angle of 35° only, in air. With such enormous discrepancies, no reliance can be placed upon the instrument, which I consider useless for measuring apertures, as it gives a different result for every length of body and for each eye-piece, and with the varying diameter of the stops by which the extent of the field of view is determined.

Professor Smith's conclusions are based upon the following facts :

1. That the front lenses of microscope object glasses only admit incident rays through a central area, far within their actual diameter.

2. That angle of aperture strictly means the angle measured by a triangle taken from the extremities of the diameter of this light spot as a base line, up to the focal distance in the axis, whether that distance is in air, water, or glass, with the difference of angle due to the refraction of each.

3. That rays extending laterally from places without the central focal point, do not constitute a proper angle of aperture, but cover an area known as field of view.

4. That rays from every part of the field of view pass through every portion of the transmitting diameter of the front-lens, and, together, enter the pupil of the eye from the eye-piece.

5. That, in the optical methods of measuring angles of aperture heretofore in use, rays from the light, or index points, have traversed and intersected all these exterior rays or oblique angles, in succession, to the limit of the field of view, which has been erroneously assigned as angle of aperture.

We appear to be in agreement upon these five conditions. I venture, however, to offer a few remarks for Professor Smith's consideration. I have formed a high opinion of the utility of his apertometer, as it can be used in the same manner, but with better defining effect than Professor Abbe's for distant objects ; but it has the much greater advantage of possessing an examining microscope rotating about the center of a sector in the focus of the object glass, which may traverse the whole of the rays in succession, and ascertain their direction from the focal point up to the transmitting diameter of the front lens, enabling us to discriminate between the rays converging to the focus and those surrounding it, so that they may not be included in the measurement.

I have one of Professor Smith's apertometers constructed in accordance with his description. For a stand I utilized a sturdy little microscope with a swing tail-piece, made by Zentmayer, and sent over here as a model. The only addition needed was a divided sector, or protractor, attached to the lower limb, so that the degree of inclination of the tail-piece could be easily read. The center of rotation coincided with the upper portion of the glass slide. The fine motion of the microscope enabled the lines to be focussed

nicely by the object glass of which the angle was to be measured, and the substage, fitting in the tail-piece, held the examining microscope. In arrangement and use this instrument is the same as Professor Smith's. I will, however, call his attention to the following experiments, not as indicating any defect in the principle, which I consider to be quite correct, but in the mode of use, which I submit may be the cause of error in the measurement.

In order to well define the transmitting diameter, or boundary of the light spot, on the front of the glass, Professor Smith applies a piece of tissue paper or ground glass to the open end of the object glass tube. This gives results in excess of truth, which may be attributed to the diameter of the screen. Instead of following this course, set a lamp a few feet away, exactly in the axis of the object glass, and focus the microscope on the index line; the flame of the lamp will be beautifully in focus at the same time, showing that the examining microscope does not in the least alter the focal distance of the object glass under test. On traversing the lower microscope sideways, the flame appears curiously projected, as if it were actually strung on to the lines ruled on the glass. At an obliquity greater or less, according to the aperture of the objective, the flame shows a tendency to leave the line before it vanishes. Now, with the flame this limit gives a result less than when the ground glass is used. The former, I opine, is therefore the limit of aperture. The ground glass does not increase the transmitting diameter of the front, which remains the same under all circumstances; but it allows oblique rays from a screen or field of view to pass through. The lamp flame is distant and in one fixed, axial, focal point. As the image of the flame and the ruled line are kept in the direction of the axis of the examining microscope, the angular traverse of the line of this axis must indicate the true aperture. Perhaps Professor Smith will kindly investigate this question.

The old sector is now considered almost obsolete for the measurement of large apertures, for when we come to near 180° its utility ceases. Immersion angles, either in water or glass, must then be resorted to, as 180° is thus refracted to within a sector of 82°, for, though 180° may not yet have been reached for any central angle, it is desirable to bring these exterior angles into view, in order that we may distinguish and separate them from the true one.

For the correct measurement of the angle of an object glass it is advisable to effect this without the addition of any eye-piece or

posterior lens additions, as these give rise to endless confusion and disagreement. Professor Smith does dispense with them altogether in his apertometer.

## MEASURING APERTURE.

A LETTER FROM MR. JOHN MAYALL, JR.

(*Received June 6th, 1879.*)

Prof. H. L. Smith, in his communication on "Angular Aperture, &c.," in your issue of April, alludes to an experiment with an objective, a ⅛ inch of Spencer, made when the systems were closed and a spot of ink placed on the flat surface of the front lens, just large enough to cut off the little circle of light that appears when one looks into the objective, with the front system toward the eye. Under these circumstances he was still able to see light by swinging the sector arm up to 179°. I fail to see the value of this experiment, and when further on I find Prof. Smith says that the "true air angle at the same closed point, measured by the angle of the triangle whose apex is the focal point, and whose base is the diameter of the spot of ink which just stopped out the light, is only 144°," I am forced to the conclusion that he has not, in this instance, been seriously attempting to measure aperture.

It being admitted that no aperture, properly speaking, can be measured unless the image of a point be rendered, approximately at least, as a point; does Prof. Smith mean to say that when the system of lenses is closed he can measure the true air angle? My experience with immersion lenses of high angle, is that when the system is closed, so as to get definition through the thickest cover-glass and the immersion medium, at that adjustment no true air angle can be obtained. The true air angle can only be actually measured when the objective is adjusted so as to give true focus in air, a focus sensibly free from aberration.

With regard to Prof. Smith's suggestion for a universal apertometer, in so far as the appliance is adapted to immersion lenses, it appears to me that Mr. Tolles's traverse-lens is practically the same thing; bull's-eye, sector, and eye-lens in sliding tube.

Prof. Smith finds his results corroborated for wide angles by Abbe's apertometer, saying "the agreement between the two

methods is as close as could be desired." I have also found Abbe's apertometer supported by Tolles's traverse-lens in measuring apertures.

224 REGENT STREET,
LONDON, May 27, 1879.

## APERTURE, ANGULAR AND NUMERICAL.

BY R. HITCHCOCK.

Within the past twelve months the attention of microscopists has been directed to great improvements in objectives and the methods of using them. The subject of angular aperture has also taken a new phase, and its discussion has been characterized by careful consideration of the points involved; consequently, all are gradually, but certainly, reaching the same conclusions. The differences of opinion which still exist relate only to minor points, which experiments will soon decide, when a full and rational explanation of the subject can be given. This seems to be an appropriate time, therefore, to direct attention to the most prominent results of recent observations.

There is no longer any misunderstanding of the proper meaning of the expressions balsam angle and air angle. The term 180° is no longer used, as it once was, and blindly accepted by a few in its literal sense. It is used by Prof. Abbe, but always as expressing a theoretical limit; and in this sense is, indeed, a useful and necessary term. Far different was its meaning when Mr. Tolles attempted to prove not only that it was possible to realize this angle in practice, but one even greater, which was designated + 180°. We mention Mr. Tolles because he is responsible for much of the confusion which has surrounded this subject. In this case, as in many others, positive assertion has often obtained the advantage over sound reasoning. In order to avoid confusion, it seems desirable to explain the application of the terms to those who are not perfectly familiar with the distinction between air and balsam angles.

The balsam angle of a dry objective is an expression liable to mislead, for balsam angle, glass angle and angle in fluid are generally employed—although inaccurately—as synonyms, and refer properly to the angle of light which enters the front lens of the objective. To say that the balsam angle of a dry lens is 77.5°,

means that a cone of rays, issuing from the objective at an angle of 144°, is contracted when it enters the slide to an angle of 77.5° (Pl. XVII., Fig. 11). The balsam angle of a dry objective is the extreme angle at which the illuminating ray strikes the object mounted in balsam, and is transmitted to the objective. This angle is limited by the critical angle, and cannot be greater than about 82°. Owing to the fact that the full cone of rays passed by a dry objective cannot be measured directly through glass, we are obliged to determine the reduced angle and calculate the air angle from this.

It appears from the experiments of Prof. Smith (this journal, page 203), that the highest air angle we have is not much above 163°. Mr. Mayall, in his communication to the present number, has made a very just stricture upon the tendency to apply the terms air angle and balsam angle indiscriminately to dry and immersion objectives, without reference to the necessary conditions of perfect definition. It is useless to express the air angle of an objective that works only as an immersion. When the combination is closed there is no air angle. If, however, it is desirable to calculate the air angle corresponding mathematically to a certain immersion aperture, it can be done by means of the equation:

$$sin.\ w \times n = sin.\ \tfrac{1}{2}\ \text{air angle};$$

$w$ being the semi-aperture in glass and $n$ the refractive index.

We think Prof. Smith's demonstration on page 196, is liable to mislead. It is assumed that 82° in balsam corresponds to 180° in air; but Prof. Smith shows that an objective of only 144° in air can "pass" 87° in balsam. We have to regard practical conditions of work, and must not only follow the rays without the objective, but also their course within it. In Prof. Smith's example, the angles given do not correspond to the same excellence of definition in the two cases. As regards immersion objectives, it is possible to increase the aperture far beyond 82°, for the upper surface of the cover is, optically, abolished, and the incident light passes in direct lines to the objective.

As Prof. Abbe's apertometer is an instrument that is bound to have extensive application, and has not yet been fully described in this country, the following account may prove acceptable: It consists of a semicircular disc of crown-glass of $45^{mm.}$ radius and $12^{mm.}$ thick; the back is beveled, along the diameter, to an angle of 45°, so that when the glass lies horizontal, a beam of light entering the curved edge, strikes the back surface and is reflected

vertically. At the center of the semicircle, on the face of the disc, a silvered coverglass is cemented, having a clear, central hole. On the upper face are two engraved scales; the inner one indicating air angle; the outer one numerical aperture. To use the instrument, the microscope is placed upright, and the apertometer laid upon the stage with the clear spot of the cover glass in focus. The measurement of the angle is made by moving two index points, which slide along the curved edge, until their images are seen at the margins of the field of view. The angle is then read off from the graduations. An examining lens, furnished with the instrument, may be used in this operation, and is necessary with high powers.

The numerical aperture depends upon the index of refraction of the medium and the semi-angular aperture of the objective. If we designate the index of refraction by $n$, the semi-angular aperture, determined by experiment, as $w$, while $a$ represents numerical aperture, then $a = n \cdot sin.\ w$ and $sin.\ w = \frac{a}{n}$. For water $n = 1.33$; for balsam, $n = 1.50$. For three objectives, having respectively numerical apertures 1.00, 1.10 and 1.25, as read directly from the apertometer of Abbe, the angular apertures are therefore:

$\frac{1.00}{1.33} = sin.\ w = 48^\circ\ 45'$ and $2\ w = 97^\circ\ 30'$

$\frac{1.10}{1.33} = sin.\ w = 55^\circ\ 45'$ and $2\ w = 111^\circ\ 30'$

$\frac{1.25}{1.50} = sin.\ w = 56^\circ\ 30'$ and $2\ w = 113^\circ$

The first two are water angles; the last is for cedar oil.

The full value of numerical aperture does not appear to be generally understood. Its application is far more general and scientific than angular aperture or "interior angle." The former will vary with every change in the immersion fluid; the numerical aperture is constant. Prof. Abbe says:* "But since the 'numerical' equivalent of the angular aperture (the measure which determines the number of rays taken in by the objective) is proportional not only to the sine of half the angle of aperture, but also to the refractive indices of the respective media employed, and since all the functions of the angle of aperture, and especially the resolving power of the microscope, are regulated by this numerical equivalent, it follows that, according to theory, the capacity of the new objective, compared with that of ordinary immersion lenses, is increased in the proportion of 1.50 to 1.33, and, as compared with the highest dry objectives, as 1.50 to 1." The ratio

* *Journal of the Royal Microscopical Society.*

of the numerical aperture to 1 " expresses how much greater is the number of rays admitted by the new objectives, over that number which *in air* would fill a complete hemisphere, or which would be admitted by an imaginary dry objective of 180° aperture."

The power of resolution, by strictly central illumination, is expressed by $D=\frac{\lambda}{sin.\ w}$; in which D=the distance between the lines of a finely marked object and $\lambda$ = the wave-length of the light.

The comparison of the resolving power of dry and immersion lenses, or objectives working in any way, may be made by the equation: $D:D'=\frac{\lambda}{sin.\ w}:\frac{\lambda}{sin.\ w'}=sin.\ w' : sin.\ w$ for central light, or when the same immersion fluid is used, $n$ being the same in the two cases, $D:D'=a':a$.

The slightly oblique rays which come from the mirror in its axial position, render this comparison not strictly correct for ordinary conditions of work.

## THE STRUCTURE OF THE TONGUE OF THE HONEY-BEE.

BY J. D. HYATT, PRESIDENT N. Y. MICROSCOPICAL SOCIETY.

(*Received June 23d, 1879.*)

A careful examination of the so-called tongue, or lingua, of the honey-bee, coupled with a study of the literature relating to the subject, will serve to impress the reader with the fact that no substantial progress can be made in adding to our store of knowledge, unless our conclusions are drawn from what we observe, and are not influenced by the diction of authority. As in the present instance, it often happens that opinions, which have held their sway for years over those whose ability as competent observers is not to be questioned, can be traced back to their origin in careless work or mere suppositions.

A comparison of the tongue itself with the descriptions given in the works of the most celebrated entomologists and microscopists, will afford a more curious instance of disagreement among doctors, on the one hand, and implicit reliance upon authority, on the other, than can be found outside the limits of theological discussion.

It might naturally be supposed that the honey-bee would be better known and understood, as regards habits and the structure of its parts, than any other insect, on account of its economic value and the consequent attention it has received from early ages; and that, at the present time, an organ so important as the tongue, by means of which a valuable commercial product is secured, would be thoroughly understood as to its anatomical arrangement. Certainly a knowledge of the manner in which bees obtain their food, and the kind of material best adapted to their needs, should no longer admit of conjecture.

The latest contribution to this subject is from Mr. V. T. Chambers, who has published the results of some examinations in the *Journal of the Cincinnati Society of Natural History*, under the title: "On the Tongue (Lingua) of some Hymenoptera."

My own observations have led me to conclusions somewhat at variance with those reached by Mr. Chambers, and, as I believe my method of cutting and examining the sections is superior to the one employed by the above writer, I have no hesitation in saying that his drawing does not show the true structure of the organ. In the course of my investigations I have been led to think that the relations of the tongue to the other mouth organs, or to the mouth itself, and the œsophagus, would well repay careful study. This, however, will afford a subject for further examination at another time. The present paper will be confined strictly to the consideration of the so-called tongue itself.

By way of introducing the views of former writers, I cannot do better than to quote some passages from Mr. Chambers' valuable contribution, as he has made himself familiar with the literature of the subject.

He writes as follows: "Dr. Carpenter—than whom no higher authority in Microscopy is recognized, states that the tongue is a muscular organ, though Reaumer has long before stated that it does not contain a single muscle, being operated by the muscles of the mentum to which it is in part attached, and by its own elasticity; Cuvier also calls it membraneous and not muscular; Hogg (*Microscope*), says that it is cylindrical; Kirby and Spence say that it is flat; while Reaumer shows correctly that it is neither exactly, but is something between the two; Cuvier states that the larvæ of bees feed on honey and the fecundated farina of flowers, and that the perfect insect likewise subsists on honey." * * * *

"Savigny seems to be regarded as the first who denied that the

tongue was a sucking tube. * * * There can, however, be little doubt that he regarded the aperture under the labium as the opening through which food passed to the œsophagus."

"Newport states that 'the maxillæ and labium are the only organs of the *Apidæ* employed in feeding;' that 'in the true *Apidæ*, which subsist entirely upon honey, they (the maxillæ) are drawn out to a great length, and with the labium beneath form a tube through which the aliment is conveyed to the mouth, as in the hive and humble bees;' also that 'when the maxillæ are extended to form a sucking tube with the labium, they are a little separated at their base, and inclose between them the cavity of the mouth, within which is a soft fleshy body, the lingua, or true tongue, situated anterior to and serving as a valve to the pharynx.' Again, he states that the labium 'is the part employed in gathering honey. In *Apis*, *Bombus*, and *Anthophora*, it is a long, tapering and muscular organ, formed of an immense number of short annular divisions, and densely covered throughout its whole length with long erectile hairs. It is not tubular, but is solid;' also, that 'the manner in which the honey is obtained, when the organ (labium) is plunged into it at the bottom of the flower, is by lapping or a constant succession of short and quick extensions and contractions of the organ, which occasions the fluid to be accumulated upon it, and ascend along its upper surface' (why not its under surface too?) 'until it reaches the orifice of the tube formed by the approximation of the maxillæ above, and the labial palpi and this part of the ligula below. At each contraction a part of the extended ligula is drawn within the orifice of the tube, and the honey with which it is covered ascends into the cavity of the mouth, assisted in its removal from the surface of the ligula by the little bunch of hairs with which the elongated second joint of each labial palpus is furnished. From the mouth the honey is passed on through the pharynx into the œsophagus, by a simple act of deglutition as in other animals.'"

"Burmeister, on the other hand, states that the tongue is a pierced sucking instrument, and that the office of the so-called sucking or honey stomach is simply to become inflated as a receptacle for the air which is drawn back out of the tube in the act of sucking. On the other hand again, Kirby and Spence, Dr. Carpenter, Shuckard and many others, state just as positively that the tongue is not pierced at all, and that the insect does not feed by suction. Reaumur, while admitting that it seems to be pierced,

gives his reasons (derived from observing bees eat syrup on a glass, and other observations, not from dissections) for concluding that it is not pierced, and states that if it is pierced the aperture must be too small for use as a sucking tube. Previous to these observations, Reaumur, following Swammerdam, had believed that bees fed by suction through the tongue. After that he and Shuckard also believed that the nectar arose along the outer surface of the tube through the hairs with which it is clothed, after having just been lapped up by its terminal portion, until it reached 'a sort of tube,' formed by closing the labial palpi paraglossæ and maxillæ around the tongue. Kirby and Spence proposed to call the Hymenoptera, Lappers, from their mode of feeding, as distinguished from suctorial and mandibulate insects."

The views of these authors * seem to have been generally accepted by all subsequent writers without further investigation. The *Encyclopædia Britannica*, new edition, which may be supposed to embody the latest and most authentic information on the subject, states : " For the purpose of taking up fluids, bees are provided, in common with all hymenopterous insects, with a long and flexible proboscis or trunk, which may be considered as a lengthened tongue, though, strictly speaking, it is formed by a prolongation of the under lip. *It is not tubular*, as Swammerdam had supposed, but *solid* throughout; and the minute depression at its extremity *is not the aperture of any canal* through which liquids can be absorbed. The trunk of the bee performs strictly the office of a tongue, and not that of a tube for suction; for when it takes up honey or any other fluid aliment, the under or the upper surfaces are more immediately applied to it, and rolled from side to side, and the bee thus *licks* up what adheres to it." Reaumur, Savigny, Newport, Kirby and Spence, Carpenter, Huxley, and Hunter in the *Encyclopædia Britannica*, seem to have adopted, substantially, this view of the structure and use of the tongue ; and certainly Mr. Chambers is entitled to no little credit for his hardihood in venturing to question the conclusions of so many eminent authorities.

The mouth-organs of the bee are extremely complex, consisting of a number of pieces adapted to collecting either solid or liquid food, and also to building and filling the waxen cells ; the only one of these organs respecting the structure and use of which there is any disagreement, is the piece variously termed lingua,

* Kirby & Spence, An Introduction to Entomology, 1828.

labium, lower lip, tongue, trunk, *etc.*; and the main question is whether this tongue is a solid lapping organ or a tubular one adapted to sucking fluids. Mr. Chambers describes it as consisting of three parts; a solid, colorless, tubular rod, termed by some authors the true tongue, enclosed by a hairy sheath, within which, on each side of the rod, as shown in his drawing of a transverse section, is what he calls the "membranous sack."

The colorless rod or tube is represented in his figure as somewhat triangular in shape, but with its lower angle rounded; just within this angle is the circular canal which extends through the entire length of the rod. Within this tube Mr. Chambers describes a "thin partition of fine hairs," but he is not "fully convinced that this is the true interpretation of that which certainly is seen." Mr. Chambers is decidedly of the opinion that the tongue of the bee is a sucking organ.

The reader is now sufficiently acquainted with the present state of our knowledge of this subject; I will therefore proceed to give the conclusions which I have reached from my examinations, and describe the methods employed so that the reliability of these results, which are somewhat at variance from any heretofore given, may be estimated.

It seemed to me that the only reliable method of determining the structure of the tongue would be to obtain extremely thin transverse sections along its entire length, which might be examined with any desirable power of the microscope; but the obstacle which presented itself was the compound nature of the organ, ordinary methods of cutting which, resulted in distortion and displacement of the parts in the section to such an extent as to render these processes quite unreliable. I therefore resorted to the device of imbedding the organ in a transparent cement, by means of which I could readily cut sections along the entire length and not exceeding one five-hundredth of an inch in thickness, leaving the parts cut through in their normal shape and relative position for examination. A great advantage of this method is that any desired number of sections can be made in a few minutes, a comparison of which will eliminate all possibility of error in interpretation.

The appearance of the tongue of the bee from the bifurcation of the maxillary palpi to the apex, omitting the other appendages, is shown in Plate XX., Fig. 1. It consists of the hairy sheath, or labium, which is chitinous but quite flexible, having a slit along the

inferior side, reaching to within about one fourth of its length from the apex. This sheath is densely clothed with hairs, regularly disposed in transverse rows; these hairs being short and triangular in shape near the base of the organ, long and spiny about the middle, smaller and more flexible near the apex.

Enclosed within the hairy sheath, but not attached to it except near the apex, is the colorless rod (*b*); this can readily be withdrawn from the open side of the sheath, as shown in Fig. 1.

The proboscis terminates in a hollow cone, or funnel, which serves, no doubt, as a sucking disc.

The colorless rod is membranous and extremely elastic, and may be greatly expanded by slight pressure, or distended by its contents, and probably, when seen in one of these conditions, has received from some authors the name of "membranous sack."

In the examination of several hundred sections, I have not found any structure that agrees with the description of the "membranous sack."

The rod is *not tubular* as described by Mr. Chambers, but has a *deep groove* on the lower side (Fig. 3), and this groove, being closed by the infolded edges of the hairy sheath, gives it the appearance of a circular canal, as shown at *e*, Fig. 2.

At the back of the rod is a thick layer of muscle (Fig. 3, *b*), which serves to enlarge or contract the canal (*e*), thus making the tongue a sucking organ; for no doubt the canal can be entirely closed or greatly distended by this powerful muscle.

The unaccountable presence of hairs in the canal (*e*), observed by Mr. Chambers, will be readily understood by reference to Fig. 2, in which they are seen projecting into it from the edges of the sheath.

## DESCRIPTION OF PLATE XX.

The same letters designate corresponding parts in all the figures.

Fig. 1. The bee's tongue; showing the slit on the inferior side of the sheath, with the colorless rod partly withdrawn.

*a*. Hairy sheath.

*b*. Colorless rod.

*c*. Hollow cone.

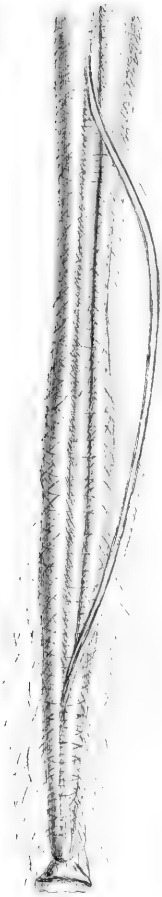
Fig. 2. Transverse section across the middle of the tongue. × 300.

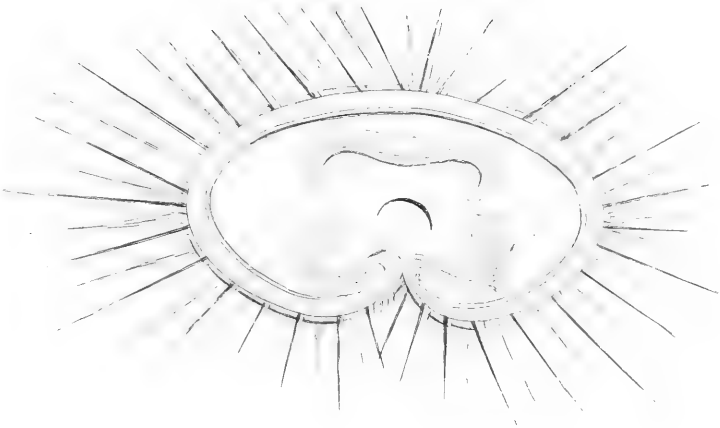
*e*. Groove in the colorless rod.

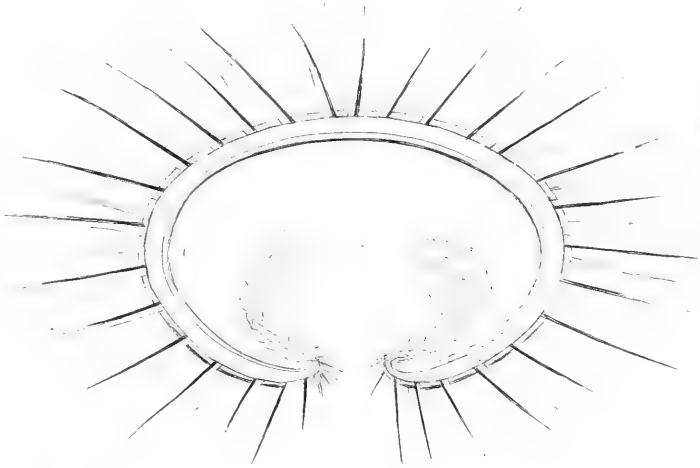
*f*. Curved ends of the folded edges of the sheath.

Fig. 3. Section of the colorless rod with attached muscle (*b*).

Fig. 4. Hairy sheath showing the manner in which the edges are folded.







When a section of the rod is removed from the hairy sheath, it will present the form shown in Fig. 3; but this form varies somewhat in different parts of the rod, being nearly square in outline near the apex, while the walls decrease in thickness with a corresponding increase in the size of the groove (*e*) towards the base.

By reference to Fig. 2, which represents a transverse section of the tongue near the middle of its length, it will be seen that the two folded edges of the sheath which meet in front of the open groove of the rod, are pressed closely back upon themselves, the ends (*f*), which are covered with fine colorless hairs, recurving gracefully over on each side. This folding and recurving will be better understood by reference to Fig. 4, in which the folded edges are shown slightly separated, the colorless rod being removed. The space occupied by these curved ends, Mr. Chambers represents as entirely vacant, whilst those spaces really vacant on each side of the rod, he represents as filled with the "membranous sack."

The figures in the plate are drawn with the aid of the camera, precisely as seen under the microscope; Fig. 2 being enlarged 300 diameters. The canal (*e*) is therefore about $\frac{1}{1000}$ of an inch in diameter.

Concerning the food of bees and the precise manner in which solid and fluid aliments are conveyed to the œsophagus, I will only add that my conclusions as to the structure of the tongue prove that the inferences of those who have supposed it to be a "solid lapping organ" are far from right, and on the other hand the evidence is equally explicit in showing that neither the rod nor the hairy sheath is a tube. Taken together, however, they not only form a tube, but an elastic, muscular sucking instrument, in every way adapted to the purpose of imbibing fluids.

It is not a little curious that the two parts which make this tube are so entirely different in form from the two half-cylinders forming the proboscis of lepidopterous insects; but the unity of plan in the two cases is very apparent.

Undoubtedly much yet remains to be learned respecting the anatomy, not only of the bee, but of many other insects. More important results, however, are to be expected from new methods of examination than from any amount of perseverance in those heretofore pursued.

## OLEOMARGARINE AND BUTTER.

BY THOMAS TAYLOR.

(*Received July 2d, 1879.*)

In making investigations with the view of distinguishing oleomargarine from butter, I submit the specimens to the following tests: 1. Specimens of each are placed on glass slides, and subjected to a uniform heat on a marble slab. The oleomargarine will melt first. Oleomargarine as manufactured and sold contains a large amount of fatty, star-like crystals and very small dark-brown, nitrogenous bodies, varying in size from one to two thousandths of an inch. The star-shaped crystals vary in diameter from two to five thousandths of an inch. If oleomargarine is boiled and rapidly cooled by the use of ice-water, a solid portion will form at the bottom of the vessel containing it, while an oily portion will remain above. The latter, when viewed under the microscope, with powers of from one to three hundred diameters, will appear like pure, unboiled butter. No fatty crystals will be seen. The only indications of oleomargarine will be the presence of the few dark-brown, nitrogenous bodies which are always present in more or less abundance in oleomargarine. The solid portions of the boiled oleomargarine tested in the same way will reveal a mass of stellate and feathery crystals, covering the entire field. These crystals vary in diameter from two to five thousandths of an inch.

Sometimes small portions of animal tissue and even blood-vessels are seen in oleomargarine, indicating that the latter has not been carefully prepared. If a portion of pure butter is boiled and allowed to cool in the manner described above, a solid portion will appear at the bottom with the oily portion floating upon it. Separate the two parts and examine them as before. The oily portion will appear as a mass of stellate crystal forms or starry crystallized fat. Very few oil globules will be observed. According to my observations, the oily portion of boiled butter differs very materially, in appearance, from that of boiled oleomargarine.

The solid portion of boiled butter contains all the salt used in its manufacture. When viewed through the microscope it appears very cloudy, and full of stellate crystals. Boiled butter retains its buttery odor. Oleomargarine when boiled has a fatty odor. Heating or boiling tends to increase the size of

the oil globules. To detect and remove the mycelium of any fungus that may be present, add to the specimen of butter a solution composed of equal parts of turpentine and alcohol, shake well and allow the mixture to stand several hours in a tall vessel. The salt will fall to the bottom, the curd will follow, carrying with it the mycelium, and the oil will appear on top, combined with the turpentine. Decant the clear oil and dissolve the curd in acetic acid. If any mycelium was present it will remain after the curd is thus dissolved, and can be examined under the microscope in the usual manner.

In Plate XXI., I have endeavored to indicate the microscopical appearances of oleomargarine and butter described above. Fig. 1 represents pure butter; Fig. 2 the same slightly heated; Fig. 3 boiled olein, the oily constituent of butter; Fig. 4 the solid portion of boiled butter; Fig. 5 oleomargarine; Fig. 6 olein of boiled oleomargarine; Fig. 7 the solid fats of boiled oleomargarine; Fig. 8 fungi found in rancid butter.

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[Well-made oleomargarine may be quite free from any crystalline appearance, at least while fresh. We have examined a number of specimens from different sources with this result. The sudden cooling with ice in the manufacture seems to prevent the immediate formation of crystals, but it is not unlikely that these will gradually form in course of time.

In its natural condition, and before it has been subjected to fusion, very careful scrutiny with the microscope is required to distinguish oleomargarine from real butter. Ed.]

## HÄCKEL *vs.* VIRCHOW.

BY WALTER C. HUBBARD.

To the microscope, as an instrument of research, we are indebted for many of the remarkable advances in biology, which the morphological studies of Häckel have given to modern science.

Considering the attention given to Häckel's theories, fostered by the recent publication of his work on the development of man, a reference to his "Free Science and Free Teaching," lately published with a preface by Prof. Huxley, may be of interest. This

is a reply to Prof. Virchow's address before the German Association at Munich in 1877, in which the author states clearly, and with much vigor, the reasons for his dissent from Virchow's position, and enunciates with the distinctness characteristic of Häckel, the advanced views he advocates. In this controversy, Virchow's opinion is the more conservative, while Häckel, sure of his position, permits no doubt or question to weaken his convictions. Truth will ultimately evolve from the conflict of warring theories. An implicit acquiescence in modern views, or stagnation of thought concerning the great questions which science is presenting for solution, is manifestly unwise. Hence, the value of such antagonisms; for each advocate, in endeavoring to pierce the logic of facts of which his opponent makes an armor, adds, perhaps unwittingly, to the sum total of human knowledge—casts a stone upon the burial-heap of ignorance and idle conjecture.

Briefly, Virchow took exception to Häckel's positive assertion of the truth of Darwinism, or natural selection, holding it to be as yet an "unproved hypothesis" and questioning the propriety of teaching anything the certainty of which is not absolutely demonstrated, anything subjective in its character as opposed to the external or objective; the latter to be the only mental diet of learners in the schools. Naturally, this stimulated Häckel to reply. And he does it with cogent reasoning, grim humor and caustic irony. We will attempt to outline his argument.

The progress of the evolution theory, says Häckel, has been greatly advanced by the fact that there are but two alternatives from which to choose, either that of natural development, or of supernatural creation. He defines the universal theory of evolution, Monism; the theory of descent, Transformism, explaining the origin of organic species by transformation; the theory of selection, Darwinism, at present the most important, but by no means the only one. These several theories, according to Häckel, are continually and unwittingly confused with each other. Doubtless, many imperfectly known causes have been of importance in effecting the origin of species, and the judgment of naturalists will differ as to the value of each; but this does not affect the validity of the general doctrine of descent, the only rational one. The proofs of this doctrine, Häckel considers, are sufficient, and will never be stronger; they are valuable because deduced from the totality of biological phenomena, not from this or that single observation.

The evidence, upon which the theory of descent rests, shows that the observed phenomena can only be explained by this theory, and reduced to mechanical causes; the guarantee of truth lying in the fact that these ultimate causes are the same for all the complicated processes of nature. He asks, where else can the facts be found than among those of physiology and morphology, paleontology and distribution, and the biological sciences in general. We have also the evidence of actual experiments. Häckel refers to the sponges, as yielding the most positive indication that the term "species" has only relative value. He alludes to the great progress of morphology, and finds in it justification for his conclusions. He shows the importance of craniology, and expresses the fear that Virchow and others have forgotten what they wanted to prove by their measurements.

That man has descended from the ape is nowhere assumed, but from the order of apes—from one or more species now long extinct. The theory does assert that the species in the long series of man's immediate ancestors, were ape-like animals. Häckel states that the relative certainty of this hypothesis cannot be compared, however, with the absolute certainty of the general theory of descent; he considers all such hypotheses dependent upon the knowledge existing at the time in which they are made. In the chapter on "Cell Soul and Cellular Psychology," Häckel expresses his opinion "that we must ascribe an independent soul-life to each organic cell." He defines soul according to the two theories—realistic and spiritualistic—adhering to the former, and adds that Ehrenberg maintained that all Infusoria had nerves, muscles, and organs of mind and sense. Häckel concludes that in the lowest condition of the human ovum, the mental attributes of man begin their course of development, and he finds in this a proof of his realistic theory.

Concerning methods of teaching, Häckel inquires where the distinction can be made between subjective and objective knowledge; he holds that all human knowledge is subjective, believing an objective science without theories inconceivable. He reviews the several sciences, and finds that even in mathematics the fundamental principles cannot be proved. The modern discussion as to a fourth dimension of space, is cited as an example of the development of thought in the least expected direction. In physics, what is known of the essence of matter, or of force? Gravitation is but an hypothesis. Electricity and magnetism, what

are they? The idea of an ether filling space, however probable, rests upon conjecture. Even atoms are not objective. Geology requires a theory of its records. In fact, Häckel shows the impossibility of teaching science at all, if Virchow's position is tenable.

Prof. Virchow renders himself liable to severe criticism by his assertion that the attempt to depose church dogmas, and place in their stead the religion of descent, must fail. Häckel is not slow to avail himself of this opportunity to reply, and takes issue with his opponent in no measured terms. With this assertion at least he has no patience. He asks pertinently, which idea of religion is to be adopted, and leaves his opponent to define upon what scientific basis the chosen one shall rest. A discussion follows upon the connection between socialism and the doctrine of descent, in which any logical contact of the two is disclaimed. The theory of descent, it is asserted, is aristocratic in the fullest sense, and warning is given against the misapplication of scientific theories.

The views of Prof. Virchow have naturally been received with delight by the clerical party in Germany, and have also been applauded, owing to the odium brought upon the theory of descent, by falsely coupling it with the political vagaries of the socialists. The alarm about these malcontents extends to any philosophical views which appear to be in dissonance with the established social condition. The high standing of Virchow has lent an additional weight to his argument; opposed to him stands Häckel, the uncompromising advocate of free thought.

Owing to these tides of opinion, which ebb and flow in the ocean of human thought, it is well at times to have a restatement of the positions of the leaders—reports from the outlying posts of the tendencies of intellectual progress. Theories should stand the tests of criticism, hostile and appreciative; and as they approximate the truth, their value is proportionately increased. What seem to be certainties are, after all, only probabilities: science only can show what is the most likely to recur under similar conditions, and to it are we indebted for all positive advancement.

Häckel, in basing his conclusions upon observation and experiment, seems to approach nearer the truth than any who advocate views from mere conjecture.

In raising the "odium theologicum" against purely scientific

opinions, prejudices which are not easily allayed are excited. Differences in the interpretation of facts are to be expected and hoped for ; final conclusions should be determined by their reasonableness and their fitness to the phenomena they explain.

## THE ORIGIN AND DEATH OF THE RED BLOOD-CORPUSCLE.

BY PROF. C. H. STOWELL.

(*Received June 26th, 1879.*)

At the early period of embryonic life, when the fœtus is little more than $2^{mm.}$ in length, the blood becomes red. The red elements are much larger than those found in the adult, varying in size from $9.75\ ^{\mu}$ to $15.0\ ^{\mu}$ in transverse diameter. In shape they are circular, oval, or globular. Nearly all have a nucleus readily seen without the aid of reagents.

What is the origin of these primary red corpuscles of the embryo ?

Early in the history of the embryo the rudimentary heart consists of a mass of epithelial cells, and radiating from it are two or more tracts—generally one on each side—which, by their subsequent subdivision, form the vascular area.

These cells are nucleated and vary in shape according to the pressure to which they have been subjected. In size they agree with the early red corpuscles described above.

At a certain time some of these nucleated cells in the interior of the mass composing the rudimentary heart, become loosened from their fellows. The exact time of this occurrence and its cause are not known. There are certain normal functions of the body performed in a regular way, the cause or causes of the regularity remaining in obscurity. We only know that these particular cells are separated from the rest to serve a special purpose as carriers of oxygen.

The remaining cells become transformed into the tissue composing the walls of the vessel, which, by twisting upon itself, finally becomes the heart. There is reason to believe that throughout the vascular area, cells in the interior of the blood-tracts become loosened from their fellows, while the remaining ones are metamorphosed into the walls of the vessels. These loosened cells may

be either slightly or quite deeply colored. It would seem that the hæmoglobin is deposited as small granules in different parts of the cells, to become evenly disseminated afterwards.

At this time there are large, circular, oval, nucleated red blood-corpuscles, identical with those seen as late as the middle period of uterine life. They increase greatly by cell division, at least until the embryo reaches a certain age, after which their multiplication may be due to other causes.

The development of the red corpuscles in the adult is, and must be, different from their embryonic origin. The basis upon which this assertion rests must be stated, for it might be said that the corpuscles in the adult are either the identical ones found in the embryo, or that they are formed from these by cell division.

The first statement cannot be true, for there is every reason to believe that the red blood-corpuscle is exceedingly short-lived, (see Foster's *Physiology*, 2d edition, p. 27.) The number of corpuscles in the blood varies greatly at different times, as is proved by counting them. Again, after hemorrhage or disease, the normal amount may be regained in a very short time. If the urinary and bile pigments are derived from the hæmoglobin, the number of red corpuscles destroyed must be very great. The second assertion cannot be true, for the corpuscles very seldom, if ever, increase by cell division in the adult (*Ibid.*, p. 28).

They must, therefore, have an origin entirely distinct from that of the embryonic cells.

One object of this paper is to strengthen an old theory and answer some objections to it.

If we take the pulp of the spleen and examine it carefully, there may be seen some large, circular cells, colored with hæmoglobin. These cells are, perhaps, the protoplasmic cells of Kölliker. Some of them contain in their interior, the remains of from one to ten red corpuscles. The reason why these very large cells are not found in the circulation, is probably because they are too large to enter the venous capillaries (see below histology of the spleen). Their large size is attained by appropriating to themselves, through their amœboid movements, the remains of one or more red corpuscles; this operation must take place in the spleen pulp, outside of the vessels. Their size will prevent them from entering the first venous capillaries, until they have undergone cell division. This division may be due to the same cause that keeps the amœba about an average size, *viz.:* the attraction of its constituent

particles for each other not being equal to the external pressure after they attain a certain growth. As a result of cell division, spherical, nucleated, colored corpuscles would be produced, sufficiently reduced in size to enter the circulation; and we have proof positive that they do enter as suggested above. Special precautions must be taken to demonstrate the presence of these corpuscles in the circulating blood, and Schmidt believes them to be always present in normal blood, in limited numbers. They are also seen in the medulla of bone. They have the appearances of white blood-corpuscles, colored with the hæmoglobin of the red.

When lymph, taken from the thoracic duct or any other lymph vessels in the system, is examined immediately, it is found to be colorless, or nearly so; but when allowed to clot, it assumes a decided pinkish tinge, which, by microscopical examination, is found to be caused by the presence of red blood-corpuscles. The red corpuscles appearing so constantly after the withdrawal of the lymph from the body, could hardly have an accidental origin. (Dalton's *Physiology*, 6th ed., p. 368.)

Recklinghausen saw the white cells of frog's blood develop into red corpuscles, even when out of the body. (*Arch. für Mic. Anat.*, 1866, p. 137.) Were there not such a difference between them in structure and form, these facts would lead to the conclusion that the white corpuscles give origin to the red. Kölliker, Neumann, and Schmidt are of the opinion that the nucleus disappears from the white cells, while Huxley holds that the red corpuscles represent the bare nucleus of the former. Beale has taught us, that as the cell grows in age its nucleus diminishes in size. His method of staining certainly supports his statements. (Beale, *Mic. in Med.*, 4th ed., pp. 232 and 259.) If the hæmoglobin is not deposited in the white corpuscles until they have reached a certain age, they will be entirely without a nucleus. If, as is claimed by Böttcher and verified at this laboratory (this Journal, October, 1878, p. 46), the red corpuscle has a nucleus the hæmoglobin must have been deposited prior to the time just given.

This time may be associated with the period when the white cell ceases its active amœboid movements, becoming passive, a condition which would occur most naturally when it was old and its nucleus small. The appearance derived from following the methods of Böttcher is said to be due to the coagulating effect of the corrosive sublimate on the albumen of the red corpuscle. If this is true, it seems strange that the coagulating agent does not serve

all red corpuscles alike and give a nucleus to each one. The truth is, a hundred may be examined before finding ten showing "the coagulating effect of the corrosive sublimate."

This bleaching, hardening and staining method of Böttcher proves the existence of three classes of red corpuscles.

Those red corpuscles (very few in number) having a nucleus and nucleolus, are recently desired from young white corpuscles. Those having a nucleus only, are either from older white corpuscles or are the older forms of those red ones possessing a nucleus and nucleolus ; while those consisting of a homogeneous mass are either directly grown from the older white corpuscles, or are the oldest forms of those composing the first or second class.

The results of Beale's investigations lead to no other conclusion, and the recent researches on the structure of the nucleus by Aurbach, Hertwig, Priestley and Klein, do not, in the least, invalidate these statements.

Although there may be a difference in the structure of the red and white corpuscles, it is only such a difference as the growth of cells renders necessary.

Some reason must be given for the change in shape from a spherical body to a biconcave disc.

Hæmoglobin possesses a great avidity for oxygen, it also retains this property when united with the white corpuscles, and, under proper conditions, will combine with this gas even in excess.

Will this excess of oxygen have any effect on the shape of the corpuscle ?

Using a carbonic acid gas apparatus, of the kind described in the *Hand-Book for the Phys. Lab'y*, by Burdon-Sanderson, and examining the blood in a suitable chamber, the effects of the gas on the red corpuscles can be studied.

It is not to be expected that the carbonic acid will unite with the red corpuscles, but the intention is to displace the excess of oxygen so far as possible, and thus reduce the red corpuscles nearer to the condition of the white.

Experiments lead to the conclusion that one of the changes resulting from this displacement of the excess of oxygen, renders the biconcave red corpuscles more globular. The alteration is not a complete one. The red corpuscle does not become as spherical as the white, but such a complete change might be confidently expected if all the excess of oxygen could be removed. The

change in form, however, is sufficient to give rise to the belief that oxygen is the active agent in causing the biconcave shape.

In speaking of the difference in color between arterial and venous blood, Foster says (Foster's *Physiology*, 2d edition, page 277, 1878): "There may be other changes. * * * When a corpuscle swells, its refractive power is diminished. * * * Anything, therefore, which swells the corpuscles tends to darken blood. * * * Carbonic acid has apparently some influence in swelling the corpuscles." And, it might be added, it swells them becauses it displaces the excess of oxygen as described above. There is no such excess of oxygen in the white corpuscles, because they have no hæmoglobin to draw oxygen to them. Dissolve out the hæmoglobin or remove the excess of oxygen from the red corpuscles, and they will not be unlike the white in shape. Hence, all that is necessary to change a white to a red corpuscle is the dissemination of hæmoglobin through the substance of the latter; this will attract an excess of oxygen, and a change in shape results.

If the corpuscles have such a short existence, the question naturally arises: Where and how do they die?

The serum of fresh blood contains no dissolved hæmoglobin, so that if any red corpuscles are destroyed in the circulation, either the number must be very small, or else the hæmoglobin must be speedily transformed into some other body.

Experiments made to show that the liver is a place of destruction for the red cells have given contradictory results. However, "a careful examination of the figures leads to the conclusion that the red globules are rather destroyed than formed in the liver." (*Physiology*, Küss, 2d edition, page 124, 1815.)

An account of the histology of the spleen will throw light upon the matter under consideration.

Following the divisions of the splenic artery, it is seen to divide again and again, until finally the branches diminish to the size of capillaries. These soon become indistinct. Cell demarcations may still be recognized, but these also soon disappear, and there is now a minute blood current without definite walls. (Frey's *Comp. of Histology*, page 120, 1876.) "As the failing branch of a drying brook wanders at last between the pebbles of its bed, slender and scanty, so is it with these finest blood-currents."

The blood now enters the splenic artery and flows undisturbed through the branches to the very finest capillaries. The walls

that separate it from the soft tissue now disappear, and it has to pass through a quantity of splenic tissue, with nothing to keep it from immediate contact with that tissue.

Having no walls to confine it, it now flows this side and then the other side of the "pebbles" (lymphoid cells) of its bed. One portion of the red elements of the blood passes through this tissue into the primordial venous capillaries, and finally reaches the general circulation through the veins. Another portion, however, meets a mechanical death by sticking fast to the splenic tissue.

The study of blood teaches that for the colored elements movement is life and rest is death. (*Ibid.*, p. 121.)

The red corpuscles, being thus brought to rest, find their grave. But the younger corpuscles do not allow the older ones to remain quiet; for, with an amœboid motion, the white cells envelop the dead bodies of the red, and greedily appropriate them to their own use. In this way, those large white corpuscles mentioned above originate.

If the spleen becomes enlarged, what will be the probable result? The larger it becomes, the more tissue there will be through which the red elements must pass, the more fine blood-currents without walls, therefore the greater the destruction of the red corpuscles. On the other hand, the number of the white cells will be correspondingly increased; for, although this subject cannot be discussed here, the spleen must be considered as a birthplace of the white corpuscles.

The equilibrium will thus be destroyed and there will follow a great destruction of the red and a great increase in the number of the white corpuscles; the extent of which will depend upon the size of the spleen.

Extirpation of the spleen does not always cause the result anticipated, and it is asserted that the number of white corpuscles is not materially changed, neither does hypertrophy of the lymphatics always follow. In answer to this it may be said that extirpation of one kidney does not always lead to any material change in the amount of urine, neither does a microscopical examination of the remaining kidney, after a time, show any increase in size of either tubuli or glomeruli. (Flint, *Physiology*, Vol. III., 1876, p. 404.)

The spleen is classed with the adenoid tissues. (Frey, Küss, &c.) Extirpate the spleen, and, as in the case of the kidney, the remaining adenoid tissues will carry on the work.

When the spleen is removed an abnormal condition is induced and it would be difficult to assert where the red corpuscle meets its death.

Therefore, the origin of the very first red corpuscles is from nucleated cells in the vascular area ; a little later in embryonic life, from cell division. Their origin in the adult is from the leucocytes ; the latter, becoming impregnated with hæmoglobin, owing to the action of oxygen, change to biconcave discs ; the nucleus of the white cells becoming gradually changed into the formed material of the red. Their death is owing to a mechanical cause in the spleen, and probably occurs, to some extent, in the liver also. This paper embodies the views of the writer, founded upon the opinions of various authors as well as original investigations made at this laboratory.

Physiological Laboratory,
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## THE SIMPLEST FORMS OF LIFE.

BY B. EYFERTH.

(*Translated from the German for this Journal, with additions.*)

(*Continued.*)

### II. FAMILY. DESMIDIACEÆ.

Cells single, or (seldom) united in series, of various, often ornamental, shapes, generally divided into symmetrical halves by a constriction. Division by separation of the two parts, and growth of the connecting piece between them into two new halves. Spores formed by copulation without the mother cells, from both of which the entire plasma escapes to form a single spherical zygospore, which becomes surrounded by a thick, often verrucose or spinous, membrane. Many species of elongated form possess round vacuoles at each end, with small, strongly refracting, particles in constant molecular motion.

The numerous forms live generally singly in ponds and ditches.

Cells not in two symmetrical halves, long, cylindrical,
  Chlorophyll in the axis of the cell, *Gonatozygon*, d. B.
  Chlorophyll on the cell walls, *Genicularia*, d. B.
Cells divided, without or within, into symmetrical halves,
  in chain or ribbon-like families,
    generally with gelatinous coating, compressed,
      flat, *Sphærozosma*, Corda.

| | |
|---|---|
| circular, cask-shaped, | |
| with ring-like furrows, | *Hyalotheca*, Ehr. |
| without furrows, with two teeth on the ends, | *Didymoprium*, Ktz. |
| without gelatin, | |
| barrel shaped, | *Bambusina*, Ktz. |
| 3 (seldom 4) cornered, | *Desmidium*, Ag. |
| single, or slightly united in families, | |
| elliptic, flat, compressed, | |
| deeply constricted in the middle. | |
| borders lipped, | |
| zygospores spiny, | *Micrasterias*, Ag. |
| zygospores warty, | *Euastrum*, Ehr. |
| borders not lipped, | |
| without spines, | *Cosmarium*, Corda. |
| with spines, | *Anthrodesmus*, Ehr. |
| not flat, compressed, | |
| spherical, spinous, | *Xanthidium*, Ehr. |
| 3–5 cornered, corners prolonged, | *Staurastrum*, Meyen. |
| spindle shaped or cylindrical, | |
| without median constriction, | |
| chlorophyll in the central part, | |
| stellate, | |
| cells generally sickle shaped, | *Closterium*, Ntsch. |
| cells straight, rounded on the ends, | *Penium*, Bréb. |
| in spiral bands, | *Spirotænia*, Bréb. |
| with median constriction, | |
| rounded or truncated at the ends, | *Pleurotænia*, Ng. |
| emarginate at the ends, | *Tetmemorus*, Rfs. |
| oblong, round Chlorophyll in a longitudinal band, | *Palmoglœa*, Ktz. |

The first six of the above are not common ; most of the others are abundant, especially species of *Cosmarium* and *Closterium*.

1. Gen. *Gonatozygon aspermum*, Rb. short filaments of 0.01 d. ; rare.
2. Gen. *Genicularia spirotœnia*, d. B. Chlorophyll in spiral bands.
3. Gen. *Sphœrozosma*, Corda. Cells elliptic, flat, deeply constricted in the middle (similarly to *Cosmarium*), in ribbon-like filaments.

   *Sp. vertebratum*, Rlfs. Cells 0.033 d., not quite so long ; in gelatin.
4. Gen. *Hyalotheca*, Ehr. Cells cylindrical, with rim, united into round filaments, with thick gelatinous envelope.

*H. dissiliens*, Bréb. Cells 0.02–0.025 d., half as long.

5. Gen. *Didymoprium*, Ktz. Cells short, cask-shaped, with oval section, both sides provided with two blunt teeth, in tubular gelatinous envelope [sometimes absent]. Chlorophyll in a cross, with starch granules.

*D. Grevillii*, Ktz. Cells 0.05 d.; half as long.

6. Gen. *Bambusina*, Ktz. Cells short, barrel-shaped, circular in cross section, with two raised ridges in the middle which bear small teeth on two opposite points. Chlorophyll 5–6 rayed.

*B. Brebissonii*, Ktz. Cells about 0.02 d., twice as long; united into knotty, fragile filaments.

7. Gen. *Desmidium*, Ag. Cells short, 3–4 cornered, deeply constricted in the middle (hence the corners appear bidentate). Chlorophyll rayed, directed towards the corners. In filaments, mostly twisted.

*D. Swartzii*, Ag. Cells three-cornered, 0.02–0.04 d., half as long. Common.

*D. quadrangulare*, Ktz. Four-cornered, rare.

8. Gen. *Micrasterias*, Ag. Cells elliptic, flat, length and breadth about the same, divided by a deep median constriction into two parts, each of which appears lipped, owing to another more or less deep constriction. Zygospores spinous.

*M. denticulata*, Bréb. Cells circular, 0.25 d.; halves tri-labiate the lateral lips deep, median lips again bi-labiate, lips all emarginate with rounded corners. Common.

*M. rotata*, Rlfs. Similar to the preceding, but middle lips curved, with undulating borders; smaller lips bent, with pointed corners. Common.

*M. papillifera*, Bréb. Circular, 0.1–0.125 d., with glandulous teeth. Halves five-lipped, middle lips bent; curved.

*M. Crux Militensis*, Ehr. Cells 0.01–0.125 d.; halves three-lipped; smaller lips fissured; bent.

*M. truncata*, Bréb. Cells 0.125 d. Halves five-lipped, toothed.

The species of this genus, as of the following, are, in most cases, difficult to determine, because many transition-forms are found.

9. Gen. *Euastrum*, Ehr. Cells elongate, 2–3 times so long as broad, deeply constricted in the middle; halves lipped, or only bent outwards; zygospores verrucose.

*E. oblongum*, Rlfs. Cells 0.125—0.14 long, verrucose. Halves five lipped; terminal lips with narrow opening.

*E. didelta*, Rlfs. Cells about 0.125 l. Halves three-cornered, five lipped. Lips round or wavy.

*E. Ralfsii*, Rb. Cells 0.035 l.; three-cornered and three-lipped.

*E. verrucosum*, Ehr. Cells 0.06—0.1 l., warty; halves with three-heart-shaped lips of equal size.

*E. binale*, Rlfs. Cells 0.022 l. Halves distinctly three-lipped, almost quadratic; terminal lips emarginate, with corners pointed.

10. Gen. *Cosmarium*, Corda. Cells elliptic, deeply constricted in the middle; chlorophyll (in cross section) radial, with a central starch granule. Zygospores warty or radiate. Numerous ill-defined species, some very common.

*C. Botrytis*, Mgh. Cells 0.033—0.05 l., densely verrucose or spinous, nearly as broad as long, rounded or blunted. Very changeable in form and appearance.

*C. quadratum*, Rlfs. Cells up to 0.055 l., smooth, almost quadratic, corners rounded.

*C. cucumis*, Corda. Cells 0.06—0.08, smooth; halves cylindrical or almost spherical.

*C. Phaseolus*, Bréb. Cells 0.025—0.03, smooth, circular; halves turgid in the middle.

*C. Cucurbita*, Bréb. Cells large as 0.02 l., less constricted in the middle; halves egg shaped.

11. Gen. *Arthrodesmus*, Ehr. Cells deeply constricted; halves laterally prolonged into spinous projections. Zygospores spinous.

*A. convergens*, Ehr. Halves elliptic, with simple, converging spines.

*A. octocornis*, Ehr. Halves with four simple spines or projections.

12. Gen. *Xanthidium*, Rlfs. Cells spherical, deeply constricted, provided with spines. Zygospores spinous.

*X. aculeatum*, Ehr. With simple awl-like spines, and scattered warts.

*X. fasciculatum*, Ehr. Halves kidney-shaped, or obtusely eight-cornered, the outer corners each with two spines, otherwise smooth.

*X. antilopæum*, Ktz. Halves obtusely six-cornered, ends broad, somewhat wavy, each of the four outer corners with a pair of bent spines.

*X. armatum*, Rlfs. With short, divided spines.

13. Gen. *Staurastrum*, Meyen. Cells very deeply constricted; halves seen from the side three-five cornered. Zygospores spinous. Numerous species.

*S. fucigerum*, Bréb. Cells 0.055—0.09 d., in lateral view three or four cornered; corners produced into divided prongs. *S. aculeatum* similar, but with undivided spines.

*S. muticum*, Bréb. Cells 0.027—0.035 d.; halves elliptic, in side view three or four (seldom five) cornered; surface smooth. *S. orbiculare*, similar but circular.

*S. dilatatum*, Ehr. Cells 0.022—0.04 d.; surface regularly punctate, in section quadrangular.

14. Gen. *Closterium*, Ntsch. Cells spindel-shaped or cylindrical, not externally constricted in the middle, generally curved, sickle-shaped. Chlorophyll in cross-section stellate, with starch grains; the rays, in side view, appear as longitudinal bands. Zygospores smooth.

*C. Dianæ*, Ehr. Cells 0.14—0.2 l., in the middle 0.0186. Much curved, half-moon shaped.

*C. lunula*, Ehr. 0.4—0.66 l., in the middle 0.07—0.1 d. Back greatly arched; front nearly straight; cell covering smooth; zygospores spherical.

*C. Ehrenbergii*, Mengh. Similar to *C. lunula*, but front surface turgid in the middle. Very common.

*C. lineatum*, Ehr. Cells 0.5—0.66 l., about 0.03 d. in the middle, greatly attenuated at the ends: finely striped.

*C. rostratum*, Ehr. Cells 0.3—0.5 l., very slender, ends almost bristle-like, slightly bent. Closely striped and ribbed; spores four-cornered.

15. Gen. *Penium*, Bréb. Cells spindle-shaped or cylindrical, straight, ends rounded. Chlorophyll as in *Closterium*. Spores smooth.

*P. lamellosum*, Bréb. Cells 0.1—0.33 l., elliptic, slim; ends rounded.

*P. interruptum*, Bréb. Ends keel-shaped, attenuate.

*P. margaritaceum*, Bréb. With verrucose, longitudinal bands.

16. Gen. *Spirotænia*, Bréb. Cells cylindrical or spindle-shaped, with spiral bands of chlorophyll lining the walls.

*Sp. condensata*, Bréb. Cells 0.1—0.125 l., 0.02—0.024 d., cylindrical, rounded on the ends, with one band of chlorophyll; generally in gelatinous sheath.

*Sp. obscura*, Rlfs. With several bands of chlorophyll.

17. Gen *Pleurotænium*, Ng. Cells cylindrical or spindle-shaped, with median constriction ; chlorophyll in longitudinal bands.

*P. baculum*, d. B. Cells 0.25 l., slim, straight, somewhat turgid each side of the constriction, ends blunt.

*P. turgidum*, Bréb. Cells about half so broad as long.

18. Gen. *Tetmemorus*, Rlfs. Cells cylindrical or spindle-shaped, constricted in the middle, ends carved.

*T. Brebissonii*, Rlfs. Cells spindle-shaped 0.09—0.18 l., with finely dotted longitudinal stripes.

19. Gen. *Palmoglœa*, Ktz. Cells elongate, round ; chlorophyll in longitudinal bands ; copulation by complete fusing together of the cells.

*P. macrococca*, A. B. Common in moist places, out of water.

# EDITORIAL.

## ANNOUNCEMENT.

With the close of the first volume the publishers desire to express their sincere thanks for the liberal encouragement and support with which they have been favored during the past year.

It has been their earnest wish to establish a Microscopical Journal which would be creditable to themselves and to the country. Each number has been an improvement upon the preceding, even the present one has defects which could not be remedied without sacrificing too much the unity of the volume. Still, we do not hesitate to invite fair criticism of the typography and press-work in this number, which we believe could not be excelled, under the circumstances, and certainly never has been in any scientific periodical heretofore published. For the high position among scientific journals which the QUARTERLY already occupies, we are to a great extent indebted to the original work of American authors. This fact speaks well for their energy and interest in the study of science ; as much of the work was done at a time when there was no suitable journal through which the results could be given to the world. With the encouragement offered by a well-established periodical devoted to Microscopical

subjects, we may well believe that far more scientific work would be accomplished in the same length of time.

We are obliged to announce, contrary to our expectations when writing the above, that the existence of the QUARTERLY ceases with this number. About the first of the present month (July) the Editor found that it would be impossible for him to give the Journal the necessary supervision during the coming year; hence the necessity of this suspension.

A few complete sets of volume I. may be obtained at the regular price.

Subscribers whose payments extend beyond the present number will have the balance due them returned.

The address of the publishers will hereafter be 51 & 53 MAIDEN LANE, NEW YORK.

## GENESIS OF MAN.*

In a pamphlet of sixty-four pages Mr. Ward has published three papers, originally printed in the *Penn Monthly*, which, from the care bestowed upon them, and the study given to the writings of Häckel by the author, are sure to be valued by the American public. It is evident that the writer is a great admirer of the German savant and philosopher. Whether we are prepared to accept the conclusions reached by this truly great and noble intellect, leading, as they do, from fact and analogy to a stern materialism by strictly scientific processes of reasoning, depends, in great measure perhaps, upon our knowledge of the facts and principles upon which they are founded. Häckel does not shrink from boldly following the results of scientific work to their ultimate consequences, and while we owe to Charles Darwin the first public recognition of the doctrine of descent, to Häckel's researches we are indebted for the strongest basis upon which this theory rests.

Notwithstanding the indications derived from the study of adult living and fossil forms, and however great the influences of climate or conditions of life may be, these cannot, it seems to us, carry with them the same force of argument that may be drawn from the results of embryological study.

* Häckel's Genesis of Man. By Lester F. Ward, A.M. Philadelphia: Edwards Stern & Co.

In the case of living-adult forms there are, and always will be, breaks in the chain connecting unlike forms—wide chasms to be bridged by the exercise of reason and supposition.

When, however, we study the development of these organisms from their first appearance on the field of existence as moners, mere particles of protoplasmic matter of microscopic size, and follow them through every stage of growth, we reach conclusions, which are intelligible in the light of such knowledge of sequence and relation, as only investigations of this kind can give. For this reason the work of Häckel cannot be too highly valued, and is sure to be a lasting monument to his name.

It is not our purpose to review the work before us, but rather to briefly present the salient features of Häckel's system of reasoning. We will not, therefore, speak of the many original thinkers and students who preceded or were contemporaneous with him, and whose labors contributed not a little to the ready appreciation of his work. Among these were Göthe, Lamarck and Darwin, each of whom, and especially Lamarck, foresaw the ultimate logical conclusion and boldly proclaimed it long before the world was ready to accept it.

To understand Häckel's position, our studies must commence with the very beginnings of life. To him the moner represents the lowest form of organic structure. Between the moner and the inorganic world, there must be some bond of connection; for the completeness of this theory requires that, at some time in the world's history, life, in its simplest form, must have sprung spontaneously from non-living matter. He has made no effort to explain the process, nor to observe its repetition. Although the elaborate experiments of Dr. Bastian have failed to indicate the proper conditions under which this transformation of the inorganic into the living can take place, future researches may establish this hypothesis upon a basis of fact.

Assuming then, as Häckel does, that spontaneous generation has produced even a single particle of living protoplasm, the entire monistic scheme of development, including man, becomes complete.

The fundamental idea of Häckel's school is, that all animals in the course of their development from the germinal cell, pass through various stages of existence which afford us a perfect history of the process of their slow evolution from simpler forms. At numerous points, along the stem which leads directly from the

moner up to man, diverse lines of growth begin, branches not followed by the human embryo which keeps on in its direct course, and touching only these other forms at the points of divergence.

There is a difference between the moner and a cell: the moner is a lower stage of existence than the cell, the latter is distinguished by a certain differentiation which engenders a nucleus within its protoplasm. The moner has no nucleus.

The multiplication of all forms of life which occupy a place but little above the lowest, is brought about by the union of two cells, designated respectively male and female. The former, or spermatozoon, is a true nucleated cell, an infusorium ; the latter, or ovum, is an amœba.

Following up the growth of a human being, the sperm-cell penetrates the ovum, and the two at once coalesce and lose their individuality ; the nuclei of both disappear, and there results a mass of protoplasm. All trace of internal cell-structure having thus disappeared, the result of this union corresponds to the moner. Two perfect cells have thus produced, by their union, a form the very lowest in the scale of being; the cell has gone backward in its process of evolution. Every animal begins its life at this point, which is the cytod, or, as Häckel names it, the monerula stage.

The next change observed is the formation of a nucleus, when the monerula becomes a true cell ; but, owing to the qualities conferred upon it by the sperm-cell which it has absorbed, the cell is altered, in its nature and capabilities, from the earlier type in its life-history. This later form represents the amœboid stage of the human being.

The next condition begins with the binary subdivision of the nucleus and the surrounding protoplasm, which process is repeated until the entire contents of the cell are converted into a mass of minute cells. This is the morula stage, a condition also represented by living organisms.

The morula is now changed by the absorption of fluid from the surrounding medium, and this, collecting in the central portion of the morula, presses the minute cells outward until they form a layer just within the original enveloping membrane. There is thus produced the blastosphæra stage, and the layer of cells mentioned is known as the blastoderm.

The gastrula follows, and differs from the last form by the

presence of two layers of cells, instead of a single one, each consisting of several rows of cells, the inner layer being formed of cells larger and darker in color than those of the outer. The gastrula also possesses an opening through which refuse matter is excreted and nourishment is received.

The embryo now assumes a worm-like form, and in its simplest form is allied to the Turbellaria. The main distinction between this and the gastrula stage lies in the number and character of the cellular layers, now four in number.

From the worm stage branch off the articulates on the one side, the molluscs on the other; the vertebrates constituting the central stem.

Following the worm, the embryo becomes a vertebrate, but of a very simple and imperfectly developed form, for which Häckel has established the sub-type Acrania.

In the next stage the nervous system and vertebræ become definately formed, and this is known as the monorrhina condition.

The human being then becomes a fish, and finally reaches the last, or ammion stage.

Thus we have briefly outlined the changes through which the human embryo passes in its course of ontogenetic development, as viewed by the German histologist. To bring them forward with their full force would require a translation of the volumes he has written.

Each of these various stages is, or should be, according to Häckel's view, represented by an adult living animal, which has reached one of these stages and there completed its course of development, having previously passed through each of the lower ones.

It would be interesting to relate how perfectly observed facts agree with the theory in the minutest details; also to notice the cases in which the living representatives of the types, previously established upon theoretical grounds, have been discovered. We can only mention a few which will be familiar examples.

Commencing with the monerula and amœboid stages, which have already been described, the morula succeeding them finds its representative among certain species of *Cystophrys* and *Labrynthuleæ*. The blastosphære is represented by numerous forms, the most familiar, perhaps, being among the Volvocinæ.

The gastrula is familiar in the larval forms of sponges, corals,

and in zöophytes, and leads us directly to a better knowledge of the well-known gastræa theory.

In the face of such facts as may be brought forward in support of this theory of development, it is hard, indeed, to resist the logical conclusions which have been drawn from them regarding the origin of life, and the gradual evolution of man from lower forms.

The concluding sentence of the pamphlet before us reads: "Either the dualistic conception of teleological design, *i. e.*, miracle, must be admitted, or else there is no alternative from [but] this explanation."

## THE POISON OF YELLOW FEVER.*

For the past few months medical journals have teemed with articles treating of yellow fever, but we venture to assert that our knowledge of the disease and the proper modes of treating it, has not been greatly enlarged by them.

Although the disease is one that has long been known to the medical profession, the methods of combating it today are not greatly different from those employed ten years ago. The reason for this slow progress is doubtless to be found in our limited knowledge of the causes which produce the disease, and the manner in which the specific poison acts upon the system.

The microscopical study of disease-germs has not been very prolific in practical results, and the question as to the existence of specific germs of this character is yet an open one. Investigations of the causes which produce disease are probably among the most difficult and unpromising of any which the microscopist or physician can undertake. As an instance of the difficulty to be encountered, we may call to mind the almost universal prevalence, especially in low countries, of what is commonly called malaria. As to the cause of this disorder, we know absolutely nothing. The air is charged with poison of some kind, but no analysis has yet revealed either its presence or its mode of action.

Regarding the cause of yellow fever, we are quite as much in the dark. Even the most able physicians who have studied the subject, are still divided as contagionists and non-contagionists. While many believe it to be purely an infectious disease, others, of equal ability, oppose this view: some consider it endemic in

* On the Nature of the Poison of Yellow Fever and its Prevention. By Dr. H. D. Schmidt. *New York Medical Journal*, May, 1879.

our southern Atlantic and Gulf States, others contend that the germs are destroyed each winter by frost, and that the poison must be again imported before the disease will reappear. We believe, however, that recent experience has not upheld the last assumption.

Dr. H. D. Schmidt, of New Orleans, a man whose testimony is reliable, and whose ability as an observer is not to be questioned, now offers his opinions as to the nature of the active agent, in the form of an excellent review of the subject, embracing the results of his own experience.

Infection may be of two kinds; either a gas emanating from decomposing organic matter, or spores of living organisms or Bacteria when it is known as *contagium vivum*. Contagion, however, must be a product of the living body, of glandular origin. Dr. Schmidt makes a sharp distinction between miasmatic and contagious diseases, based upon the immunity from a second attack which characterizes the latter.

The germ theory suffers in his hands. There are but four diseases in which bacteria have been found in the blood, under circumstances which have afforded strong support to the doctrine of contagium vivum. These are splenic fever, septicæmia, typhus recurrens and infectious pneumo-enteritis. It appears, however, that either of these maladies may affect a patient without the presence of the specific bacterium which is presumed to be its cause, with the possible exception of typhus recurrens. Moreover, it has been fully proved that bacteria may be present in the blood in considerable abundance without engendering disease of any kind.

On the whole, it appears that the application of the hypothesis of contagium vivum to the explanation of the phenomena of disease, has had its day. Even in septicæmia, bacteria are not always found.

Contrary to the general opinion, the air is not always full of fungus spores. Doubtless a few are constantly floating about, but they are not in sufficient quantity to affect the general health. The particles in the air, which are so clearly shown by the experiments of Professor Tyndall, are nothing but the inorganic dust which arises from constant abrasions, retained in suspension by the currents of air, along with a few spores, which, in a suitable nidus, may develop and induce fermentation or decomposition. We may collect them by exposing a plate of glass,

covered with glycerin, to the wind. In this way Cunningham, at Calcutta, collected particles of silica, amorphous granules, carbon, lime, starch-grains, cells, hair, vegetable tissue, cotton-fibers, oil-globules, pollen, spores of cryptogams and, occasionally, a few bacteria.

In speaking of the possible action of spores or living particles so minute as to be overlooked with the microscope, Dr. Schmidt maintains that the theory of contagium vivum is not founded upon any assumption regarding invisible germs. We must, however, remind the reader that, although the true spores of minute monads have been seen in mass by such careful observers as Drs. Dallinger and Drysdale, these spores are so exceedingly minute when first discharged, that they could not possibly be recognized, or even found, after they are once scattered. When they issue from the parent cell they are seen as a mere cloudiness, in which it is almost, if not quite, impossible to distinguish the individual particles, even with the most perfect illumination and best optical appliances. Therefore, the assumption of invisibly minute spores would be quite consistent with facts of observation, viewed from the stand-point of the germ theorist.

The weight of evidence, as adduced by Dr. Schmidt, tends to prove that the specific virus of yellow fever is a product of the human body. The poison may exist in the gaseous form—its presence is always indicated by a peculiar odor which emanates from patients affected by the disease—and it may be carried long distances in articles of clothing. An eminently contagious disease, it can only be communicated from one person to another; except under very rare, but, at the same time, possible conditions, which may lead to its spontaneous development in the system. It is necessary to assume that it had a spontaneous origin in some past time.

It is a curious fact—not without a strong bearing upon the views above set forth—that, as the virulent action of putrescent blood is greatly intensified by passing through the bodies of several animals in succession, so the activity of the yellow fever poison seems to become greater as it passes from patient to patient, and the last persons attacked during an epidemic are likely to have the disease in its most aggravated and dangerous form.

If the cause of yellow fever is a glandular product, very simple sanitary measures will suffice to prevent its spread. No means of disinfection designed primarily to destroy living germs, will equal in efficiency perfect ventilation. The poison does not require to

be destroyed, but diluted. Dr. Richardson, of London, has already proved that disease poisons are only active when used in a certain degree of concentration. Not long ago the writer strongly advocated a system of artificial ventilation to be applied to vessels from yellow fever ports, which was embodied in a communication to the *New York Times*, but not published. The arguments were based mainly upon the assumption that any gaseous poison could be readily removed from any part of a ship by a current of air. Should the poison consist of organized germs, this same means would tend to prevent them from finding a lodgment, or, at least, a suitable nidus for rapid growth and multiplication, by maintaining a pure air, and drying up the moist places where the fungoid cells would otherwise multiply.

Our knowledge of the zymotic diseases is still so limited that the only rational means we have of preventing their spread, are those of thorough ventilation. We may, even today, question whether sewer-gas or the effluvia from decomposing animal or vegetable matter have in them any specific disease-germs. This does not seem to be proved on either side. We do not argue that such gases are harmless, but it seems not improbable that their poisonous action may be merely of a chemical nature, rendering the oxygen of the air inactive, and thus preventing the elimination or oxidation of impurities which therefore accumulate in the blood, and engender disease.

If this view be accepted, it will be found to afford a reasonable explanation of the origin of malaria, receiving some support from the fact that this poison, in certain localities, is much more active at night than during the daytime, when the actinic power of the sunlight may counteract its baneful influence upon the oxygen of the air.

## MR. WENHAM'S POSITION REGARDING HIGH BALSAM ANGLES.

(*Received July 7th, 1879*).

*To the Editor :*

In your letter to me of June 5th, I am glad to find that you have candidly put the following direct question, which has not been asked before. "I wish you would give me a positive reply to this question. Do you claim that no objective has been made with an immersion aperture above 82°? This has been attributed to you." I have had to meet a similar imputation in the *Transactions of the R. M. S.* for this month. In the

year 1854 I first pointed out the fact—not till then noticed—that the angle of aperture of an object-glass, however great in air, became reduced to below 82° in Canada balsam. In 1855, in the same Journal, I demonstrated how wide apertures, or angles greater than 82°, could be obtained in balsam by the adaptation of an additional front lens, used with an intermedium of the same refractive power as glass, such as Canada balsam. This was completely successful, and I have the same lens (a $\frac{1}{5}$ inch of 120°) still in my possession. It works well with water, but better still with glycerin, or a highly refractive oil.

In the early stage of the controversy, the fact of reduction from an air aperture to 82° in balsam, was disputed, but it is a mistake to suppose that I have declared that no angle beyond 82° could be obtained with an object mounted in balsam. I have looked over the pages of the late *Monthly Microscopical Journal* from the year 1870 to its end, and examined the passages referred to by Mr. Stephenson in his foot-notes, and find that I have not made a statement so utterly inconsistent with the fact; I first pointed out the balsam deficiency, and suggested and carried out the remedy.

At an early period of the controversy, I wrote the following sentence which I now quote from the *Monthly Microscopical Journal* for June, 1872, page 273. "Mr. Tolles has accepted the only condition (the four system) under which the full aperture can be brought to bear on a balsam mounted object. It is the tiny hemisphere. I am glad of his announcement that he has succeeded in this, and should like to see the same thing done in this country, particularly with large aperture glasses, say higher than $\frac{1}{8}$ inch."

Since the $\frac{1}{5}$ inch of 1855, a number of others having a long working distance have received the addition of supplementary fronts. For large immersion angles, this never fails to give good results, in accordance with the original perfection of the object-glasses without the fronts.

Two of these supplemented one-fifths were sent to the late Philadelphia exhibition, therefore any attempt to attribute to me a denial of the principle with which I have been so long acquainted, either arises from mere prejudice, or is taken as an assumed ground for adverse criticism.

I readily admit that a great deal of unnecessary irritation has been displayed, which time has shown to be worse than useless, as it has led to recrimination, careless, and inconsistent wording. What shall be considered a standard apertometer? is the question which I now wish to be settled, as I have not yet succeeded in applying any method of my own to the measurement of aperture, with which I am satisfied.

LONDON, JUNE 21st, 1879.

F. H. WENHAM.

## NOTES.

—Dr. J. Pelletan, Editor of the *Journal de Micrographie*, announces that he has undertaken to publish the catalogue of Diatoms arranged by Mr. Frederick Harbirshaw of New York City. This catalogue will contain a complete list of the diatoms known and described, up to the date of completing the manuscript, giving the synonyms, and full references to the entire literature of each species.

The labor of compiling the matter must have been very great; and was only rendered possible by a complete library of works and papers on diatoms such as Mr. Habirshaw owns.

It was originally written by the author with the electric pen; but only fifty copies were made, which were distributed gratuitously. The entire work has been re-written for publication, bringing it up to date. The proofs are to be revised by Mr. F. Kitton.

We are glad to know that this valuable work is to be made available to all diatomists, and, while we can scarcely hope that it is sufficiently appreciated to repay the expense of its publication at once, we trust that many subscriptions will be sent from this country, where in truth, the book should be published. We commend the spirit of enterprise of Dr. Pelletan in undertaking it.

The volume will be an 8°, printed with care, and is to appear in three parts, at intervals as short as possible. The subscription price is 10 francs, for the present. When the publication is complete it will probably be raised to 15 francs. To American subscribers it will be about $2.50 or a little less (12 fr. 50), including postage.

Subscriptions should be addressed to Dr. J. Pelletan, 34 Boulevard des Batignolles, Paris, France.

—Mr. M. A. Certes has described, in the *Comptes Rendus*, a method of preserving Infusoria, which has already attracted considerable attention. The process is very simple, and may be briefly described as follows: A drop of a 2 *per cent.* solution of osmic acid is placed upon a cover glass and inverted upon the fluid in which the Infusoria are swimming upon a slide. In other cases, it suffices to expose the organisms, previously disposed upon the slide, to the vapors of osmic acid for the space of ten or more minutes. This acid fixes the animals instantaneously, and the minutest details, the cilia, flagella, buccal armature, etc., can be examined. It is not claimed, however, that this process will preserve all forms, but most of them can be secured by its use in a more or less perfect condition.

The best coloring agents for use in this connection are Ranvier's picro-carmine, and eosin. The staining solution most highly recommended is composed of

| | |
|---|---|
| Glycerin, . . . . . | 1 part. |
| Water, . . . . . | 1 " |
| Picro-carmine, . . . . . | 1 " |

in order to avoid the contraction of the tissues, caused by the sudden

addition of glycerin, it is advisable to place the preparation in a moist chamber with a drop of the staining solution at the edge. The water slowly passes off and the glycerin gradually takes the place of it. Strong glycerin is used as a preservative.

—The Editor of the *Index Medicus* calls our attention to a misunderstanding which led us to criticise the plan of his publication in our last issue (p. 225). We readily modify our remarks by quoting from his letter as follows: "In the actual work of indexing, no distinction whatever is made to indicate doctrine; articles from all sources being entered under their subject-heading merely."

—We notice a new scientific periodical, the first number of which has reached us, entitled *Lo Bollettino Scientifico*, edited by Doctors De Giovanni Achille, Maggie Leopoldo and Zoja Giovanni, professors in the University of Pavia. It is published in Milan.

—The National Committee on Micrometry is composed as follows: F. A. P. Barnard, LL. D., President of Columbia College, New York City, Chairman; R. H. Ward, M. D., Troy, N. Y., Secretary; George E. Fell, C. E., Buffalo, New York; Henry Jameson, M. D., Indianapolis, Indiana; Prof. S. A. Lattimore, Rochester, N. Y.; Prof. Edward W. Morley, Hudson, Ohio; Joseph G. Richardson, M. D., Philadelphia, Pa.; Prof. Stephen P. Sharples, Boston, Mass.; Prof. H. L. Smith, Geneva, N. Y.; Prof. Albert H. Tuttle, Columbus, Ohio; J. J. Woodward, M. D., Washington, D. C.; Lester Curtis, M. D., Chicago, Ill.

Nearly all the prominent microscopical societies of the country are represented on the above Committee.

—*The American Chemical Journal*, edited by Professor Ira Remsen, with the aid of chemists at home and abroad, is a new periodical, the first number of which appeared last April. Six numbers will form a volume of 400 to 500 pages. It will contain: "Original papers, articles from other journals, reviews and reports" and "notes." We hope it will prove a success, for it is under able management, and, judging from the first number and the Editor's announcement, it is destined to be valuable both to professional and practical chemists. Not a single thoroughly scientific journal devoted to chemistry in a country of nearly fifty millions of inhabitants! How great must the thirst for knowledge be.

—Mr. H. T. Butlin has been studying the "fur" on the tongue, and finds it to consist of the glœa of certain fungi. By cultivation, he found *Micrococcus* and *Bacillus subtilis* always present. Besides these he sometimes found *Bacterium termo*, *Sarcina ventriculi*, *Spirochæta plicatilis* and *Spirillum*.

—In the *Comptes Rendus*, C. Chamberland mentions a minute organism which is found in almost every organic solution that has been made neutral in reaction by potash. The germs or spores of this organism are said to retain their vitality after boiling for several hours; but a temperature of 115° C. soon kills them.

## DIGEST OF CURRENT LITERATURE.

*** JOURNAL OF THE ROYAL MICROSCOPICAL SOCIETY, (*April, 1879*).—THE PRESIDENT'S ADDRESS, by H. J. Slack.—An interesting account of the principal discoveries of the year.———OBSERVATIONS on DACTYLOCALYX PUMICEUS (STUTCHBURY), WITH A DESCRIPTION OF A NEW VARIETY, D. STUTCHBURYI, by J. W. Sollas.—This article is illustrated with four full plates, and several cuts in the text. It embraces the results of studies carried out with specimens in the Bristol Museum. ———THE APERTURE QUESTION, by J. Mayall, Jr.

*** (*May, 1879, extra number*).—A CONTRIBUTION TO THE KNOWLEDGE OF BRITISH ORBATIDÆ, by A. D. Michael, assisted by C. F. George. —Three plates accompany the article, which gives the generic classification of the members belonging to this little studied family of the *Acarina*. ———NOTES ON THE PYGIDIA AND CERCI OF INSECTS, by Henry Davis.———ON STEPHENSON'S SYSTEM OF HOMOGENEOUS IMMERSION FOR MICROSCOPE OBJECTIVES, by Prof. E. Abbe.———THE VERTICAL ILLUMINATOR AND HOMOGENEOUS IMMERSION OBJECTIVES, by J. W. Stephenson.—The purport of this article is to show that an increase of aperture above 82° balsam is demonstrated by means of this method of illumination. By reflecting a beam of light from the illuminator upon an object adhering to the cover glass and removing the eye-piece, an annular circle of light will be seen, surrounding a darker central space. This ring of light is produced by the rays which issue from the objective at an angle greater than the equivalent of 180°, and it may also serve as a measure of this excess. Thus, an objective having a numerical aperture of 1.25 will show an annulus, the width of which will be one-fourth of the radius of the central space. When these extra rays reach the under surface of the cover glass, they suffer total reflection, while the others, which mark the boundary of the 180° limit, pass on. The image of the flame, therefore, which is seen when the eye-piece is used, is formed by the rays outside of this limit.———NOTE ON DIAGRAMS EXHIBITING THE PATH OF A RAY THROUGH TOLLES' ⅛ IMMERSION OBJECTIVE, by Professor R. Keith.—A very short note accompanying a plate of diagrams, which is valuable to those who are interested in Prof. Keith's calculations.———NOTE ON MR. WENHAM'S PAPER "ON THE MEASUREMENT OF THE ANGLE OF APERTURE OF OBJECTIVES," by Prof. R. Keith.———REPLY TO THE FOREGOING NOTE, by F. H. Wenham.

*** JOURNAL DE MICROGRAPHIE, (*March, 1879.*)—FECUNDATION OF VERTEBRATES, by Prof. Balbiani, (Second part.)———THE COLLECTION OF CRYPTOGAMS, by Dr. Léon Marchand.—The author is adjunct professor at the Superior School of Pharmacy, in Paris, and has charge of the course of Cryptogamic Botany. This lecture is highly interesting, since it gives an excellent account of the work that is being accomplished in the study of cryptogamic plants in this school; and also

some good suggestions about collecting, preparing and preserving them. There is a full-page plate, illustrating some useful apparatus for collecting and transporting these plants.———NOTE ON THE PASSAGE OF THE EGGS FROM THE OVARIES OF BATRACHIANS, by F. Henneguy.—The eggs leave the ovaries of Batrachians in a manner which is quite distinct from that common in other vertebrates; the peritoneal envelope of the ovary becomes ruptured at the center of each ovule capsule, and the ovules escape. After the passage of the eggs, the external surface of the ovary is pierced with minute orifices which become very apparent when it is stained by carmine. It is probable that the egg is forced from its capsule by the contraction of the latter, but thus far the presence of muscular fibers in this has not been demonstrated.———DIATOMS FROM THE ACHIPELAGO OF THE EAST INDIES, by Dr. P. T. Cleve.———ON MICROSCOPICAL PREPARATIONS, by Dr. J. Pelletan.—This is a letter which it would be well for those who are mounting specimens for the microscope to read with care. The uselessness of a very large proportion of mounted objects for purposes of study is well known. Dr. Pelletan says: "They are often very pretty, placed upon a choice glass, in an irreproachable cell, with varnishes of all colors," *etc.*, but the objects are without intrinsic value. "Certain preparations in Cryptogamic Botany, have some value; certain sections, dissections, or dissociations relative to vegetable anatomy, thin sections of hard bodies, animal tissues, minerals, vegetables, principally sections of wood, are very instructive, but among the other classes of preparations the nomenclature of which fills the catalogues, it is only by hazard that one meets with an interesting slide." "The more expert, prepare immense insects, or enormous Arachnides, entire, after having removed their contents; some are so very skilful that they make preparations of really magnificent aspect. But, unfortunately, the tegument alone is preserved, and the traces that remain of the internal organs are filled with a uniformly transparent mass, in which the microscopist finds nothing to study." We cannot quote further from this article, but we commend its perusal by all who desire to mount objects for study."

*** (*April, 1879*).—ORGANIZATION OF THE ZOÖLOGICAL SERVICE.—An extract from a work of M. Dormadieu, having particular relation to the the microscopical part of the service. The principal subject of interest is a working table, very elaborate in its arrangement. It is illustrated both in perspective and by a sectional view, but no proper idea of it can be obtained except from a more complete description than we are able to give.———CLEAR WORKING DISTANCE, by R. B. Tolles.———HYDRASTIN, by Dr. John King.—Some remarks about preparing the crystals of this alkaloid for the polariscope.———THE USE OF COLLODION FOR MAKING MICROSCOPICAL SECTIONS, by Mathias Duval.—The use of a solution of gum, solidified by alcohol, as an imbedding material is well known, and it is undoubtedly very useful for certain objects. But when

we have to deal with such soft tissues as young embryos, and more particularly the blastoderms, we require a material of a different character. It appears that a clear solution of pure collodion is especially suited to such cases, when employed according to the plan here proposed. After trying successively mixtures of wax and oil, soap and oil, soap, gelatin, and various other media, the author attempted to use collodion. What appeared most objectionable in the use of many of the above mixtures was; first, the want of transparency, not permitting the operator to direct the knife to the desired point; and next the necessity of removing the mixture from the section before mounting, which required so much washing as to endanger its perfection. The tenacity and transparency of collodion brings it to our attention, but at the same time, its contractility and hardness, when dry, only indicate its possible use with resistant and relatively hard objects; it has thus been employed by Dr. Latteux already. For very delicate tissues, like the blastoderms of embryos, it would not be possible to employ it in this condition.

If a drop of collodion be allowed to fall into a quantity of alcohol at 36°, it forms in this liquid a sphere which does not alter in volume, and presents the elasticity and consistence of a piece of caoutchouc, and, at the same time, retains its perfect transparency. The ether diffuses into the alcohol and evaporates, while the solid collodion imbibes the alcohol and does not lose it again by dessication. The method of using this material for imbedding soft tissues is as follows: After hardening in osmic acid and alcohol, or in any other way, and staining with carmine, they are placed in alcohol. From this they are transferred to ether for a few moments, and then to a pure collodion solution, in which they may remain from ten minutes to twenty-four hours, according to the extent to which it is desired to have the collodion penetrate the tissues. They are then placed in alcohol. The collodion solidifies without contraction and all the parts of the tissues are retained in their normal position. Thus prepared the tissues may be cut into sections at once, or preserved indefinitely in the alcohol. The sections may be mounted at once in glycerin, without removing the collodion, as its presence is not to be observed. This medium has other advantages, which we cannot enumerate here.——— NOTE ON THE CONSTITUTION OF THE SPERMATOZOIDS OF THE BULL-FROG, by F. Henneguy.———TERRESTRIAL DIATOMS, by Julian Deby.—A memoir read before the Société Belge de Microscopie, in January, 1879.———FOSSIL CALCAREOUS ALGÆ. From *Nature*, March 27th, 1879.———NEW LABORATORY MICROSCOPE, by Dr. J. Pelletan.—An instrument designed by the writer, fully described.

***ZEITSCHRIFT FÜR MIKROSKOPIE (*No. I, 1879*).—CONTRIBUTIONS TO THE ANATOMY OF THE EYE, by Dr. Ludwig Löwe.—This lecture is illustrated by two large sectional cuts, one of the human eye and the other of an eye from the embryo of a dog, which afford an excellent idea of the structure of this organ and the relation of

the parts to each other.———CONTRIBUTIONS TO THE TECHNIC OF INJECTING, by Dr. Hermann Schäfer.———THE TRAVELLING MICROSCOPE OF CARL ZEISS.—This instrument is illustrated by a fine wood-cut which shows it to be substantially made, as all German stands are, and very compact. The cost is 450 marks for the stand, including four objectives and all accessories.

*** (*No. II, 1879.*)—PROF. ABBE'S APERTOMETER, by Dr. Leopold Dippel.—An excellent description of the apparatus and its use, to which we refer more particularly in another place.———THE OBJECTIVE SYSTEM FOR HOMOGENEOUS IMMERSION, by Carl Zeiss.———THE DIFFRACTION APPARATUS AND EXPERIMENTS TO DEMONSTRATE THE THEORY OF PROF. ABBE.—Both of these articles are clearly written and of the greatest interest. We reserve them for a more complete analysis, to be given at a future time.

*** THE AMERICAN JOURNAL OF MICROSCOPY (*May, 1879*). SURRIRELLA CRATICULA, AN ABNORMAL FORM OF NAVICULA CUSPIDATA, by J. D. Cox.———A FEW NOTES ON PART III., DIATOMS, EDITED BY CLEVE AND MÖLLER, Nos. 109–168, by H. L. Smith.——— SOME REMARKS ON MICROSCOPICAL MANIPULATION, by Prof. H. L. Smith.—This article relates principally to working with the mechanical finger.———PRACTICAL HINTS ON THE PREPARATION OF OPAQUE OBJECTS, by Geo. E. Fell.———THE PREPARATION OF INSECTS FOR MICROSCOPICAL EXAMINATION, by M. J. Underhill.

*** BULLETIN DE LA SOCIÉTÉ BELGE DE MICROSCOPIE (*April, 1879*).—LITHOLOGICAL RESEARCHES UPON THE PHTHANITES OF THE CARBONIFEROUS LIMESTONES OF BELGIUM, by M. A. Renard.

*** In *Zoologischer Anzeiger* for February 3d, is a brief account of the development history of the silk-worm, *Bombyx mori*, by Tichomiroff. In the number for February 17th is an excellent article "On some Variations in the Development of the Lower Organisms," by Prof. Wm. Schmankewitsch. Prof. V. Graber contributes to a later number of the same periodical an article on "Amœboid Epithelium;" and Dr. W. Mayzel describes the "Process of Segmentation in the Eggs of Worms (Nematodes)."

*** The June number of *Grevillea* contains the concluding part of Mr. M. C. Cooke's communication on "The Dual Lichen Hypothesis." The result of his examination of this hypothesis may be summed up as follows:

1. It is not in harmony with existing scientific facts. "The assumption that two separate and distinct organisms are combined in one plant, which, by its own proper system of reproduction, is capable of continuing its species, each individual of its progeny also exhibiting the same phenomena of assumed dual existence, is inconsistent." So also is the assumption that a fungus is "parasitic upon a smaller and weaker organism."

2. "Unless it can be shown that the fact of its parasitism is sufficient to alter the entire character of a fungus, it is not a sufficient cause to account for the existence of Lichens."

The last part of the article is a vigorous argument in favor of regarding the Lichens as simple plants. Mr. Cook considers that the dual hypothesis is doomed.

*** In *Hedwigia* for April Dr. George Winter describes some experiments upon the "Rapidity of Germination of Fungus Spores, and the Growth of the Young Mycelium." The spores from the various plants showed great differences in the rate of germination, some, as *Nectria cinnabarina* and *Botrytis cineria* required respectively only two and one-half and four to four and one-half hours, while others as *Acrostalagmus cinnabarinus* took sixty-five hours. Seven tables showing the growth of the mycelia, are given. *Mucor mucedo*, when cultivated in a nourishing fluid with free access of air, was the most rapid grower.

*** In the May number we notice, among some other articles treating of the algæ, one by F. V. Thümen, entitled "Melampsora Salicina of the Meadow Rust." The writer believes that the plants heretofore classed under this name must be separated into several species, which are enumerated and described. He makes seven species in all.

## MICROSCOPICAL SOCIETIES.

[Space does not permit us to publish the proceedings of societies in full. We are only able to notice the papers read and matters of general interest. We would consider it a favor if secretaries of societies would send us reports of meetings regularly.]

### WELLESLEY COLLEGE MICROSCOPICAL SOCIETY.

The regular meeting was held Monday evening, May 12th; the President, Miss Cook, in the chair. After the reading of the Secretary's report, Miss Whiting called attention to some recent additions to the collection, among which were a case of slides, Ehrenberg's Illustrated Works and two Zeiss objectives, a $\frac{1}{16}$ inch and a $\frac{1}{25}$ inch.

Miss Mussey read a paper on sponge spicules, speaking particularly of those of the *Euplectella*.

Miss Waterman followed with a paper on insect scales.

Miss Cook then delivered a lecture on the eye, first dissecting one and showing its several parts, then speaking of the microscopical structure of the retina.

After this the company adjourned to the Laboratory, where slides were exhibited illustrative of the subject treated.

The Society gave a reception in the Museum of the College on the evening of June 16th.

Dr. Hunt, the President, and many members of the Boston Microscopi-

cal Society were present, and other distinguished friends of science and education.

The exhibits, under fifty microscopes, were mostly specimens of the work done by members of the Society, and many of the objects were illustrated by drawings.

Miss Brown exhibited the anatomy of the cricket, under nine microscopes, showing the trachea, nervous system, digestive tract, inside of proventriculus, labrum, maxilla and mandibles, cornea, and a vertical section of the eye.

Miss Drury exhibited papillæ of the skin with taste-bulbs, touch-corpuscules, skin of frog, hair follicle with oil and sweat gland; Miss Nunn, section of retina, showing seven layers; also several very interesting preparations from the cray-fish, illustrating some original work not yet completed.

Miss Cummins exhibited bread and cheese mould, showing the mycelium and sporangia; Miss Whipple a section of *Nuphæ advena*, showing stellate tissue; also interesting double-stained specimens.

Miss Beattie showed the peristome and operculum of a moss, cells of the petal of pelargonium; Miss Cook, blood-corpuscles of newt and the circulation in the stamins of *Tradescantia*, also circulation in arteries and capillaries of the frog's mesentery.

Living specimens of Hydroids and Bryozoa occupied another table. Two microscopes were devoted to rock-sections. The Sorby-Browning micro-spectroscope, with bright line micrometer, showing absorption bands in blood, attracted much attention. There were also shown microphotographs, multiple images in the beetle's eye, starch-grains of tousles-mois, with the polariscope, and a method of drawing with the camera lucida.

A table was devoted to mounting materials, and the processes of preparing objects were illustrated.

Another table was filled with specimens of the elegant illustrated volumes from the Microscopical Library, and the journals of reference, American and Foreign.

With this exhibition a very pleasant season of microscopical work closed.

MARION METCALF, Cor. Sec.

## STATE MICROSCOPICAL SOCIETY OF ILLINOIS.

The annual meeting was held Friday evening, April 26th; President H. W. Fuller in the chair.

A paper on "Tactile Hairs" was read by Prof. Lester Curtis, which may be summarized as follows:

The tactile hairs, commonly called whiskers, are peculiar to carnivorous animals. The growth of an ordinary hair takes place by the multiplication of the cells which surround the papilla, and the follicle possesses no muscles of volition, or special arrangement of nerve fibers.

The first noticeable peculiarity of the tactile hair, as in the snout of a mouse, is the great size of the follicle, several times the diameter of an ordinary hair follicle. This follicle has a swelling at a point about one-third of the distance from the top, which corresponds with a remarkable enlargement within.

Two-thirds of the lower portion of the follicle is surrounded by striated muscular fibers, which appear to arise from the side of the follicle and then pass off to a considerable distance to become lost in the muscular fibers of the lips. These muscles are furnished with a rich plexus of unusually large capillaries. Other muscles are attached to the hair in a manner somewhat similar to the ordinary erectors of the hair, but are more abundant and of the striated variety.

Within the follicle, and outside the root-sheath of the hair, is a close plexus of very fine capillaries, which send branches over the enlargement before mentioned and form a peculiar ring-like plexus above it. Between the branches of this ring-like plexus there is but little tissue; but in the mouse and cat, at least, it does not form a sinus, as is claimed by some.

The enlargement surrounds the hair excentrically and consists of two parts, the outer of which, when the follicle is divided longitudinally through the center of the hair, is nearly circular in outline and is attached to the inner part by a short, thick pedicel. It is interspersed with oblong nuclei. The inner part is not so wide, but is longer and surrounds the root-sheath like a band.

The speaker considered these last structures to be of a nature similar to the terminal organs of nerves found in other portions of the body, but was not prepared at present to prove this position.

The paper was illustrated by diagrams on the black-board as well as by numerous slides, and closed with a brief bibliography of the subject.

The annual address of the President reviewed the work of the Society for the past year, recommended informal meetings at the residences of members during the summer, and concluded with a general *résumé* of microscopical work for the year.

The Society then proceeded to the election of officers for the coming year, with the following result:

*President*, Dr. H. A. Johnson; *Vice-Presidents*, Prof. H. H. Babcock and Dr. Lester Curtis; *Treasurer*, W. H. Summers; *Recording Secretary*, E. B. Stuart; *Corresponding Secretary*, Dr. Wm. T. Belfield, Rush Medical College; *Trustees*, H. W. Fuller, Prof. E. S. Bastin, Jas. Colgrove, B. W. Thomas and H. F. Atwood.

The Society then passed a vote of thanks to Mr. Fuller, for his faithful efforts in its interest during the period of his presidency, extending over eight successive years.

President Johnson and Messrs. Curtis, Babcock, Fuller and Stuart were elected a committee to appoint a delegate from the Society to the National Committee of Micrometry.

E. B. STUART, Sec.