
N. L. Kellicott.
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William Benjamin Carpenter.

The death of the eminent physiologist and naturalist, William Benjamin Carpenter, C. B., LL. D., M. D., F. R. S., occurred at his home in London on the tenth of November, 1885. Death resulted from severe burns caused by the upsetting of a lamp while he was taking a vapor bath.

Dr. Carpenter was born at Exeter, England, in the year 1813. He studied at University College, London, and afterwards at the University of Edinburgh, where he graduated in 1839. Before graduating he had published an article 'On the Unity of Function of Organized Beings.' His graduating thesis was entitled 'The Physiological Inferences to be deduced from the structure of the Nervous System of Invertebrate Animals.' The subject was treated in a masterly manner, and thus early in his career was manifested that independence of thought and clear perception which have characterized all his work as a teacher and a leader in scientific thought. As a striking instance of this it may be said that in this thesis he first advanced the conception of the reflex action of the ganglia of the cord in articulated animals. This idea met with strong opposition at the time, but has since been universally adopted.

We can but briefly allude to some of the numerous positions of honor and responsibility he has ably filled. Early in life he was appointed Lecturer on Animal and Vegetable Physiology in the Bristol Medical School. In 1844 he became Professor of Physiology in the Royal Institution. About this time he produced one of his important monographs, entitled 'Microscopic Researches into the Structure of the Skeleton of Invertebrate Animals,' which was illustrated with forty plates, still of great value for their accuracy. In the same year he was elected to fellowship in the Royal Society. In 1847 he was appointed Lecturer on Geology in the British Museum. In 1849 he received the appointment of Professor of Jurisprudence in University College. In 1856 he became Registrar of the University of London, a position he held until 1879, when he resigned. While Registrar of the University he was able to devote considerable time to original research.

Perhaps it may be justly said that to Dr. Carpenter's efforts and foresight we are mainly indebted for our present knowledge of the flora and fauna of the deep sea. He strongly urged the subject of deep-sea exploration upon the attention of scientific men, at a time when zoologists almost universally believed that no life could exist in the sea at considerable depths, and finally succeeded in securing a small vessel, the 'Lightning,' in 1868, to prosecute his observations. The results were so unexpectedly rich and promising that the 'Porcupine' expedition soon followed. He also suggested that a naturalist should accompany the north polar expedition of the 'Alert' and 'Discovery' on board the store-ship 'Valorous,' and the results of this cruise were thereby rendered of far greater value. He accompanied the survey ship, 'Shear-

water,' and on this expedition made further observations on the currents of the Straits of Gibraltar. Finally the 'Challenger' was fitted out by the British Government, and made a voyage of exploration around the world, the final reports of which are still unpublished. The last monograph published from Dr. Carpenter's pen was his 'Report on the Specimens of the Genus Orbitolites,' forming volumn vii of the 'Challenger' reports. It was our pleasure to visit him at his home one day, soon after his work on this genus was completed, and to see some of the original preparations from which the drawings for the report were made. We also received a number of typical specimens from the 'Challenger' collections, and brought away in addition to these a complete series mounted by Dr. Carpenter, illustrating all the points in his monograph, which is now in the National Museum at Washington.

In this connection may be mentioned his earlier work on the foraminifera, published by the Ray Society. The system of classification therein elaborated has been followed in its essential features by most subsequent observers.

As an author of books Dr. Carpenter is well known, and few writers indeed have ventured to write learnedly upon so many subjects with the same confidence and success. His books remain as enduring monuments to his vast store of knowledge and intellectual activity. His 'Revelations of the Microscope,' although a popular work, clearly shows the great scope of his abilities, and the great fund of information constantly at hand. His 'Principles of Human Physiology' and 'Principles of Mental Physiology' are standard works at the present day.

About three years ago Dr. Carpenter visited this country, and delivered the Lowell Institute Lectures on Human Anatomy.

Considering that Dr. Carpenter has been interested in the microscope during the greater part of his active life, and, probably more than any other person, has been identified and associated with its gradual improvement from the time of the construction of the first English achromatic microscope objective by Mr. Tulley, of London, the 'telescopic triplet,' we have thought our readers would one and all be pleased to possess an accurate portrait such as we present this month.* The original negative was made about three years ago by Mr. A. Bogardus, of New York city.

In reviewing the long and useful career of Dr. Carpenter, with his unceasing, unselfish devotion to truth, which he valued far more than fame and honors, and comparing it with what we see around us day by day, we are impressed with the thought that but few lives are truly great. Even the inspiration of wisdom, an intimate knowledge of the profoundest truths and noblest conceptions of science, cannot take away from most men the lingering traces of past ages of barbarism. There still remain petty jealousies, blind prejudices, unworthy considerations of self, and these mean thoughts and feelings too often lead us to conceal truth from our own vision, and antagonize progress.

We have often felt there is something wrong in human nature, something incompatible with broad culture or the elevating tendencies of scientific thought. We sometimes ask ourselves, as we see such unbecoming manifestations of petty feelings, whether there is not, after all, something lacking in our system of study and thought. It is as though the study of science were a business for individual profit and aggrandizement rather than a profession for gaining knowledge and seeking for truth. Yet humanity is frail; its faults are

* The plate has been received from the engraver, but not being satisfactory, we have preferred to wait another month to have a new plate made. The portrait will be sent with the February issue.

not entirely those of to-day, but they are inherited from past generations. Hence it is that few lives are truly great and noble, even in the search for truth, but some are greater and more noble than they seem, for after all it is the hidden motive and desire that moulds the character.

So, when a great man passes out of the world, it is hard to fill his place ; yet he leaves behind an example of a life well spent, which will be an influence to be felt long afterward. Such a man was Dr. Carpenter. His death is a great loss to the world, but it could not, in any case, have been long delayed. He leaves behind a legacy more to be prized than the fame and wealth of kings, the memory of a man who was truly great.

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A New Mounting Medium of High Refractive Index.

Professor Hamilton L. Smith has recently discovered a mounting medium which he regards as superior to any hitherto described. It is even superior to the preparations described in these columns in September of last year. These consisted of stannous chloride in glycerin jelly, giving a refractive index of 1.7, and of realgar in arsenic bromide, with a refractive index of 2.4. The new medium, which has a refractive index considerably above that of the stannous chloride medium, is prepared in the following manner :—

Dissolve 1⅓ ounces of antimony bromide in two fluid drachms of a fifty per cent. solution of boro-glyceride. This, when cold, makes a very viscid medium, like old stiff balsam, of a dark, sherry wine color. Mounts made with it in the extremely thin film required are as colorless as with old balsam, and when laid upon white paper the color of the medium is clearly perceptible if it has not been injured by overheating—certainly less than most mounts in styrax.

It is used precisely like Canada balsam. It works easily at a moderate heat, and boils very readily. The heat must be continued until the boiling is nearly over, but care must be observed not to overheat, as the glycerin is liable to burn. When entirely cooled the cover will be firmly attached, as with balsam, and the slide may be cleaned with moist tissue paper, without fear of disturbing the cover.

A finishing ring may now be applied, but Prof. Smith advises that a bit of paraffin should be placed on the slide, melted, and caused to flow around the mount, by tilting the preparation. A vigorous rubbing with a cloth will remove all excess of paraffin, leaving a sloping or bevelled ring around the mount. This operation has preserved mounts for two months already, with no indication of change. Any finishing cement may then be applied.

The medium is only slightly deliquescent, but is decomposed by water and injured by contact with immersion fluids, hence some protection is necessary.

We now quote from Prof. Smith's letter as follows :—

'The boro-glyceride which I have used was prepared for me by Mr. C. F. Booth, of Tarrant & Co., manufacturing chemists, New York. This substance is a hard, brittle, and glassy compound of glycerin and boracic acid, and will no doubt serve an excellent purpose as a mounting material from its antiseptic properties. I use a 50 per cent. solution of this in glycerin.

'I wish to say here that recently, in looking over some of my earliest mounts in the chloride of tin and glycerin medium that I had thrown aside because of leakage (as this material, before I used gelatin, always remained more or less soft, and so made it difficult to clean off the cover before ringing), I was surprised to find that not only had the leakage stopped but that the drop

outside was indurated, and when removed the whole seemed perfectly sealed and showed no tendency to the smearing when wiped hard, that had caused me at first to suppose these mounts were spoiled, and they remain up to the present moment now apparently good. The boro-glyceride 50 per cent. solution will not permit as much chloride of tin to be dissolved as I mentioned in the directions for the gelatin preparation in the September number. A 25 or 30 per cent. solution will be better here, and this medium still answers admirably for ordinary diatoms.

'The gelatin and tin compound is more hygroscopic than the compound of boro-glyceride and antimony; still if properly made and used will answer admirably and remain unchanged, I believe, for any length of time.'

The value of these mounting media is not easily over-estimated. They are not yet in general use, and have not been applied to many scientific investigations. They are not even in the market, and this may be a hint to some of our readers who may wish to make their microscopical work a source of some profit, for there should be a demand for the media among the dealers. There can be no doubt their use will become general among those who use the microscope for very fine work: and it seems not improbable that they will be of very great value to the student of bacteria, making clear the more minute characters that are scarcely discernible in balsam. It needs but a glance at the *Pleurosigma* or the lines on *Amphipleura* to perceive the wonderful benefit to be derived from their application to many researches in biology and histology.

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An Efficient Pipette.

BY D. S. KELLICOTT.

A pipette, or dropping tube, is a very simple piece of apparatus—one scarcely worth while to write about and to take up the space of a scientific periodical—but it is useful, if simple, and when just that particular instrument is wanted, it is indispensable—'for want of a nail,' etc.

An elastic ball pipette, properly constructed, is in every way superior to the simpler dropping tube filled by hydrostatic pressure, and controlled by closing and opening the upper end by the finger. Such an instrument should be prompt; should draw the water up forcibly in order to catch with facility minute swimming forms; it should enable the hand to deliver accurately few or many drops, and the bulb should be so firm that it serves for a handle without forcing out the contents of the tube. It is needless to remark that a person at work needs a number of pipettes—some with wide mouths, others drawn out to a narrow orifice, and others, perhaps, with a special bulbous reservoir blown in the tube. All styles are worked equally well by the arrangement which I started out to describe.

This is made from the cheap playing balls which may be had of suitable sizes for a few cents each. I formerly used them by enlarging the air opening by means of a heated wire to fit the upper end of the glass-tube, but by use it soon got loose and worthless. To prevent the tearing out of the rubber I now bore an additional hole through the opposite side of the ball, and pass the tube through both openings: the protruding upper end is then hermetically sealed or plugged by a cork. The ball is now firmly supported, and, after a hole has been drilled or filed through the tube so as to come within the ball, the pipette is complete and it is durable. The walls of the bulb are stiff so that a strong suction may be had if desired, and the instrument used by grasping the ball without danger of dropping the contents at the wrong time and place.

The tubes require cleaning by means of a little cotton on the end of a wire, so those drawn to a point had better

be stopped with a cork, whilst the wide-mouthed ones may be sealed by the blow-pipe, or if tubes are to be cleaned by immersion in acid, etc., all may be thus sealed.

An equally good, perhaps better, way to secure a pipette with all required advantages is as follows: Take a proper piece of large rubber tubing, *e. g.*, 3 inches long with half or three-fourths inch bore, and two short rubber corks to fit; pass the tube through one stopper and into the other; drill a hole in the glass-tube near the upper one, and bring all to place. This form works promptly, is durable, and has one advantage, when laid on the work-table the point is free from the same so it does not gather dust.

I am aware there is little new microscopical apparatus to be devised under the sun, so many may be using similar or equally good pipettes, none use better and many use poorer. These may act on the above suggestions and make for themselves the best.

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Photo-Micrography.—III.

BY THE EDITOR.

2. Apparatus (continued).

b. Microscope and accessories, camera, etc.

As regards the microscope stand, but little need be said, since any good stand will serve perfectly well. There is an advantage, however, in a large body-tube, particularly for work without an eye-piece. A mechanical stage is desirable, and a sub-stage also.

In arranging the microscope for photo-micrography the body-tube should be lined with dead-black cloth, to avoid reflections. If the ocular is not to be used, remove the draw-tube, and prepare a lining for the body-tube as follows:—Choose some rather heavy, smooth paper, and a strip of black cloth as long as the body-tube and wide enough to line it, the edges overlapping by half an inch, more or less. Paste the cloth on one end of the strip of paper, and let it dry. Then make a roll, the cloth inside, and fit it in the tube. Apply some mucilage at the end which, when dry, will maintain the paper tube of the proper size, remove it from the body-tube and apply mucilage along the entire length. The tube is then ready for use. In this way we have made many a paper tube, which has more than served its time for its intended purpose. By rolling several thicknesses of paper, thickly coated with mucilage, together, very strong and serviceable tubes can be made, which may serve as draw-tubes, fittings for accessories, etc.

We now come to the question whether or not oculars shall be used. In the one case the camera may be very short, since the image is magnified rapidly by the very divergent rays from the ocular as we recede from it. In the other case the magnification is obtained by increasing the length of the camera, taking the more slightly divergent rays directly from the objective, sometimes interposing an amplifier to increase the power, or to improve the definition.

Having seen excellent results from both methods, we are not disposed to express a very decided opinion against the use of the ocular, although strongly disposed to favor the other plan. The reasons for this may be briefly stated. In the first place, none of the photo-micrographs produced with the ocular that we have seen have been of a nature that would test the highest capabilities of an objective. It is true, we have seen photographs of the *Amphipleura pellucida* taken in this way, but in such cases the field of view has invariably been very small, only a portion of the frustule being shown, so that it would be impossible to judge of the definition over a larger field, such as would be obtained with the same magnification without the ocular. It is scarcely to be expected that the widely diver-

gent rays coming from an ocular will project an image upon a plain surface with the same accuracy as the rays coming directly from the objective. The ocular, it would seem, inevitably must introduce aberrations of its own, which, while they might not be noticeable in a small field, would become very conspicuous over a large plate. From considerations of this nature we have hitherto* advised the use of the ocular only for small pictures. By this is meant, for example, such photographs as will cover a plate not over four inches square, or such as would be required for making positives for the projecting lantern by contact printing. Therefore, a camera of the ordinary 4×5 size is quite large enough for use with the ocular, and Prof. Aubert, as will be seen further on, speaks highly of the small Walker camera, which takes plates only $2\frac{3}{4}$ by $3\frac{1}{2}$ inches, mounted above the ocular.

As regards working without an eye-piece, this is the plan followed by Dr. Woodward in all his fine work, for which the Army Medical Museum became famous in his day. The great advantage of this method is seen when large plates are used, requiring sharp definition over a field ten or twelve inches in diameter. A long camera is required for such work. At the National Museum, where 8×10 plates are used, the camera-bed is $5\frac{1}{2}$ feet in length. The ordinary cameras are not made to extend sufficiently, but a conical tube of metal can be fitted to the front, as shown in fig. 1, or a similar cone can be easily constructed of paper, in the manner already described. The length of the cone must be governed by the size of the plate to be covered and should be determined by experiment.

Although the ordinary view-cameras may be used perfectly well, Mr. Walmsley has devised a more elaborate photo-micrographic and copying camera, which, as its name implies, is peculiarly adapted to this work. It is represented in fig. 2. As will be seen from the cut, the bellows is capable of very considerable extension, the base being separable into two parts. The ground glass has a large circle of thin glass cemented in the centre by balsam, which is said to give a very fine screen for focussing upon. The central part of the camera opens by a door on the side, for convenience in copying pictures, making positives for the lantern, etc. The plate-holder is single and opens at the back (the most convenient way), and it takes plates $4\frac{1}{2}\times5\frac{1}{2}$ or $3\frac{1}{4}\times4\frac{1}{4}$.

In working in the manner here proposed it is advisable to use an amplifier, not merely to gain in magnification, but for reasons that have already been given but a short time since.* We may, however, briefly refer to the subject again in this place. It will be obvious upon consideration

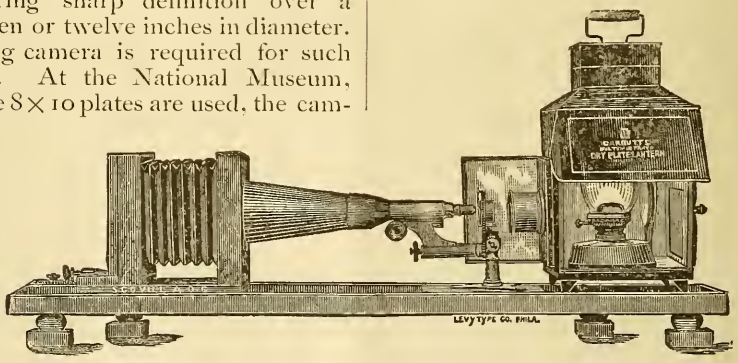

Fig. 1.—Scovill's Photo-Microscopic Equipment.

* Vol. vi, p. 168.

* Vol. vi, p. 168.

that as the screen or sensitive plate, upon which the image formed by an objective is received, is moved further away, the objective must be brought nearer to the object in focussing.

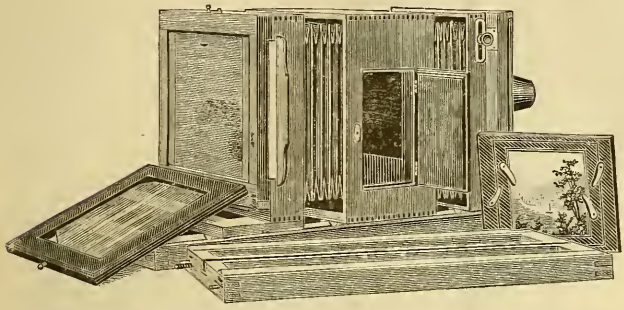

FIG. 2.—Walmsley's Photo-Micrographic and Copying Camera.

The objective, however, being made for use with an ocular, it will readily be seen that it can only be working at its best when the rays of light pass through it in the same manner as they do when viewing an object with the ocular. Obviously, therefore, when the objective approaches nearer the object, to form an image on the distant screen, the lens must be working at a disadvantage. The importance of this fact may be more readily apprehended when one considers how sensitive some objectives are to slight changes in the length of body-tube. To correct, or rather to obviate, any defects in the image due to this cause, Dr. Woodward, after numerous experiments, succeeded in using an amplifier in such a manner that the objective, being properly focussed upon the object with the ocular in the usual manner, remained in that position, the image being focussed on the screen by moving the amplifier only. In this way the finest photo-micrographs yet made have been produced.

We have omitted all reference to the method of working without a camera in a dark-room, so much favored in the past by various workers, for the reason that it involves considerable expense in fitting up, and the plan does not offer any advantages, so far as we can discover.

It should not be inferred from anything we have written that large plates are required for scientific purposes. On the contrary, a 4×5 plate serves every purpose, and for the amateur it is far better than larger

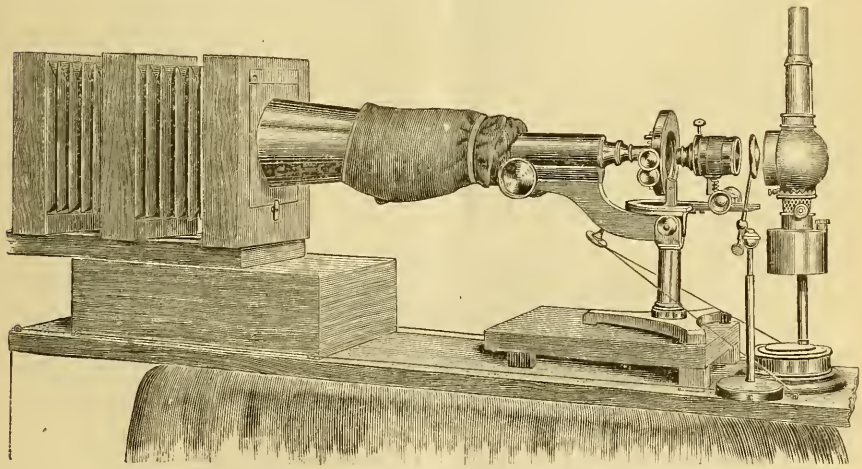

FIG. 3.—Walmsley's Photo-Micrographic Equipment.

ones, as regards convenience, to say nothing of expense. Dr. Sternberg, if we recollect aright, uses 4×5 plates for all of his work. Dr. Van Heurck's photograph of the *A. pellucida*, which we have at hand, is only 3¼ inches in length, and shows but a small portion of a frustule. The fine photographs of diatoms by Mr. J. D. Cox are mounted very neatly on cabinet cards. Some of the most attractive mounts we have seen are from Dr. G. A. Piersol, who has adopted a plain, delicate yellow card six inches by eight, for prints evidently made from 4×5 plates. Probably the amateur will usually be content with plates no larger than this, which is a very convenient size.

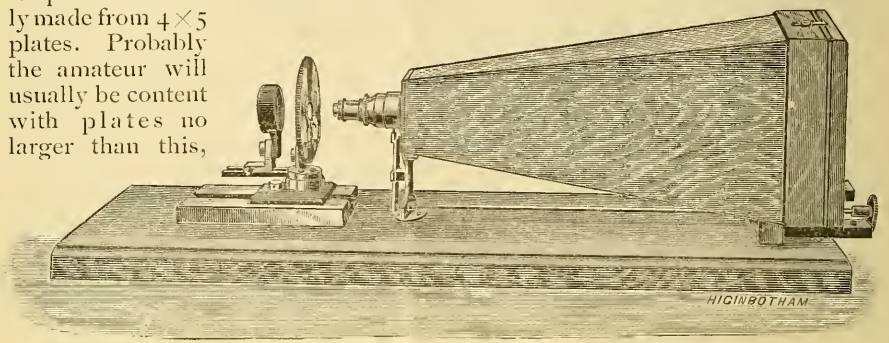

Fig. 4.—Bausch & Lomb Photo-Micrographic Apparatus.

We come now to consider the arrangement of the camera in connection with the microscope. A heavy, perfectly flat and smooth board should be provided as a common base for microscope, camera, and if possible, also for the lamp or heliostat. Place the microscope on the board with the body-tube perfectly horizontal, and arrange the camera so that a line passing through the optic axis of the microscope will pierce the centre of the ground glass of the camera. Then see that the whole apparatus is in line, and mark the position of camera and microscope. The best way to do this is to glue some strips of wood around the base of the microscope, and along one side of the camera. The latter should be very carefully applied, so that the camera may be moved back and forth without getting out of line. In some instances the camera requires to be raised on a block. It should then be securely fixed in position, and it is well to screw the block firmly to the base-board.

One of the simplest arrangements is that of the Scovill Manufacturing Company, represented in fig 1. The entire apparatus is placed on a solid board, which, to avoid jars, rests upon rubber cushions. The source of light is Carbutt's lantern, already figured on page 225 of the preceding volume. This outfit can be purchased without the lantern if desired.

We now come to Mr. Walmsley's outfit, which is illustrated in fig. 3. It scarcely requires any further description, as the whole design is so clearly evident from the cut. However, the focussing device deserves especial mention. It was applied by Mr. Walmsley some time ago, and was also independently used by Dr. Sternberg in a slightly different form. A groove is turned in the periphery of the fine adjustment screw, around which a small cord is passed, and carried through a succession of screw-eyes on either side of the base-board to the rear, where a couple of small leaden weights are attached to its ends, thus keeping the cord taut. A very slight pull on either side, whilst the eye is fixed upon the image on

the screen, suffices to adjust the focus with the utmost exactness.

In Dr. Sternberg's apparatus the cord is run in a somewhat different way. One end of the cord is attached to a spool, around which it is wound several times, within easy reach of the operator. The cord then runs over the fine adjustment, and a weight is attached to the other end. The spool revolves with sufficient friction to prevent any movement until it is turned by the hand.

The apparatus at the National Museum was arranged by the writer in a somewhat different manner. There are two focussing cords running under the camera, one working the fine adjustment, the other the sub-stage of the microscope. These cords act upon the respective parts through the intervention of pulleys devised by Mr. Zentmayer. The cords have a weight at each end, so balanced that the focus can be accurately adjusted, and the slight friction will maintain it so.

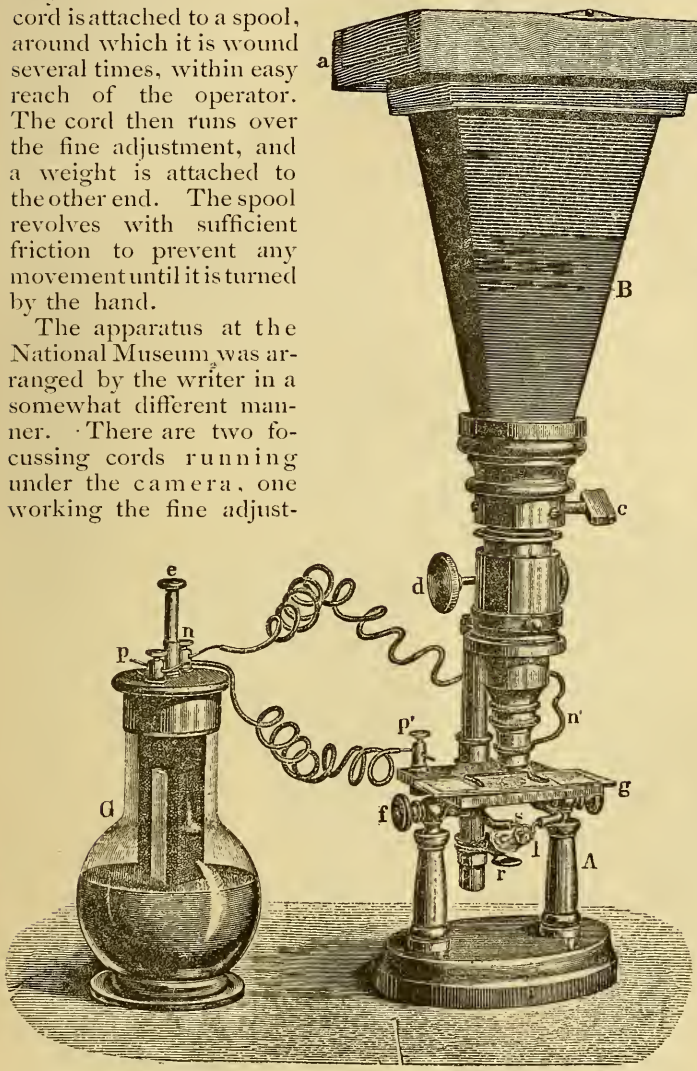

FIG. 5.—Camera for Vertical Microscope.

A very different form of apparatus is that shown in fig. 4, in which the microscope is dispensed with, and the objective screwed into the tube of the camera itself. A focussing-rod passes under the camera, as will be seen in the figure. We have not used this apparatus, which was devised by Mr. H. F. Atwood, and are therefore not qualified to say much about it. However, we do not doubt it has some merit for amateur work, one of its good features being the absence of a long microscope tube, which is frequently very much in the way.

One more form of apparatus remains to be illustrated, the method of using the electric light with the vertical microscope. This is shown in fig. 5, which represents a German outfit complete.

Prof. Aubert mounts a small cam-

era, known as Walker's pocket-camera, above the eye-piece, with the microscope vertical, and with this photographs objects of all kinds, even in liquids. In a recent letter he wrote as follows:—'I have had an adapter made which slips over the eye-piece and accurately fits the tube containing the landscape lens, thus giving rigidity to the whole apparatus. By keeping the landscape lens in the tube, one loses light, it is true, but no correction is necessary for actinic focus. I have other and larger cameras, but generally use the pocket-camera when the object will permit.'

Dr. Sternberg's apparatus differs from all others in that his camera is suspended upside down from a heavy wooden beam at such a height that focussing is done while standing erect. This is a plan to be highly recommended; and we are inclined to think it would be better to suspend it still higher, so that one can walk under the apparatus, mounting on a small platform to focus and manipulate. It would save considerable floor-space, and would not be so inconvenient as might be supposed at first thought.

We must now proceed to consider the subject of illumination, and the apparatus for that purpose.

[*To be continued.*]

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Bulloch's Lithological Microscope Stand.

The general construction of this stand, which has been mentioned before in these columns, is shown in the illustration (fig. 6). It is similar to the professional stand, except in the following details:—There are two stages, one with a plain, sliding object-carrier. Each stage is graduated to fifteen minutes of arc, reading by a vernier to twenty seconds, and can either be revolved by hand or by a tangent-screw, as shown in the illustration, which also acts as a slow motion. The worm cut on the periphery of the stage has 360 teeth equal to single degrees, and the tangent-screw head is divided into sixty parts, so that each division reads to one minute. The tangent-screw can be thrown in or out of connection as required. This arrangement is common to both stages. The second stage, as shown in the illustration, is furnished with a sliding object-carrier, and with micrometer screw movements in two directions for the direct movement of objects without reference to magnification. The screw-threads are one-half millimetre, the head being graduated to 250, so that each division reads to two microns (.002 mm.) which may be again subdivided by a vernier into tenths. At the side of the limb there is a scale reading to half millimetres, and the slow motion screw-head is graduated to 300 divisions, reading to 1 micron. The polarizing prism below, fitting in the sub-stage, has a graduated circle of degrees and a spring catch at each 90°. The analyzing prism at the lower end of the body-tube has a revolving movement by a lever of 90°, and can be removed by a slide similar to that of Wenham's binocular prism. There is also at the lower end of the tube a Klein quartz plate, and a centring nose-piece. There is a gonometer eye-piece with crossed spider lines, a Nichol prism, and a calc-spar plate. The fitting is made adjustable, for if the calc-spar is not cut in the proper direction, the cross cannot be placed in the centre of the field without slightly tilting the crystal. To change from polarized to ordinary illumination the prism below the stage can be turned aside, leaving the wide-angle condenser in position; or the whole sub-stage can be turned aside, which movement is supplementary to swinging on an axis with the object on the stage as a centre. When the condenser is not required there is a supplementary sub-stage for the lower prism, so that the prism can be used close to the object, and no light admitted except that which has passed through the prism.

Each stage has stops for a Maltwood finder, and also stops for the small

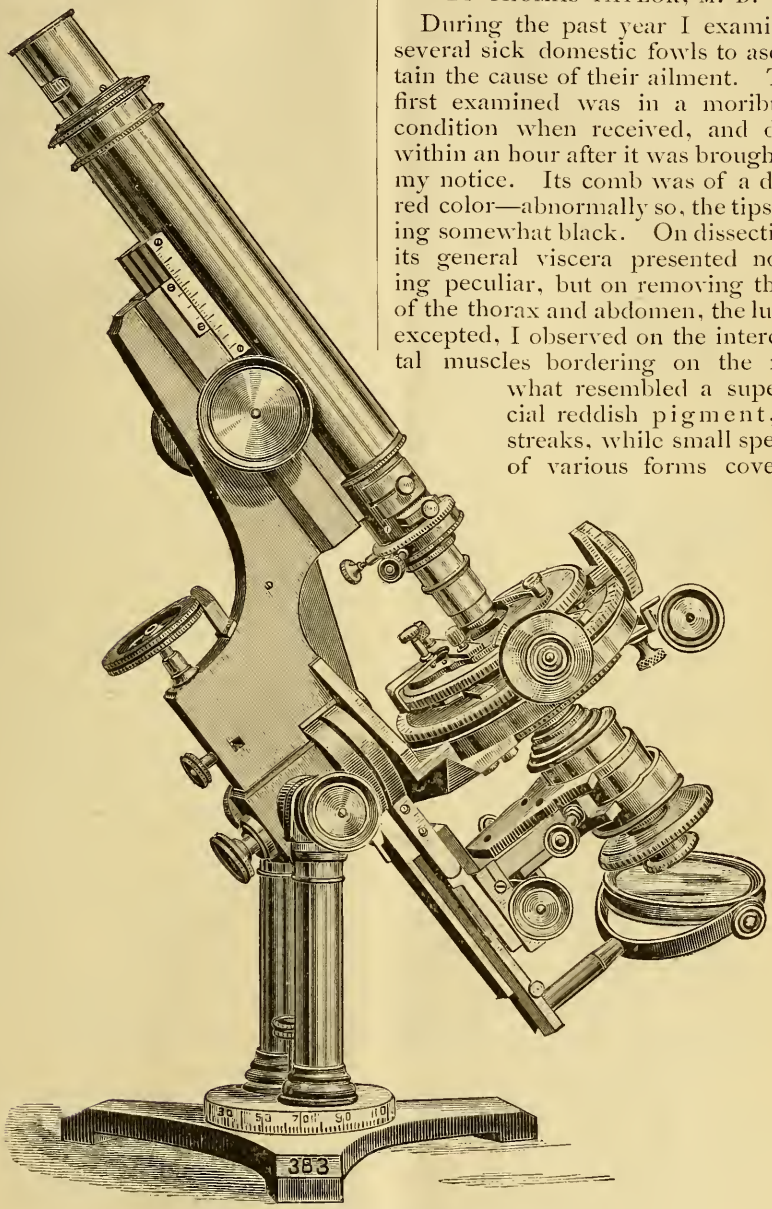

FIG. 6.—Bulloch's Lithological Stand (⅓ actual size.)

lithological slides. Mr. Bulloch has already made several of these elaborate stands to order, which have given much satisfaction to their owners.

Internal Parasites in Domestic Fowls.*

BY THOMAS TAYLOR, M. D.

During the past year I examined several sick domestic fowls to ascertain the cause of their ailment. The first examined was in a moribund condition when received, and died within an hour after it was brought to my notice. Its comb was of a deep red color—abnormally so, the tips being somewhat black. On dissection, its general viscera presented nothing peculiar, but on removing those of the thorax and abdomen, the lungs excepted, I observed on the intercostal muscles bordering on the ribs what resembled a superficial reddish pigment, in streaks, while small specks of various forms covered the lining of the abdominal cavity. These varied in size from the point

* Abstract from Pamphlet published by the Department of Agriculture.

of a pin to that of a small pinhead. On removing a small portion of this colored matter, and viewing it under a suitable power of the microscope, I found it to consist of living mites (*Acari*) in various stages of growth. I next removed a small portion of the lung tissue, and placing it under the microscope, here again discovered several living mites. Another portion was removed from the lungs, not exceeding half a grain in weight, when three more mites were dis-

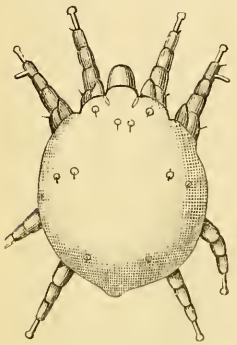

FIG. 7. Cytoleichus Sarcoptoides.

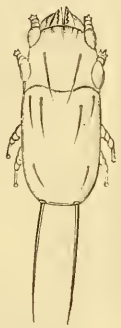

FIG. 8. Laminosioptes Gallinorum.

covered. These last were so lively that it was difficult to keep them long in view without changing the stage.

This mite closely resembles *Cytoleichus sarcoptoides* Mègnin. Although this species has not hitherto been found in America, it is known in Europe, and has been found in such habitats as above described; and Mègnin states that it causes the death of wild and domestic fowls. He says that they are found in the air passages of the lungs, in the bronchial tubes and their divisions, in the bones with which the air sacs communicate, and in other cavities. They are also found in the bronchi of birds, and, when they are extremely numerous, cause titillations of the bronchial mucous membrane, indicated by a slight cough, in some cases causing symptoms of asphyxia, and of congestion, to which the birds may succumb. He instances an example in the case of a pheasant which died of an unknown disease, and in which, when dissected, this obstruction of the bronchi was well manifested.

I think it probable that these mites, after they have effected a lodgment in the lungs, bore through the pleura and invade the thoracic and abdominal cavities, where they breed in large numbers, producing great irritation, and ultimately the death of the fowl.

About two months after the dissection of the first fowl in which I found the mites already described, a second fowl in a moribund condition was brought to me for examination by the same gentleman who brought the first. The comb of this fowl was also highly engorged with blood, and the tips black. Its crop was greatly distended. It was unable to stand up, breathed with difficulty, yet exhibited considerable strength when about to be killed. It had been sickly during the previous four weeks. I took the precaution in this case to remove the skin so that I could examine the cellular tissue when I observed great numbers of small, white, opaque specks, of various dimensions, varying in size from the one-hundredth of an inch to the one-twelfth of an inch in diameter. When viewed under the microscope, the tissue showed within its folds and cell structure numerous mites which proved on examination to be *Laminosioptes gallinorum* Mègnin. Further investigation showed that the opaque markings above alluded to contained, in many instances, the remains of one or more of these mites. The substance of the opaque specks was calcareous. The habitat of these mites seemed to be confined to the cellular tissue wholly. I examined the viscera and cavities of this fowl, but found neither living mites nor their remains, or calcareous specks.

Mègnin states that in Europe this acarus has been found in all turkey

hens, and especially in foreign turkeys of the family *Phasania*. He says that these acari gather in millions in the cellular tissue and destroy the fibres, but without causing any other change than the production of the calcareous concretions spoken of. He further says: 'They have been noticed in such numbers in old birds as to leave no doubt as to their being the cause of death.' The existence of either of the mites above described, in American fowls, has not hitherto been known.

From the results of these examinations, it seems probable that a considerable amount of disease prevailing among American domestic fowls, and not referable to any known type, may be due to the presence of such parasites as I found in the cases above mentioned. Investigations in this direction may therefore have an important bearing on the healthful raising of domestic fowls.

—o—

Staining Tissues in Microscopy.—VII.

BY PROF. HANS GIERKE.

[*Continued from p. 236, vol. vi.*]

140. Adler. Vorläufige Mittheilung über eine mit Silberimbibition gemachte Beobachtung. Zeitschr. f. rat. Med. 3. Reihe, xxi, 160.

The net-like figures that appear on epithelium after treatment by silver nitrate are considered to be fibres similar to elastic tissue.

141. Broueff und Eberth. Zur Kenntniss der Epithelien. Würzb. naturwiss. Zeitschr. v, p. 34.

These authors confirm v. Recklinghausen's treatment of epithelium. The silver salt is precipitated in the cementing substance between the cells.

142. Harpeck. Ueber die Bedeutung der nach Silber imprägnation auftretenden weissen lücken und spaltähulichen Figuren in der Cornea. Arch. f. Anat. 1864. Heft. 2, p. 222. and

143. Hartmann. Ueber die durch den Gebrauch der Höllensteinlösung künstlich dargestellten Lymphgefässanhänge, Saftkanälchen und epithelähnlichen Bildungen. l. c., p. 235.

Both authors explain the appearances in the cornea in epithelial and connective tissue, after impregnation with silver, as fallacious indications of tissue elements, being merely the result of artificial treatment. The first thinks that in manipulating the cornea cracks are produced that fill with the silver precipitate. The second considers the network of lines between the endothelial cells as a peculiar form of precipitate, resulting from the combination of the silver with the constituents of organic tissue, albuminates, and alkaline chlorides.

144. His. Ueber ein perivasculäres Kanalsystem in den nervösen Centralorganen und über dessen Beziehungen zu dem Lymphsystem. Zeitschr. Wiss. Zool., xv, 127.

His adheres to his previous statements.

145. Auerbach. Tageblatt der 40. Versamml. deutsch Naturf. u. Aerzte No. 6;

Untersuchungen über Blut und Lymphgefässe. Arch. f. path. Anat., xxiii, 340.

Auerbach does not believe in v. Recklinghausen's cement substance, but thinks the black lines result from combinations of the silver salt with albuminous substances and with sodium chloride deposited in accidental grooves on the epithelium.

146. Henle. Bericht über die Fortschritte der Anatomie im Jahre 1866. Zeitschr. f. rat. Med. 3. Reihe. xxx Heft 1, p. 6.

Henle confirms Auerbach's views.

147. Hüter. Zur Pathologie der Gelenkflächen und Gelenk-

kapseln, mit einem Kritischen Vorwort über die Versilberungsmethode. Arch. path. Anat., xxxvi, 25.

148. Schweigger-Seidel. Die Behandlung der thierischen Gewebe mit Argentum nitric. Bericht der Sachsischen Gesellschaft d. Wissensch, 1866, p. 329.

These authors agree entirely with v. Recklinghausen as to the significance of the silver deposit.

149. Federn. Untersuchungen uber die Bedeutung der Silberzeichnungen an den Capillaren der Blutgefässe. Weiner Sitzber. der Acad., liii.

Federn has grave doubts as to the results of the silver treatment.

150. Müller. Histologische Untersuchungen über die Cornea. Arch. pathol. Anat., xli, 110.

In Müller's method silver iodide is used with silver nitrate. The preparations are first immersed in a 1% solution of silver nitrate in the dark for 2–3 minutes, then add a small quantity of a silver iodide solution made by the help of potassium iodide. Move about in this, wash in distilled water and expose to the light for two days in a 1% solution of nitrate of silver oxide. The nucleus will remain uninjured by this method.

151. Ranvier. Journal d'Anatomie, 1868, No. 3. p. 275.

After the preparation is removed from the silver solution it is washed in distilled water and exposed to the light. It is then placed in a 1% solution of gold chloride. In order to stain the nucleus use carmine solution in which the ammonia is neutralized by oxalic acid. The preparations are to be preserved in a mixture of equal parts of a 5% solution of oxalic acid and glycerin.

152. Legros. Note sur l'épithélium des vaisseaux sanguins. Journ. de l'Anatomie, 1868, No. 3, p. 275.

A solution of sodium hyposulphite is used to avoid the undue darkening of the preparation.

153. Robinski. Recherches microscopiques sur l'épithèle et sur les vaisseaux lymphatiques capillaires. Arch. de Physiol., 1869, p. 451.

The tissues are exposed 30 seconds to the action of a silver solution of 0.1–0.2%. The limiting membrane of the cells is stained, not the cement substance between them. Hartmann's earlier assertion (143) that silver stainings are deceiving, withdrawn by authority of Hartmann himself.

154. Schwalbe. Untersuchungen über die Lymphbahnen des Auges und ihre Begrenzungen. Arch. mikr. Anat., vi, 1.

Schwalbe thinks the appearances of the precipitate due to an albuminous fluid flowing over the surface of the membrane. Compare Auerbach and Schweigger-Seidel, No's. 145 and 148.

155. Feltz. Recherches expérimentales sur le passage des leucocythes à travers les parois vasculaires. Journ. de Anat., 1870, p. 33.

Feltz explains all silver lines as artificial productions such as may be obtained by the treatment of albumen or collodion films with silver. They may also be seen on photographic paper prepared with silver salts and exposed to the light.

156. Robinski. Die Kittsubstanz auf Reaction des Argent. nitric. Archiv. Anat., 1871. p. 184.

Repeats the statements made in 153.

157. Severin. Beiträge zu der Lehre von den Entzundungen. Dorpat, 1871. Diss.

A warning against false conclusions. Surfaces without epithelium may show a black network.

158. Soboroff. Untersuchungen über den Bau normaler und

ekstatischer Venen. Arch. pathol. Anat., liv, 137.

Another disciple of v. Recklinghausen.

159. Reich. Mikroskopische Studien mit Silbersalpeterlösung au den Gefässen des Auges, und anderer Organe. Sitzber. d. Wein. Acad., 1873.

Reich uses a most excellent method of staining vessels with silver. He first uses a cleansing injection of distilled water or saltpeter $\frac{1}{8}$–$\frac{1}{4}$%, then a $\frac{1}{6}$ to $\frac{1}{4}$% solution of silver nitrate, followed after a few minutes by a milk-warm gelatine injection. The material is then laid in alcohol, exposed to the light, and finally examed in water or glycerin. The views of v. Recklinghausen on the meaning of the lines are adopted.

160. Golgi. Sulla struttura della sostanza grigia del cervello. Communicazione preventiva. Gazz. med. Ital. Lomb. Ser. 4, t. vi.

The silver staining is recommended for central nerves. Small pieces, hardened in potassium bichromate, are subjected to long treatment with $\frac{1}{2}$–1% solution. The nerve elements become black.

161. Torquato Beisso. Del midollo spinale. Genova, 1873, p. 4 f.

Describes a method like the last. Sections of the spinal marrow, hardened in alcohol, are dipped 1–2 minutes in an alcoholic solution of silver nitrate.

162. Rouget. Mémoire sur le développement, la structure et les proprietes physiologiques des capillaires sanguins et lymphatiques. Archives de Phys., p. 603, 1873.

To bring out the details, soak 3–5 seconds in silver nitrate 1 to 750–1000, wash and repeat the nitrate, finally expose to light in glycerin. The preparations may be treated 2–3 hours in a mixture of glycerin, alcohol, and ammoniacal carmine.

EDITORIAL.

Publisher's Notices.—All communications, remittances, exchanges, etc., should be addressed to the Editor, P. O. Box 630, Washington, D. C.

Subscription price $1.00 PER YEAR *strictly in advance. All subscriptions begin with the January number.*

A pink wrapper indicates that the subscription has expired.

Remittances should be made by postal notes, money orders, or by money sent in registered letters. Drafts should be made payable in Washington, New York, Boston, or Philadelphia.

The regular receipt of the JOURNAL, which is issued on the 15th of each month, will be an acknowledgment of payment.

The first volume, 1880, is entirely out of print. The succeeding volumes will be sent by the publisher for the prices given below, which are net.

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Vol. III (1882) complete, $2.00.
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Vol. V (1884) complete, $1.50.
Vol. V (1884), Nos. 2–12, $1.00.
Vol. VI (1885), $1.00.

INOCULATION TO PREVENT HYDROPHOBIA.—It is well known that the investigations of Pasteur upon this dreaded malady have been so promising of good results that already several patients have applied to him for inoculation with the virus he has cultivated. Among others, two children from Jersey City, who were bitten by a mad dog not long ago, have been sent to France to be treated in this way.

Mr. Pasteur has found by a course of successive inoculations of rabbits with marrow of a mad dog, his experiments extending over a period of three years, that the period of incubation of successive inoculations from rabbit to rabbit is at first fifteen days, but gradually becomes less, until seven days is the uniform period of incubation. When the virus is reduced to this condition, he has been able to render a dog proof against rabies by a series of daily inoculations conducted in a peculiar manner, using the marrow of affected rabbits soaked in sterilized broth for inoculation.

In *Popular Science Monthly* of January is a translation of an article by Mr. Pasteur, read before the Paris Academy of Sciences, from which we take the following extract:—

'By the application of this method I had succeeded in getting fifty dogs, of various ages and races, proof against rabies without having had a

single failure, when, on the 6th of July last, three persons from Alsace unexpectedly presented themselves at my laboratory : Theodore Vone, a grocer of Meissengott, near Schelstadt, who had been bitten in the arm on the 4th of July by his own dog, became mad : Joseph Meister, nine years of age, who had been bitten by the same dog at eight o'clock in the morning of the same day, and who, thrown to the ground by the dog, bore the marks of numerous bites on his hands, legs, and thighs, some of them so deep as to make walking hard for him. The more serious wounds had been cauterized only twelve hours after the accident, or at eight o'clock in the evening of the same day, with phenic acid, by Dr. Weber, of Villè ; the third person, who had not been bitten, was the mother of Joseph Meister.

· At the autopsy of the dog, which had been killed by its master, we found its stomach filled with hay, straw, and pieces of wood. It was certainly mad. Joseph Meister had been picked up from under it covered with froth and blood. M. Vone had marked bruises on his arms, but he assured me that the dog's teeth had not gone through his shirt. As he had nothing to fear, I told him he might go back to Alsace the same day, and he did so ; but I kept little Meister and his mother.

· The weekly meeting of the Academy of Sciences took place on the 6th of July. I saw our associate, Dr. Vulpian, there, and told him what had passed. He and Dr. Grancher, Professor in the École de Médecine, had the kindness to come and see little Joseph Meister at once, and ascertain his condition and the number of his wounds, of which there were no less than fourteen. The opinion of these two physicians was that, in consequence of the severity and number of the bites upon him, Joseph Meister was almost certain to have hydrophobia. I then informed them of the new results which I had obtained in the study of rabies since the address I had delivered at Copenhagen a year previously. The death of this child seeming inevitable, I decided, not without considerable and deep anxiety, as you may imagine, to try upon him the method with which I had had constant success on dogs.'

——o——

Postal Club Boxes.—Box W² was received November 30th, containing some very interesting preparations from Camden microscopists.

1. Stained fern frond. J. L. De La Cour. The staining is very well done, by the process given by Mr. A. C. Cole. The dried frond is bleached in Labarraque's solution and transferred to alcohol of 50%. It is then prepared with a solution of acetate of alumina, stained with carmine and washed in acidulated water. It is thus stained red throughout, but by soaking in a solution of iodine green (3 grains to 1 ounce of alcohol) and washing in absolute alcohol, it becomes double stained, red and green, in a very beautiful manner.

2. Head of horse-fly. A. P. Brown.

3. Amphipleura in three media. C. H. Kain. Specimens mounted in Canada balsam, styrax, and balsam of tolu, to show the relative visibility of the frustules and their markings. The styrax seems to have some advantage over the balsam tolu, but the latter is decidedly superior to Canada balsam in making the markings visible.

4. Section of blood-root. C. H. Kain.

5. *Cyclops* with *Epistylis*. C. Bowden. A female with a fine colony of vorticellas, *Epistylis* (*digitalis?*), attached to its back.

6. *Bacillus tuberculosis*. M. F. Middleton.

Box V² was received Dec. 9th. It contained a number of very interesting slides, two or three worthy of especial mention :—

1. Longitudinal and transverse sections of twigs from the stomach

of *Mastodon giganteus*. A. Waterhouse. These are from the mastodon found near Jamestown, N. Y., of which about a bushel were found. 'L. B. H.,' who is rather critical concerning the preparations in this box, says, 'a specimen (better prepared) should be in every geological cabinet.' This is not a bad preparation of the kind, although when we see sections made intentionally thicker at one part than at others we are inclined to take it *cum grano salis*. 'N. L. B.,' desires to know, 'what wood is it?' This question he is doubtless quite as able to answer as any other member of the Club.

2. A Sertularian from Oregon. W. C. J. Hall. The preparer desires to know the name of the specimen. Such questions as this should receive answer in the letter-packet, although, for the information of the inquirer, the answers will be of little value, except through the medium of these notices. Certainly some member of the Club can answer almost any such question as this that is likely to be proposed. If those who are able would spare the time to name specimens it would be of great advantage to the members, and, since those who once receive a box are not likely to see it again, these columns are always open for replies to such inquiries.

3. Cuticle of *Equisetum hyemale*. Samuel Briggs. 'L. B. H.' says it should be cleaned from other tissues—try nitric acid or burning.

4. Micro-photograph of Ex-Governor R. E. Fenton. Sereno Ayres, the preparer, says he does 'not present this as a superior specimen of the art, but as one of the first efforts by a process quite different from the ordinary photograph process.' He then reminds the members that some time ago he asked for information about the process of micro-photography and failed to obtain any information from the Club, and states that 'I have since discovered the process by which the enclosed was produced.' All this is interesting enough, but it occurs to us that the preparer has received about as much information from the Club as he has given to the Club about this subject. The result is not bad, and no doubt it would interest the members of the Club to know the process. We should say it is an albumen picture, and if application had been made to the Journal the inquiry would not have remained unanswered. As the apparatus required is very easily made, we shall describe the process of making micro-photographs in these columns at some future time.

5. Longitudinal and transverse sections of mistletoe. R. R. Rogers. 'L. B. H.' says the specimen was 'evidently crushed in the cutting.' It is too thick to show anything satisfactorily.

6. Alga, *Centroceras*. S. G. Love. Mounted dry, showing fructification. It will be difficult to recognize the fruit, however, unless one knows just what to look for, and where to find it. 'L. B. H.' says it should be mounted in glycerin. Somebody has called it a 'second-class mummy.'

Box X^2 came to hand December 3d.

1. Cocoa-nut shell. D. C. Baer. An interesting section, showing well the structure of the shell.

2. Mite from the ground-beetle. T. B. Jennings. A good preparation.

3. Grammatophora marina. J. A. Close.

4. This is a mount of an insect that had passed through its larval stage in a jar, but being unable to escape from the water it died, and Mr. Jennings states that the contents of the body were then devoured, after which the body was filled with eggs of daphnias. Mr. F. Ritchie suggests that there must be an error about this, since in the 'water-flea (*Camptocercus*) . . . the eggs and young are fully developed within the parent.'

5. Antenna of moth. B. B. Griffith.

6. Transverse section of diseased human colon. Geo. M. Kreider. This is a very excellent preparation for the Club, because it is well described with a drawing to indicate what is to be seen, and the significance of the appearances. The Club wants more of this kind of work.

NOTES.

— We are indebted to Mr. Nereus Baldwin for some interesting photo-micrographs which he has made. One is a photograph of a portion of the wing of a butterfly taken with a binocular microscope and the prints mounted for a stereoscope. This is very well done. The specimens of most interest, however, show the lines on *Amphipleura* in varying degrees of clearness. In one we have nearly the entire frustule on a print about seven inches in length, 'showing longitudinal lines.' The frustule was mounted in Prof. Smith's new medium, and photographed with a Spencer $\frac{1}{10}$ homogene immersion. The lines, however, are evidently diffraction or spurious lines. Another picture shows the transverse lines faintly, but as it was made from a Möller test-plate in balsam by lamp-light reflected from the mirror, it is a very creditable result both for the operator and the Spencer lens. The last picture is an excellent one of the lines of a broken frustule mounted in Prof. Smith's medium. The lines are very distinct, and show excellent skill in both the microscopical and photographic work.

— A correspondent desires to know the best method of preserving urinary casts. The subject is not well treated in the hand-books of microscopy, and we can only reply with some hesitancy, owing to our limited experience. The best results we have had in mounting tube-casts were with dilute carbolic acid for a medium, using shellac as the cement. The casts kept very well for a year or more, but the preparations are not now in our cabinet. Perhaps some reader will give his experience in this direction for the benefit of others.

— Somebody has suggested that it would be well to mention some attractive and instructive objects for mounting, as an aid to those who have not good opportunities to see many fine objects. Perhaps some useful hints will be found in the account given below of an exhibit of preparations at a recent meeting of the San Francisco Microscopical Society: 'The first series was illustrative of the structure of spiders, and the various characteristics by which this interesting group of Arachnida is separated from insects were well shown by the preparations under examination. The comb-like foot by means of which the spider weaves and traverses its wonderful web, the powerful jaws through which it injects a virulent poison into its hapless victim, the marvelous group of organs termed spinnerets, wherein is formed the viscid secretion which is finally formed into a thread and spun into a web, and finally the brilliant eyes of the jumping spider, were all carefully examined, and their peculiarities of structure pointed out, many novel and interesting facts being thus elicited. The jaws of the garden spider, *Epeira diadema*, were displayed under polarized light, and the resulting play of colors was very beautiful. But the most effective preparation of the entire lot was one of the brilliant eyes of the large jumping spider, *Salticus tardigradus*, mounted by F. Enock, a prominent English entomologist. The eyes of all spiders are simple, not compound as in the case of insects, and this forms one of the reasons for separating them from the latter group. In the hunting or jumping spiders, the eyes are especially large and very brilliant. They are set in a straight row across the forehead, the two largest in the centre, and all gleam with a weird play of color that gives an appearance of peculiar ferocity to the head.'

— The Palmer Slide Company offers thin glass for sale in sheets, squares, or circles, the thickness being guaranteed between certain limits. This is a matter of considerable importance, especially to those who use high power lenses. For those who are studying bacteria it is very desirable that very thin and very uniform covers should be available. Perhaps some specially selected covers would be offered by the Company for this work, should the demand for them arise.

— Messrs. Cassino & Co. have reprinted the Spencer-Harrison controversy concerning the origin and reality of religion, the book which was issued by Messrs. Appleton & Co., but the entire edition destroyed at Mr. Spencer's request. It may fairly be inferred that the present is a

wholly unauthorized edition so far as either writer is concerned; and the propriety of publishing the book under the circumstances is, to say the least, doubtful, and clearly brings out the necessity of international copyright to protect authors. However, Messrs. Cassino & Co. have taken the ground that the public have some rights in the matter, and these essays are a power for good, a sentiment in which we fully agree, especially as regards the last part. We have not seen the book, but assuming that both authors are properly represented, now that it is published, we trust it will be widely read; for the controversy reveals with exceptional clearness two strange psychological facts:—first, that although Mr. Spencer is regarded by the great public, to whom he is scarcely known except by name, as a man dangerous to morality and an atheist, he is, in truth, a strong theist, and an author whose writings are of immense value to the christian world; second, it shows how woefully even such a cultured gentleman as Mr. Harrison can misconstrue the words of such an accurate and perspicuous writer as Mr. Spencer. Mr. Spencer very justly sums up the whole matter in these words:—'While the things I have said have not been disproved, the things which have been disproved are things I have not said.'

— Readers should notice the numerous articles offered by Mr. Woolman in his new advertisement selected from his stock as novelties. The arrangements for showing the electric spark are ingenious, and already have become quite popular. The embryo chicks are prepared by a New York gentleman, and are excellent in every way.

— In the *Bulletin* of the Illinois State Laboratory of Natural History, vol. ii, Prof. T. J. Burrill contributes the first part of a valuable descriptive list of the parasitic fungi of Illinois. This part treats of the Uridineæ. The genera and species are described with care, and there is a good index.

— Mr. Bulloch informs us that he now makes his microtome with a feeding attachment and automatic ribbon or section-carrier. The instrument can now be furnished very complete for all histological purposes.

— Dr. G. Royston-Pigott, whose name is more familiar to readers of microscopical literature of a decade past than of the present time, has begun some articles in the *English Mechanic* entitled Microscopical Advances — Ancient and Modern, which are exceedingly interesting. Dr. Pigott seems to be more intimately acquainted with the older works and authors than most of those who have lately written upon this subject, and in his first article we find much that is not generally known about the construction and capabilities of some of the first microscopes.

CORRESPONDENCE.

Photo-micrography

To the Editor:—You must permit me to thank you for your very courteous reference to a recent lecture of mine, in your initial article on Photo-micrography in the November number of the Journal. You appear to have criticised my methods, in that they require expensive apparatus, and facilities not at the command of the majority of workers. The criticism would be most certainly just, were I attempting to popularize the subject, but my remarks before the American Institute were only intended to indicate such a line of procedure as might, without regard to expense, etc., enable us to secure the very highest results in photo-micrographic art.

I very much doubt the possibility of every microscopist being able, by the addition of a kerosene lamp and a plate-holder to his instrument, to produce results that will be of any value or of the slightest satisfaction to the worker. It has been my fortune in the last twenty years to have seen a goodly number of enthusiastic and capable microscopists fail in producing photographic images of their fields, simply on account of the cheap and flimsy means employed.

It appears to me that especially in the study of bacteriology, photography will certainly prove a most invaluable aid. The images are frequently unstable, and the value of a given preparation is often only appreciated when it has faded, or biological changes have destroyed original features. Again, in recording the growth of slide cultures, photography cannot but prove an unimpeachable witness. It is true that high-power photographs of minute bacteria are not striking pictures in an artistic sense, but when absolute truth is required, the graver or the crayon cannot be brought into competition for a moment. One cannot but be impressed with the truth of what has just been written, on

looking over the illustrations in Sternberg's last edition of 'Bacteria.' The photo-micrographs of groups of fungi have an individuality that is lost in engravings. The illustrations in this excellent little work are certainly not all that might be desired, but, as the doctor very aptly observes, it is 'easier to criticise than to improve upon them.'

It seems, when viewing a properly illuminated object in the microscope—every detail sharp and distinct—as though the fixing of such a picture upon a sensitive plate must be an easy matter. But, only attempt to secure it—the delicate gradation of color has disappeared. The illumination is faulty, and probably weak in actinic rays—there is only the single plane in focus, as you can no longer coax up detail after detail with the micrometer-screw of the fine adjustment—and, if the student has only the usual amount of patience, he is apt to give up in disgust before he has hardly begun.

After all this circumlocution I want to say this: Photo-micrography is capable of being made to secure results that will give the author of their production the very highest satisfaction as unimpeachable scientific records. Such results cannot be gotten without expensive appliances and special surroundings. If it be the aim to produce pretty little pictures of flies' wings and the like, why such may be made with the expenditure of little money, and with the production of only a modicum of cholestearin. There is a poor satisfaction in presenting a given result, if you know some one else can do very much better. Why not do it yourself better, and so on, better, until you know it represents the very best result attainable with our present means?

I am very glad, my dear Mr. Editor, that you propose to give us a series of papers on the subject of Photo-micrography, for, certainly, no one can be better prepared than you to survey the ground that has been trodden, and to indicate means for successful work.

MAURICE N. MILLER, M. D.

—o—

'Rotifer Nests.'

TO THE EDITOR:—In volume iii of the Journal, Mr. F. Wolle described a rotifer's nest or gall on *Vaucheria geminata*. I have glanced over the indices of subsequent volumes without finding further reference to the same interesting object. The description is so clear that there is little doubt, it seems to me, regarding its identity with the gall of *Notomata Werneckii*. A very satisfactory account of this rotifer and its habits by Professor Balbiani is given in volume ii, p. 530, with plate xviii, of the *Journal of the Royal Microscopical Society*. The parasite has not been detected at Buffalo, although sought after many times.

BUFFALO, N. Y., D. S. K.
Nov. 5, 1885.

—o—

Magnification.

TO THE EDITOR:—First. What is the magnifying power of a one-inch lens at 10 inches between object and image?

Answer. 7.9 diameters.

Second. What is the formula of a two-inch eye-piece as used in the microscope, not in the telescope?

Answer. A certain formula for a microscope eye-piece, as a standard, cannot be given, owing to the variable conditions to which the quality is subjected. Besides the tube-length, or rather the distance from the objective, the distance of the eye from the eye-lens, and also the angular aperture (field) have a determining influence in the construction of the eye-piece.

Third. What is the magnifying power of a two-inch eye-piece, 10 inches between object and diaphragm?

Answer. The magnifying power of an eye-piece is not varying with the distance of the object. The magnifying power of a two-inch eye-piece is just 6 diameters. (See article, 'Magnifying Power,' page 11, Catalogue, Gundlach Optical Company.)

Fourth. Unable to answer.

Fifth. What is the length of a ten-inch tube?

Answer. Ten inches, I should think.

E. GUNDLACH.

NOTICES OF BOOKS.

Iritis: Its relation to the Rheumatic Diathesis and its treatment. By Chas. J. Lundy, A. M., M. D. (Pamphlet, pp. 10.)

The Anatomy and Physiology of Bacteria and their relation to Health and Disease. By J. M. Selfridge, M. D. Oakland, Cal. (Pamphlet, pp. 29.)

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Wanted: Cleaned St. Vincent material, for cash.
E. A. SCHULTZE,
Tompkinsville, Staten Island, N. Y.

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Mounting Mediums with High Refractive Indices.*

BY PROF. WM. H. SEAMAN.

In a recent box of the Postal Microscopical Club was a slide of *Amphipleura pellucida* having separate mounts, in balsam, storax, and tolu. This diatom is well known as a very interesting test-object, the striæ on which were first clearly resolved in 1871, and played a very prominent part as a test in the battle of the lenses that raged for several years subsequently. The different mediums on this slide, and the marked improvement in definition resulting from the use of highly refracting substances, suggested that this part of microscopical manipulation was deserving of more attention, now that the fundamental principles of the construction of objectives appear to be definitely settled.

On searching for tables of refractive indices that would guide me in the selection of promising compounds, I found three deserving of note, the first in the Annual Report of the British Association for 1839, by Rev. Baden Powell, which includes the original Fraunhofer determinations of glass, and about 50 oils, and solutions of acids and alkalies. The second is by Prof. Matthieson in Die Central Zeitung f. Optik u. Mechanik, 1882.† containing 170 compounds, about 40 of which were reprinted in *Journ. Royal Micr. Soc.* (2), iii, 588. The third is a list by J. H. Gladstone in *Journ. Chem. Soc.*, xlv, 241, reprinted in Wiedemann's *Beiblätter*, 1885, of about 120 carbon compounds.

Such of these determinations as are likely to prove useful to the microscopist are added hereto calculated for the line μ D, which however is not quite in the position to give a mean refractive index, which lies nearer the line E.

Canada balsam appears to have been first used as a mounting medium by a showman in 1840, and has been more generally employed than any other substance. The great variety of other compounds proposed in the past few years have been selected for their coloring or preservative qualities, and as a rule were inferior to balsam in refractive power.

Among the earliest work in this relation may be found the essay by Mr. Stephenson in *Journ. R. Micr. Soc.* in 1880, p. 567, and *Mon. Micr. Journ.*, 1873, from which some of the data used here are taken. Mr. Stephenson added to the list solutions of phosphorus and sulphur in carbon bisulphide, and a saturated solution of mercuric iodide in potassium iodide. The tendency of the first to take fire spontaneously was very ingeniously avoided by taking a short, small vial without a neck, and fitting a wooden former to it. A piece of filter paper is pressed by the former nearly to the bottom of the vial and saturated with carbon bisulphide, and a small piece of phosphorus laid in the paper cup thus made. Solution takes place rapidly, and by pressing the former into the cup the liquid is

* Read at a meeting of the Washington Microscopical Society, January 12, 1886.

† May be found in the library of Johns Hopkins University.

forced through the filter into the bottom of the vial. Having the objects and cover in place on the slide, a rapid transfer of a small quantity of fluid to the edge of the cover is effected by a pipette, and the fluid is at once drawn under by capillary attraction. Success depends upon very little exposure to the air, so as to avoid oxidation. Mr. Stephenson exhibited slides nine years old which showed that if properly sealed such preparations would be permanent. The sealing may be effected by glue first and then a coating of balsam or other cement, as carbon bisulphide attacks all oils and resins. It does not appear that Mr. Stephenson was able to obtain so high refractive power with sulphur solution as with phosphorus, as he gives the index of the first as 1.75, the second as 2.10.* This may arise from the inferior solubility of sulphur.

On mixing saturated solutions of mercuric iodide and potassium iodide and filtering from the residue an aqueous fluid results with index of 1.68. This has the advantage that it may be diluted with water to any desired refractive power.

Monobromo naphthalin, so far as I know, was first used by E. Weissflog, of Dresden, some of whose slides were shown at a meeting of the Royal Microscopical Society in 1880, and has been employed for some time by Möller for preparing diatoms for sale, but has a lower index than the iodine mixture above mentioned.†

Prof. Van Heurck (this *Journal*, Feb., 1882) has suggested white vaseline 7 parts, copaiva 30 parts, as a fluid for immersion lenses. This makes a thick liquid remaining where it is placed, indifferent chemically and apparently adapted for a mounting medium.‡

Finally, Prof. H. L. Smith has recently§ described the use of stannous chloride and realgar, the latter a substance of higher index than any before used. These articles are so recent it seems only necessary to refer to them here.

On considering these various media, and the substances not used, which seemed likely to give good results, it appeared singular that oil of cassia had not been more thoroughly tried. Its use has been suggested,* but I have not observed any descriptions of mounts made with it. The refraction index being equal to that of carbon bisulphide, recommended it to my attention, and as all the essential oils dissolve more or less phosphorus, I made a saturated solution of phosphorus in oil of cassia, and with it prepared several mounts, which, together with others in the mediums I have described, are on the table for your examination. This mixture is easier to use because less inflammable than carbon bisulphide, but contains less phosphorus, as the latter is not perfectly soluble in oil of cassia as in carbon bisulphide. I make a ring of liquid glue on the slide, allow it to dry, drying the diatoms on the cover, adding the solution, and quickly inverting the cover in its place, then removing the surplus squeezed out by blotting-paper, carefully pressing down on the glue ring, and then sealing with balsam. The solution smokes on exposure to the air, but in these preparations there is no evidence of acid flakes.

On endeavoring to make a good solution of sulphur in carbon bisulphide, it did not appear that sufficient dissolved to get the full benefit of the high index of sulphur. I immediately sought a better solvent, and found it in anilin.

On making a test mount of this mixture on the mixed diatomaceous material used for all the other mediums, I was surprised at the brilliancy and sharpness of definition, in which, so far as I can judge, it excels any other medium yet tried. The

*See also this *Journal*, vi, 6.
†*Journ. R. Micr. Soc.* (2), i, 151.
‡This *Journal*, vi, 86, for use of storax.
§This *Journal*, vi, 162, for high refracting media.

* Dippel, Das Mikroskop and *Journ. R. Micr. Soc.* 1880, p. 1044.

diatoms used were in alcohol. I first placed the required quantity on the inverted cover, dried them, added sufficient medium to cover them, heated the cover to drive the air out of the cavities of the diatoms and cause the fluid to enter, added, if necessary, a little more, inverted in place on the slide on a turn-table, and removing any surplus by a blotter, run a ring of balsam or shellac cement around, thus finishing at one operation. The anilin is not very volatile, and the adhesion of the cover very slight, but with care, using a long bristled brush and thin balsam, a coat can be got quite sufficient to seal and fix the cover in place, and additional coats may be given when convenient. Anilin, according to Storer, dissolves its own weight of sulphur; if heat is used it will become supersaturated, and crystals will form on the slide, which are very pretty of themselves, but of course are not desirable with other objects.

As Gladstone and others have indicated that high refractive power accompanies complex molecular constitution, it is probable the best solvents for our purpose will be found among the carbon compounds like anilin, chinolin, etc. Except in the hands of a few persons, the value of these mediums for demonstrating structure appears to have been overlooked. Coarse diatoms in air are opaque for all practical purposes, their refractive index, air taken as unity, being 1.434. This is also more than water 1.33, in which they are quite transparent, more so in dilute sulphuric acid which may be concentrated to have the same index as the diatom, which then becomes invisible. Calling mediums of less refractive power than the diatom negative or — mediums, we now change our relations to mediums of greater refractive power than the object which may be called + or positive, a large number of which are arranged in the accompanying table. The relative visibility of any object may be determined by taking the numerical difference of its index from that of the medium enclosing it. Each convexity or elevation appears brighter when the tube is raised in a — medium, and a concavity brighter when it is depressed. Exactly reverse effects follow if the medium is +, for each portion resting in a depression of the object acts like a lens to concentrate the light. These facts may be used to differentiate the chemical nature of substances, for calcareous bodies have a higher index than silicious, sometimes higher than that of Canada balsam, hence it would be possible to have two surfaces exactly opposite in shape as regards elevations and depressions, but of different indices, give the same appearance if mounted in a medium of intermediate index. The beginner in this kind of work will do well to take a piece of the embossed sheet-metal, now readily obtained, which corresponds in surface with some diatoms, but in which the structure is large enough to be unmistakably understood, and study it by reflected light with modification of the direction of the light, focus, etc., and carefully note peculiarities of appearance. Some of the compounds mentioned in the table have not yet been tried, and as soon as I can prepare them I will report upon their availability.

Table of Refractive Indices for the D Line, compiled by Prof. W. H. Seaman.

References:—(R.) Report Brit. Ass. 1839. (B.) Beiblätter, 1885, No. 4. (S.) Smith Amer. M. Micr. Journ. v, 162. (J.) Stephenson, Journ. R. Micr. Soc. (2), ii, 67.

R.	Air,	1
R.	Water,	1.334
B.	Methyl alcohol,	1.330
R.	Alcohol, Sp. Grav. 0.815,	1.365
B.	Ethyl alcohol,	1.430
J.	Silex of diatoms,	1.436
B.	Glycerin, pure,	1.461
R.	Turpentine,	1.474
B.	Benzol $C_6 H_6$,	1.507
	Copaiva, *	1.50
B.	Styrolene $C_8 H_8$,	1.531
J.	Canada balsam,	1.54
	Cedar oil and dammar,*	1.54
R.	Crown glass,	1.559

* Various sources.

B.	Phenol $C_6 H_6 O$,	1.550
B.	Anilin $C_6 H_7 N$,	1.582
R.	Balsam Peru,	1.593
R.	Oil of Cassia,	1.610
R.	Carbon bisulphide	1.630
B.	Chinolin $C_9 H_7 N$	1.633
R.	Flint glass	1.635
B.	Monobromonaphtalin $C_{10} H_7 Br$	1.664
J.	$Hg I_2$ + KI in water	1.68
B.	Methylendiiodide $C H_2 I_2$	1.742
S.	Stannous chloride	1.7–1.8
J.	S in $C S_2$	1.75
J.	P in $C S_2$	2.10
	Phosphorus*	2.224
	Sulphur*	2.11
S.	Realgar $As_2 S_2$	2.4
	Lead Chromate*	2.974

* Various sources.

Photo-Micrography at the Work-Table.

BY GEO. A. PIERSOL, M. D.

It may be stated at once that the simple arrangement here described is offered by no means as a substitute for the usual apparatus for photo-micrography, but only as a very convenient supplement, which, on repeated occasions, has proved its value and ready applicability.

The possession of a light quarter-plate camera suggested its adaptation to the microscope in such a manner that a picture may be made without disturbing in the slightest degree the microscope as arranged for ordinary use—an advantage readily appreciated by those engaged in studying preparations only temporarily mounted, or objects where change of inclination of the instrument would insure failure.

To the outer end of the draw-tube is securely fastened an adapter bearing a thread fitting the photographic lens flange, which, we suppose, is already in the lens-board of the camera-front.

As a preliminary, the detached lens-board should be screwed on to the tube and the latter turned until the board occupies its proper position in regard to the camera. A mark will hereafter indicate the proper position of the tube. Now, at any subsequent time in the course of microscopical work, should an object present of which a photograph is desired, by simply screwing on the detached lens-board of the little camera and subsequently buttoning this in place on the camera, the apparatus is ready without any change having been necessitated.

Usually the eye-piece will be best removed; in some cases, however, especially with high powers of unimpeachable definition, the eye-piece may be retained with advantage, as with a short pull the definition is excellent and the light sufficient. With the standard length and large size of tube a field of nearly three inches is readily obtained with a little quarter-plate camera. With the eye-piece retained the entire plate may be almost covered.

On beginning work of a character likely to require photographs, the little lens-board may be attached at once, as it is scarcely in the way, and renders the attachment of the camera but a moment's work. The short distance between the focussing screw and the adjustments of the microscope being readily within arm's length, no arrangement for focussing is required.

At first sight it would seem that such a mode of holding the camera would be quite unsteady, but the writer can testify that with a stand of good stability the little camera is held with such rigidity that high powers ($\frac{1}{10}$ or $\frac{1}{15}$) may be used with satisfaction. It may be advisable in some instances to place a small rest of wood under the body of the microscope to prevent vibration.

Regarding illumination for photography, too much pains can scarcely be taken to secure carefully centered and equally distributed light. After many experiments with various condensers—including the Abbe and other wide-angled ones—a B eye-piece, adapted to the substage, has proved to be the most satisfactory with lamp- and calcium-light, and for all ordinary powers it can be strongly recommended as giving a

brilliant and equally illuminated field.

The introduction of the new bromide paper will be a boon sure to be appreciated to many engaged in microscopical photography. A little wrinkle in using this paper may serve others. Experience soon teaches that all unnecessary handling of the unexposed paper must be carefully avoided in order to escape the unsightly spots which record careless fingering. As 4×5 is a favorite size for micro prints, one of the Eastman's film-carriers should be utilized. A piece of 4×5 post-yellow paper with suitable opening, should be used as a mat. This is first placed in the metal frame; on top of it the piece of the bromide paper, and the two securely held in place by a piece of glass cut to fit exactly the frame and to replace the wooden carrier. By this means the paper is protected from contact on the edges and held perfectly smooth, while a centered print is insured; by transmitted light the desirable field of the negative can be selected and centered.

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A Contribution to Blood Measurement.

The microscope used in these measurements was very carefully made by Mr. Charles Fasoldt, for the purpose of comparing and bringing his rulings in accord with the standard inch, as defined by the United States Coast Survey. This instrument was also used to measure and copy the standard centimetre for the American Microscopical Society.

The stage of the microscope is moved by a standard screw of 100 threads to the inch; the micrometer head attached is divided into 100 parts. The eye-piece cobweb-micrometer is supplied with two independently movable spider-lines. The measuring line is moved by a standard screw of 100 threads to the inch. The micrometer head is divided into 100 parts. There is also a special index to register the number of revolutions of the head. A vertical illuminator with a Bausch & Lomb $\frac{1}{10}$ immersion objective N. A. 140 was used.

A Fasoldt standard stage micrometer was the standard of measurement employed, and by means of the draw-tube the divisions of the eye-piece micrometer was made to correspond to 1–1,000,000 of an inch.

A certain portion of the micrometer screw was used when comparing it with the ruled stage plate, and only that portion of the screw was subsequently used in measuring the blood corpuscles, thus practically eliminating mechanical errors. In the operation of measuring, the spider-line was placed at a zero point, the blood corpuscle was brought in optical contact with it by means of the stage movement, the spider-line was then moved across it and the divisions read off. Frequently the line was moved back, and again read off, to test the accuracy of the first contact. The spider-line was invariably brought to the same zero point for each corpuscle measured. Fresh blood was used for each series of measurements, spread upon a cover-glass in the usual way. A blood corpuscle seen with the vertical illuminator presents a novel appearance. It appears smaller than with transmitted light, that is, without coma. It resembles somewhat the yoke of an egg laying on a flat plate. When fresh the corpuscle is smooth and uniform on the surface, but soon a dimple appears, usually excentric; this enlarges slowly until, within twenty-four hours, the corpuscle appears thin and flat, with a very thin rim around the edge, quite box-like.

Many corpuscles appearing round and even with transmitted light, appear irregular or slightly crenated with the vertical illuminator. With the latter illuminator the corpuscles appear delightfully clean and distinct, and very accurate contacts with the spider-line can be made.

The following table was constructed

from measurements made by Mr. Fasoldt and myself:—

No.	Age	Weight.	No. of corp. meas.	Smallest, in millionths	Largest, millionths	Average millionths	Inch.
1	66	170 lbs.	50	215	347	308.2	1–3245
2	40	150 "	22	217	363	311.5	1–3210
3	45	120 "	49	285	397	332.9	1–3001
4	45	210 "	43	256	357	298.3	1–3352
5	38	120 "	37	259	387	317.46	1–3150
6	66	170 "	41	268	334	299.5	1–3339
Number of measurements,			242			311.305	1–3212

In the table the results are carried out to the nearest even figures (the totals are closer results).

No. 1 was from a man recently emaciated from a long illness, but now making flesh rapidly and nearly to normal weight.

No. 3, the largest corpuscles, were from an active member of the fire department, who has the reputation of being able to work half the night at a fire and resume his business next day without losing an hour of time.

No. 5 was from a mulatto.

The vertical illuminator shows plainly that blood corpuscles spread upon glass do not dry as rapidly as one would suppose.

A periscopic $\frac{3}{4}$-inch eye-piece was used giving 1500 diameters.

A further series, including a much larger number of measurements, is in progress.

S. G. Shanks, M. D.
Albany, N. Y.

—o—

Dallinger's Moist Chamber.

BY D. S. KELLICOTT.

The student of protozoic or protophytic life has much and constant use for growing cells and moist chambers. The form used by Messrs. Dallinger and Drysdale in their researches in the life histories of the monads is clearly one of the most efficient and desirable for continuous observation of developmental changes. I have in use a modification or addition which, I think, is an improvement and worth mentioning. Instead of cementing the thin glass cover, which is the object carrier, on the glass stage over the aperture in the same, it is cemented on a rather deep ring, made by cutting off a glass tube of a diameter equal to that of the aperture. The ring may then be cemented to the stage, or simply made to rest in place upon it. It will be seen that the bibulous paper stage may now be made to fit snug up to the ring, as the object carrier is lifted above it into the cell or moist-chamber formed by the outer glass tube and its thin rubber cover. Of course it is understood that the ring carrying the object plate and the stage perforation must be large enough to admit the substage condenser. To me the modification affords advantages; these will doubtless occur to any one using this piece of furniture.

I have applied the principle of the above contrivance to the construction of a moist chamber which I have in constant use, and find it handy. An ordinary glass slip is taken; a ring with a cover-glass cemented on the top rests at its centre; then a number of layers of blotting paper of proper size, with the centres cut out, are placed upon the slide sufficient to reach above the object; the lower paper should fit snugly up to the ring, and have a tongue on one side. After the object is in place, and covered or not, as the case may be, a slide is put over all, and the combination put over a dish of water, with the tongue of bibulous paper reaching into it. The drop will not evaporate, and being surrounded by a quantity of air, the infusorian or rotifer under observation will keep in good health for a long time. A special slide and cover, 3 inches by $1\frac{1}{2}$ inches, are rather more convenient, giving a larger cell than ordinary slips.

A still better plan is to use two brass plates, 3 inches by $1\frac{1}{2}$ inches, instead of glass. The lower one is perforated at its centre, and the ring and object carrier cemented over it; the tongued bibulous paper is then put on as before (only one layer is required to

supply moisture, but an additional one with a larger hole at the centre facilitates the removal of the cover). The other plate should have a larger central perforation, over which a ring and cover-glass are cemented. When in use this one is placed over the former, covering the object with the cell, and the whole placed over a small dish of water, with the tongue reaching the water. It will be seen that an examination with a low power may be made at any time through the cover; the cover to be removed for the use of high powers.

After all, how much better are these devices, or any devices, of the kind used only for interrupted observations, and in which the object is retained in a limited supply of water, surrounded by moist air, to simply placing the object on a slide, and covering by a bottle that has been cut off, and the edge ground on a plate of glass with a little emery and water. If the ground edge has been smeared with tallow, and some moistened blotting-paper put in the top of the bottle, the drop remains without loss, and is ready for examination by setting off the cover.

Microscopical Advances—Ancient and Modern.*

BY G. W. ROYSTON-PIGOTT, M. A., M. D., CANTAB.

In nothing has the progress of microscopical powers been more pleasantly displayed than in the gradual development of the precise optical definition of dots and spherules.

In copying with the camera lucida at a power of 5, I was greatly struck with Chevalier's representation of the 'Podure,' which was executed by means of la chambre claire, by a talented young artist about 1839. Pritchard speaks scornfully of these French poduras as being too easy. These scales (the present *Degeeria domestica*), as shown by Chevalier, are marked with black dots linearly arranged, and in other scales with double rows of dots, nearly parallel, and crossing each other at an acute angle. The contour of the scales in the steel engraving is decidedly oval. M. Chevalier was the first to give this resolution, which he does as following (translation):—'Podure. The scales of the Podura have generally an oblong form, but are of various sizes; with a mediocre microscope their surface appears blank, but with a perfect instrument one discovers an infinite number of points oblong, which imitate straight lines, crossed, oblique, or wavy, following the changes of the illuminations. It is not very difficult to discover these points upon the largest scales. It is necessary to choose the smallest, and we consider them as the best test objects to show the penetrating power of the microscope.'

I was not aware of the existence of this plate in 1869, when I first published resolution of this scale. The merit of this microscope is shown by the award of the gold medal to Chevalier by the jury, who declare that 'we have compared it with an excellent microscope of Amici, the best of those we possess in Paris, and that we recognize, not with astonishment, but with a lively satisfaction, that the microscope of Mr. Charles Chevalier is truly superior to that of Amici.' I find Chevalier's plate of the Lepisma is most exquisitely formed of a double set of radiating short lines of dots (denied by Dr. Carpenter).

The English resolution of the Podura is still like a series of oat seeds arranged somewhat linearly, and the sharpness of the outlines of these markings is regarded as a most severe test for the objective quality (as far as it goes). Pritchard's Hair of Dermestes demonstrates at sight the prodigious advance the microscope has made. A minute translucent cup, ornamented with four petals and intense black lines, marks the interferences of tissues stopping the passage of light, showing transcendent defini-

* From a series of articles in *The English Mechanic*.

tions. No black cordiform attachments are at all visible. But there are some scores of the species giving great differences in detail. The spherular resolution of these scales offers an interesting field of research. The blackness of the spherical rings shows the small aperture of illuminating cone and objective, whilst the ribs and membranes are beautiful studies with the best glasses.

Mr. Slack's colloid silica slides present remarkable examples of minute refracting spherules, of considerable variety, developing marginal black rings and focal disks more or less bright. Less than 1-90,000th, this bright central disk is scarcely visible; but those of 1-60,000th, or less, with a high but exquisite power, reveal the focal centre as well as the black ring in a slightly lower plane. It is interesting in these objects to select silica beads of different sizes, representing those of well-known diatoms, such as those of Formosum and angulatum for optical comparisons. When a brilliant white disk in diatoms also can be detected, it is generally accompanied, as before, by a jet black marginal ring all round the spherule; and in brilliant spherules 1-40,000th of an inch in diameter this black ring has been frequently estimated at 1-6th of the disk, or 1-240,000th of an inch thick.

This very ring plays so important a part in the definition of diatoms, cells, and molecules that I shall ask leave to call it the spherule test ring, or, shortly, the test ring; for, if a glass giving 800 diameters will not show it in a minute spherule (1-90,000th) it cannot be rated as of the finest quality. In many experiments described in these articles, its use and appearance are of the highest value. I have to thank Mr. Slack for the following formula:—

'The silica films which give the cracks are made by allowing a solution of dialyzed silica to evaporate upon a slide. The beaded silica films are made by passing silica fluoride gas through glycerin and water—4 or 5 glycerin and 1 water.'

Black margins can also be seen in fine hairs of exquisite precision of definition.

In dealing with such minute matters, the reduction of diffraction by a pleasantly subdued light—pale blue glass has several advantages—an exceedingly fine glass of quite modern date (1885) thus showed me, last night, the extremity of a fine hair less than a millionth of an inch in diameter without any indistinctness, fog, or diffraction. Too much pains cannot be taken with adjusting the screw collar, and in the selection of the object. Generally it should be chosen as close to the covering glass as possible: the film of air introduces otherwise insuperable aberrations which no action of the screw collar can surmount, unless it be mounted in Canada balsam. And this is more painfully seen with oil immersions and dry mounts than with water lenses, and still more than with the dry objective. The point of the hair is often more clearly seen if there be some subjacent structure.

I shall now beg to record some rather amazing experiences with the definition of hairs with the finest glass I could recently obtain—a 1-12th oil immersion.

The advance of the accuracy and power of the microscope is well shown in the developed structure of hairs. A favorite object figured in antiquated books is the hair of the Indian bat. Quekett represents it as frilled with a kind of coronet of small hairs, ringed at regular intervals, leaving the intermediate transparent quill exposed.

The drawing now given was taken by the use of a fine oil-immersion 1-12th, and a large angle in the oil condenser. Instead of frilled hairs, which are purely imaginary, a beautifully serrated cup, with concave notches, is seen, and edges as black as jet, ornamenting the whole of the stem at equal intervals. After so

many years of observation of this object, this result is perfectly startling, and throws a strong doubt upon innumerable accepted appearances. The black boundary edges are very nearly 1-100,000 thick.

The hair of English bat also exhibits tests of a very high order. Pritchard's plate represents it as tufted with black appendages, through which a transparent tube is carried. The complete resolution of these tufts show that there are internal tubules somewhat spirally arranged in great profusion, the edges of which are marked very strongly black, with sudden interruptions. A more intense scrutiny reveals these tubes filled mostly with brilliant molecules varying from the 1-80,000 to the 1-120,000 of an inch in diameter.

A very charming phenomenon is seen when one stringlet of beads partly overlaps another deeper set. As no light can pass through the spherules at the overlaps, intense blackness takes a variety of forms. The beads are not all quite spherular; some are ovoid; solitary beads are observable, occurring in straight or curved clusters of two, three, or more, or in long chains. If an upper chain is brilliant with focal light, a lower set is often dark. As many as a dozen stringlets often appear packed at one place in different bunches or fagots, and, of course, lying in several different focal planes; and if the glass be trascendently fine, these spherules glitter with a variety of focal colors of great beauty. Pale turquoise and ruby color, with shades of orange yellow and pale yellow approaching white.

Advancing Angular Aperture.—As already described, a constant effect of small angular aperture is to darken organic structure. Black margins of cylinders, tubes, and spherules are made darker and broader. This black margin obeys a mathematical law. Its breadth varies as the refractive index increases, and as the aperture diminishes.

If the same power be attained, either with deeper eye-pieces and weak objectives, as contrasted with shallow eye-pieces and deep objectives, the difference in the appearances is very striking and instructive.

Here is a beatiful example—*Atropos Acherontia* (Death's Head Moth). Change of angular aperture gives startling results. The whole animal bristles with a forest of spearlets of exceeding sharpness, each feather having three or four long spines.

With low aperture the scales present a superbly rich and dark amber-brown color by transmitted light. Tipped with a black point, a thin line of light runs up the spear edged with fine black borders. It will be probably admitted that the black annuli, or rings, of each spherule, if they exist in this scale, are too deep and broad under a low aperture to permit any visible streamlets of light to escape through them, so as to effectively impress their existence upon the retina of the observer. Beads appear dark till sufficiently magnified and illuminated.

But as objectives and eye-pieces are used of the same power as before under wider angular aperture of objective vision, this deep brown color pales. The universal molecular system of which the scale is composed begins to light up and glisten; each spherule obeys the law enunciated; its annulus narrows; the light permeates the scale profusely. The general effect is to change dark into brighter tints. Enlarged aperture now enables a sparkling radiance to steal through the featherlet. As power is increased, masses of organic molecules, as yet invisible, contribute streaks and mottlings of prismatic colorings. And now, if high power and large aperture, with superb definition, be employed, a new vision of beauty and refinement bursts upon the eye. The scale glit-

ters with brilliant gems. Since the molecules lie many deep, some cannot get light at all, and they appear jet black; others in lower planes are brighter. As they are found approaching the 1-90,000th of an inch in diameter, the central focal lights disappear.

To produce the best effects, a condenser free from spherical aberration is employed of about 55 degrees aperture, acting axially with direct light Some other still more wonderful appearances will be glanced at further on, when transcendent definition is approached. (Bright daylight—even, I might say, dull daylight—is always preferable for the development of superb definition).

Minute focal changes produce appearances of great interest, showing the actions of light upon refracting spherular bodies.

Supposing, first, a low focal plane be taken, there is a brilliant white disc, surrounded with its jet black annulus. If the corrections are very carefully attended to, under correction causes it to turn crimson red, with a fainter rim. A true correction gives a bluish, or peacock blue sparkle in the bead. At the highest focal plane, the emanating cone generally produces an intensely black dot above the spherule. These black dots are seen often enough above refracting molecules, scattered about insect scales, especially those placed upon the cross-bars connecting the ribs.

Such elevated dots may be called eidolic. If the spherule be large enough, say 1-20,000th in diameter, this eidolic dot takes the form of a small bead suspended above without blackness, but faintly and delicately shaded, so as to look almost planetary.

In observing these niceties, the greatest care must be taken to reduce the angular aperture of the condenser as small as convenient for sufficient illumination. There can be but little doubt that a minute pinhole placed over the condenser reduces the effective aperture of both objective and condenser.

Provisional Key to Classification of Algæ of Fresh Water.—VI.

BY THE EDITOR.

[*Continued from p. 233, vol. vi.*]

Family IX. ŒDOGONIACEÆ.

Filamentous algæ living in water, consisting of branched or unbranched series of cells, with a basal cell. The basal cell is usually obovate, or swelled and lobate, often ending in a disk-like attachment.

Oogonia naked, in the vegetative series. Antheridia filamentous, consisting of few or many successive cells. Spermatozoids spherical, single or two in a mother-cell. Oospores single in each oogonium, formed of the entire contents, usually red when ripe, producing swarm-cells after long rest.

Asexual propagation by swarm-spores, formed singly in the vegetative cells out of the entire contents, provided with cilia surrounding a hyaline end.

Synopsis of Genera.

Filaments unbranched, when in fruit with spherical, tumid cells. *Œdogonium*, 79.

Filaments branched. Cells with long bristles. *Bulbochæte*, 80.

79. Genus *Œdogonium* Link.

Unbranched. Antheridia produced either on the same filaments with the oogonia (monœcious species) or on special male filaments of very different size and origin (diœcious species). The male plants may be short, one or several-celled filaments, growing upon or near the oogonia like epiphytic dwarfs (nannandrous or dwarf males), or they may be in filaments, the male cells interspersed among the vegetative cells, resembling the female filament, or often much smaller (macrandrous males). The dwarf males arise from male swarm-cells or androspores. The androspores may be produced in two ways:—

1. In special abbreviated cells of the female filament (gynandrosporous species).

2. In androsporangia or abbreviated cells of the male filaments (idiandrosporous species). The dwarf males give rise to spermatozoids, which escape into the oogonia and fertilize the oospores.

[In the monœcious species the spermatozoids are produced in shortened cells above or below the oogonia. Each of these cells, known as antheridia, gives rise to one or more active spermatozoids, which swim directly to the oogonia, find their way through its opening and become merged into the spore.

The androsporangia of the male filaments of diœcious species resemble the antheridia, but in some species the male filament does not give rise to androspores, there being no dwarf males produced, but spermatozoids are formed in the short cells, which are then known as antheridia.

The plants belonging to this genus cannot be specifically determined except in the fruiting condition. The genus may be readily recognized, however, by the distinct rings about the ends of the cells, produced by the peculiar process of cell-division.

The oogonia, which are conspicuous, spherical, or oval tumid cells, irregularly spaced along the filaments, contain the oospores which, after a period of rest, escape as ciliated zoospores which swim about a short time and come to rest. The colorless end then elongates, and becomes attached to some object, while the green upper portion grows into a new filament. The growth of these young plants can be observed in almost every gathering of algæ.]

80. Genus *Bulbochæte* Agardh.

Filaments branched; terminal cells, and generally all the others bearing laterally a long, thin hyaline bristle, bulbous at the base. Fruiting, and general character of the sexual organs as in *Œdogonium*.

[*To be continued.*]

Staining Tissues in Microscopy.—VIII.

BY PROF. HANS GIERKE.

[*Continued from p. 15.*]

163. Alférow, Serge. Nouveaux procédés pour les imprégnations à l'argent. Arch. de Phys., 1874, p. 694.

In place of the ordinary methods, combinations of silver with organic acids, as picric, lactic, acetic, or citric, are recommended. Silver lactate is usually employed 1 to 800 of distilled water, to which is added 10–15 drops of free acid. The advantages are that no precipitation occurs except silver albuminate and silver chloride, and the preparations are clearer and finer. The manipulation with silver lactate is the same as with the nitrate.

164. Skworzow. Zur Histologie des Herzens und seiner Hüllen. Pflüger's Arch., viii, 611.

165. Adamkiewicz. Ueber die Behandlung von Gefässen mit Silbernitratlosüng. Berl. klin. Wochenschr. No. 29, p. 355.

These articles relate to the nature of the effects produced by silver staining on epithelium. Skworzow doubts the existence of a cement substance between cells, and thinks the peculiar black lines may be due to the drying up of the serous fluids. Recklinghausen's little vessels he considers artificial results of the silver treatment. On the contrary, Adamkiewicz believes the dark lines do owe their origin to an intercellular cement which lays directly beneath the epithelium, and binds it to its basic tissue. The lines react like silver albuminate and resist concentrated acids.

166. Stricker. Untersuchungen uber den Eiterungs-process. Wiener med. Jahrb., 1874, pp. 379–389.

Stricker says that by impregnating the cornea of living animals, appearances result differing from those obtained after death. The first method

consists in dropping in the silver solution, the elemental cells and their proliferations are brought out as finely granulated masses. On staining the dead cornea the vessels stand out from a basement membrane diffusely colored brown.

167. Hoyer Beiträge zur anatomischen u. histologischen Technik. Arch. mikr. Anat., xiii, 649–650.

Hoyer adds to a solution of silver nitrate caustic ammonia, till the precipitate begins to dissolve. The mixture is then diluted to 0.75–0.5% of silver salt. This does not stain surrounding tissue, only endothelium, which show therefore more plainly.

168. Hoggan, Geo. et Frs. Elizabeth. Étude sur les lymphatiques de la peau. Journ. de l'Anat. et Phys., 1879, xv, p. 54.

Études sur les lymphatiques des muscles striés, l. c. p. 588.

For examinations of the skin these authors combine salts of silver and gold. They recommend a simple apparatus. The piece of skin is stretched over a rubber ring and a second ring sprung on it. The cuticle is uppermost when the little dish thus formed is held so as to receive a ½% solution of silver nitrate; that is allowed to remain for 30 seconds, and then is substituted by a solution of gold chloride of the same strength. The muscular sheaths are treated the same way, only the silver solution is twice as strong. After acting for a few seconds the preparation is exposed for ten minutes to the light, then treated a minute with the ½% solution of gold chloride and mounted in glycerin.

169. Hertwig, R. Ueber den Bau Ctenophoren. Jen. Zeitschr. f. Nat., xiv, 313 and 324.

Marine animals are so rich in chlorides as to stain by silver nitrate with difficulty, hence it is better to harden them in dilute perosmic acid, then wash in distilled water till only slight precipitation occurs with silver nitrate, in which (1%) they are put for about six minutes.

170. Golgi. Sulla struttura delle fibre nervose midolate periferiche e centrali. Arch. per le sc. med. 1880, iv, 221.

Nerve fibres are treated with chrome salts, osmic acid, and silver solution. The fresh nerve of a rabbit is put for an hour in a mixture of ten parts of potassium bichromate (2% sol.) and two parts of a 1% solution of perosmic acid. The nerve is then cut in pieces ½ to 1 cm. long and put back in the mixture, and after some hours it is changed to a 0.5% solution of silver nitrate, in which it remains for 8 hours. Mounts may be in dammar. Bichromate of potash is used alone for from four hours to 15 days, according to the kind of nerves, which are then treated in the dark for 12–24 hours with silver nitrate, and mounted in dammar before exposure to light.

171. Sattler. Die Verwendung des Lapisstiftes zur untersuchung der Epithelien. Arch. mikr. Anat., xxi, 672–677.

A pencil of caustic silver is rubbed over the surface to be examined, and it is then placed in water acidulated with acetic or formic acid, exposed to the light for a few minutes, and mounted in glycerin.

From the microscopical text-books Gierke extracts:—

172. Ranvier. Technisches Lehrbuch des Histologie, 1877.

The material, if membraneous, is to be stretched on a flat surface, washed with water from a pipette allowed to flow over it, followed immediately by the silver solution, and again washed with water. Sections are treated in a similar manner. If the silver solution is too weak, as 1–500 or 1–1000, or the light too feeble, there is a uniform coloration quite different from impregnation proper, in which the nucleus should be darkest, the protoplasma lighter, and the intercellular substance least colored of all.

173. V. Thanhoffer. Das Mikroskop und seine Anwendung. Stuttg., 1880.

The tissue is taken from the silver solution and put in a dry dish, while a 2% solution of acetic acid is dropped on it continuously with a brush while exposed to the light.

His pupil, Krauss, has devised a peculiar method. The material is taken from the silver, washed and put in a bright red solution of potassium permanganate. The reduction is rapid, even in the dark. Sometimes failures occur. It is even possible to mix the fluids. Another student, Carl Oppitz, uses silver nitrate and stannic chloride. Preparations treated as usual with silver are laid for two or three minutes in a ¼–½% solution of stannic chloride, in which they are carefully agitated. Reduction is rapid and the precipitate very fine grained. Impregnation with chloride of gold or chloride of gold and potassium.

174. Cohuheim. Ueber die Endigungen der sensiblen nerven in den Hornhaut. Arch. pathol. Anat. w. Physiol., xxxviii, 343.

Chloride of gold is substituted for silver nitrate in a similar process. The metal is rapidly reduced by the action of light on organic tissues. These become yellow, then red, and finally a bluish black. A ½% solution of gold chloride is applied, and then several days of soaking in water acidulated by acetic acid. Mount in glycerin or balsam. Different cells vary in intensity and color. Glands redden quickly. Many nuclei remain colorless. Nerve elements of both kinds color more quickly than protoplasm. Capillaries become red, but epithelium and cement substance do not take the color.

175. Arnold. Ein Beitrag zu der feineren Structur der Ganglienzellen. Arch. path. Anat. u. Phys., xli, 178.

The chloride of gold and potassium is dissolved in a 1% sol. acetic acid and the preparation treated with a bath of this mixture of 02.0–0.05 % strength. In 3–4 hours, or as soon as a violet tint appears, change to a 1% acetic acid in which the material may rest for 3–5 days till it assumes a deep color. This method is particularly adapted to show the nerve filaments in the ganglions; after the connective tissue is dissolved, moisten with glycerin, to which a little acetic acid is added, and expose to the light on a slide resting on a white surface. In 4 to 5 days the ganglion cells will be intense, the nuclei clear, the nucleoli feebly red, the axis and thicker nerve fibres bright red, but after 8–10 days even the finer fibres take an intense color.

176. Curvoisier. Ueber die spinulen und sympathischen Zellen des Frosches. Centralbl. f. d. med. Wiss., 1867, No. 57.

A simpler method than the last. A sympathetic ganglion is slightly crushed or pulled apart, then laid for ½–1 day in 0.2% acetic acid, dissected on a slide, and treated continuously with a few drops of gold chloride, 0.1% sol. while exposed to the light. (This process succeeds much better in a moist chamber).

177. Bastian.

Dissolves 1 pt. gold chloride in 2000 dist. water, adds a drop of hydrochloric acid. Reduction takes place in a mixture of equal parts alcohol and formic acid. The operation may be hastened by heat, and our author has also made double stainings of silver and gold.

178. Nathusius. Ueber die Mark substanz verschiedener Horngebilde, etc. Arch. f. Anat. Jahrg., 1869, p. 69.

Chloride of gold is used in a solution of 0.005 to 100 of water. The sections are reduced by a solution of subsulphate of iron.

179. Gerlach. Artikel Rückenmark in Stricker's Handbuch der Gewebelehre, 1871, p. 678.

In the examination of the spinal marrow potassium gold chloride is

preferred. The organ is hardened in ammonium bichromate, then put in solution of gold chloride (1–10000) to which a little hydrochloric acid is added. It takes 10–12 hours to bring out a light lilac hue, then wash in acidulated water, and finally in 60% alcohol, likewise slightly acidulated. (Gerlach's gold-stained preparations are, with respect to the finer nerves, unsurpassed and rarely equalled. The acid fuchsin process of Weigert alone can compare with it).

180. Hénoque. Du mode de distribution et de la terminaison des nerfs dans les muscles lisses. Arch. de l'Anat. et Physiol., 1870.

181. Klein. Beitrag zur Kenntniss der peripherischen Verzweigung markloser Nervenfasern. Centralbl. f. d. med. Wiss., 1871, No. 38.

Derselbe. On the peripheral distribution of non-medullated nerve fibres. Quart. Journ. Microsc. Sci., vol. xi, p. 405; vol. xii, p. 201.

182. Chrchtschonovitsch. Beitrage zur Kenntniss der feineren Nerven der vaginal schleimhaut. Weiner Acad. Sitzber, 1871, Abth. ii, Februar, p. 301.

All three recommend for very fine nerves and their branches a particular gold method. Portions of the fresh organ are placed for 30–45 minutes in a ½% solution of gold chloride, then for 12 to 24 hours in distilled water. They are then treated with an almost saturated solution of tartaric acid in a well-corked flask. Klein and his pupil, Chrchtschonovitsch, set the vessel in warm water of 50° C. and allow all to cool. Henoque heats the water to boiling, which is thought to injure the epithelium by K. and Ch. The brown or violet pieces of tissue are cut in fine sections in which the nerve ramifications may be clearly seen.

183. Boll. Die Histologie und Histiogenese der nervösen Centralorgane. Arch. f. Psych. u Nervenkr., iv, 52.

Contains more precise directions on Gerlach's gold and potassium chloride method. The staining is better, the shorter the time of exposure to the ammonium bichromate. The materials do not stain well 8 days old, after 14 days they are worthless. Alcohol should not be used even to moisten the razor lest it cause a precipitate. The quantity of solution (1–10000) need not be so large, and the sections should not lie in it over 18 hours; 12 is usually the best time.

184. Lawdowsky. Bemerkungen zur mikroskopischen Technik. Med. Bote, 1874, No. 37–39; Russisch.

Expresses dissatisfaction with ordinary gold stainings, and recommends a modification introduced by Nesteroffski in Kieff, which consists in reducing by ammonium sulphide. Each section requires about a drop, which is soon removed by blotting-paper and glycerin substituted. The preparations are very clear and transparent, the metallic precipitate being dissolved. They should be kept in the dark. The method is especially adapted to show the network of nerves in the walls of the colon, the nerve endings in the muscles, and the large central nerves.

185. Löwit. Die Nerven der glatten Musculatur. Wiener Sitzber, lxxi, April, 1875.

186. Fischer. Ueber die Endigungen der Nerven im quergestreiften Muskel der Wirbel thiere. Arch. mikrok. Anat., xiii, 356.

To show nerve terminations in muscles, make a 1% solution of gold chloride, and a mixture of 1 pt. formic acid and 2 pts. dist. water. A few c.c. of the last are put in a watch-glass, and pieces of the tissue under examination 1 to 2 mm. thick are dipped in for ½ a minute till transparent. They are then dipped for 10–15 minutes in gold chloride till they are quite yellow. Then in dilute formic acid in the dark, (1 pt.

acid, 2 of water), and then for 24 hours in pure formic acid in the dark. Finally wash well in distilled water and mount in glycerin.

187. Thin. A contribution to the anatomy of the lens Journ. Anat. and Phys., x, 229.

A solution of gold chloride ¼% is forced into the arteries until the tissues are saturated. The pieces are then laid in a similar solution for a short time and may then be tinted with hematoxylin.

188. Flechsig. Die Leitungsbahnen im Gehirn und Rückenmark des Menschen. Lpz., 1876.

The large nerves are first put in a 1% solution of ammonium bichromate. When hard enough to cut well into sections, wash, and put into 0.5% gold chloride for ¼ to ½ hour, wash well and transfer to 10% solution of caustic soda. The reduction is almost instantaneous, the white substance becomes dark violet, the gray remains colorless. After laying for some hours in the soda, the preparations are thoroughly washed, and mounted in Canada balsam as usual.

189. Ranvier. Leçons sur l'histologie du systéme nerveux. Paris, 1878.

To bring out the nerves of the cornea, lay it for five minutes in fresh filtered lemon juice, then for 15–20 minutes in 3 c.c. of a 1% solution gold chloride, and finally in distilled water to which a drop of acetic acid has been added. Reduction follows after exposure to the light for 2–3 days, and the fabrillœ of the nerves show clearly. To bring out the nerve terminations in the muscles, the method is to be modified by transferring the sections of muscle from the solution of gold chloride to a 20% solution of formic acid for 12 hours in the dark.

190. Hoggan. Combination of silver nitrate and gold chloride. See No. 168.

[*To be continued.*]

EDITORIAL.

Publisher's Notices.—All communications, remittances, exchanges, etc., should be addressed to the Editor, P. O. Box 630, Washington, D. C.

Subscription price $1.00 PER YEAR *strictly in advance. All subscriptions begin with the January number.*

A pink wrapper indicates that the subscripdion has expired.

Remittances should be made by postal notes, money orders, or by money sent in registered letters. Drafts should be made payable in Washington, New York, Boston, or Philadelphia.

The regular receipt of the JOURNAL, which is issued on the 15th of each month, will be an acknowledgment of payment.

The first volume, 1880, is entirely out of print. The succeeding volumes will be sent by the publisher for the prices given below, which are net.

Vol. II (1881) complete, $1.50.
Vol. III out of print.
Vol. IV (1883) complete, $1.50.
Vol. V (1884) complete, $1.50.
Vol. V (1884), Nos. 2–12, $1.00.
Vol. VI (1885), $1.00.

DR. CARPENTER'S PORTRAIT.—We regret to announce that the plate engraved for us, proofs of which had been received and approved, was destroyed by the recent large fire in Philadelphia. The plate was in the possession of Messrs. Crosscup & West, who had prepared it with especial care and correspondingly excellent results; but their entire establishment was consumed on the night of the 25th, if we recollect aright, with a loss to the firm of between $15,000 and $20,000.

Under the circumstances we trust our readers will accept this unavoidable delay in good part, and as for ourselves we are not disposed to urge the production of a new plate until the firm have had an opportunity to recover somewhat from the inevitable consequences of such a misfortune. We hope to have another plate in time for the April issue, if not before.

—o—

THE LIMITS OF RESOLUTION.—In the last number of the *Journal* of the Royal Microscopical Society, Mr. Frank Crisp has treated this subject in his usual able and lucid manner. The results are of considerable interest.

Referring to the formula which gives the limit of resolution for any

angular aperture, which is expressed by $\delta = \frac{\lambda}{2a}$, λ being the wave-length of the light, it is obvious that the limit of resolution for any aperture depends upon the length of the vibrations. In the Numerical Aperture Table which is published from time to time in this journal, among the advertisements, the value of λ is 0.5269μ, which is the wave-length of yellow light, and the theoretical limit of resolution given in the table is only true for light of that particular color. Taking the wave-length of blue light corresponding to the spectrum line F, $\lambda = 0.48606\mu$, which would give a smaller value to δ in the equation, hence the theoretical limit of resolution would be materially increased. In photography the actinic rays are assumed to be most active between lines G and H in the spectrum, having the maximum action near line h, $\lambda = 0.4000\mu$.

According to the table referred to, the theoretical limit of resolution for yellow light, or what may be regarded as the limit for ordinary white light, for the highest possible numerical aperture, which is 1.52, is 146,528 lines to an inch. Using monochromatic blue light the number rises to 158,845, and in photography the limit rises to 193,037, corresponding to line h in the spectrum. Mr. Stevenson has calculated the limits for various apertures, and embodied them in a table for the journal referred to.

It will be understood by the reader that the theoretical results cannot be fully realized in practice.

More lines can be resolved with sunlight than with lamp-light, but this is not due to the preponderance of short vibrations, as has been quite generally supposed. The short vibrations act upon a photographic plate with greater intensity than the others, but in eye-observations they are not strong enough to be effective against the brighter portions of the spectrum. Hence with sunlight we have only the power of resolution of white light, as given in the table, but owing to the intensity of the light it is possible to utilize the extreme angular aperture of an objective, and thus approach more nearly to the theoretical limit. This portion of the subject is fully explained in the article referred to.

——o——

Microscopical Societies.—We have once more opened a column to be devoted to reports and notices of microscopical societies. The Washington Society desiring to have its proceedings published, we were glad to offer such space as can be spared for the purpose, and at a recent meeting the Secretary was requested by the Society to send regular reports to the Journal.

Hereafter all news relating to the societies will be published in the column now established for the purpose, and we believe it will prove an interesting part of the Journal.

The Washington Microscopical Society, although one of the youngest, is having good meetings, and there is always something brought forward, either in papers or discussions, that is worth recording. We receive regularly reports from the San Francisco Society, which have been noticed as often as possible, and no doubt other societies will in future send occasional if not regular notices.

NOTES.

—Messrs. Walmsley & Co. have just issued the seventeenth edition of their fully illustrated Catalogue of Microscopes and Accessories. It is the most complete microscopical catalogue to be obtained, embracing the manufactures of Messrs. R. & J. Beck, Bausch & Lomb and other makers. The lithological stand deserves to be well known as a convenient instrument for a moderate price. The new Star microscope is a $15.00 stand, described recently in these columns, well deserving the praise bestowed upon it.

The catalogue is sold for ten cents, and we would advise all microscopists to secure copies.

— The obelisk which stands in Central Park, New York City, has been seriously affected by the severe climate, and disintegration of its surface was proceeding so rapidly that some method of protection was considered necessary. A preparation of paraffin has been applied for the purpose. Mr. P. H. Dudley examined the shaft during the treatment and found the surface very porous and full of minute fractures. Beneath the superficial flakes he found a growth of green cells, rod-shaped, with straight sides and slightly convex ends, 2 to 6 micro-millimetres in length. He has been unable to find a description of the plant. An account of the process of protecting the shaft, as well as some remarks of Mr. Dudley, is given in the *Transactions* of the N. Y. Academy of Sciences.

— We are pleased to receive a copy of a very creditable new publication, the *Journal* of the Trenton Natural History Society, the first number of which was issued in January, published by the Society at Trenton, N. J. The number before us is full of interesting articles on natural history, not too technical to attract, but well adapted to general reading. The Society is to be congratulated upon the first number, and we trust the effort will receive the well merited support of many subscribers. Dr. A. C. Stokes has an article in this number entitled Notes on Peridinium and other Infusoria.

— The following process for preparing a dead black surface on brass, for optical instruments, etc., is given by *The Locomotive:*—'Take two grains of lampblack, put it into any smooth, shallow disk, such as a saucer or small butter-plate, add a little gold size and thoroughly mix the two together. Just enough gold size should be used to hold the lampblack together. About three drops of such size as may be had by dipping the point of a lead pencil about half an inch into the gold size will be found right for the above quantity of lampblack; it should be added a drop at a time, however. After the lampblack and size are thoroughly mixed and worked, add twenty-four drops of turpentine, and again mix and work. It is then ready for use. Apply it thin with a camel's-hair brush, and when it is thoroughly dry, the articles will have as fine a dead black as they did when they came from the optician's hands.'

— General John Newton, Chief of Engineers, United States Army, originator of the plan and director of the work, has prepared a complete account of the operations for the removal of the obstructions at Hell Gate, from their beginning to the explosion of Flood Rock, in October last, which appears with full and new illustrations as the leading article in the February number of 'The Popular Science Monthly.'

— Mr. J. Trail Taylor, who for fifteen years occupied the editorial chair of *The British Journal of Photography*, having completed the term of his literary engagement in America, where he has edited for a number of years our valued contemporary, *The Photographic Times*, has returned to England to resume his old position, and will, as in times of yore, be glad to receive all friends of the Journal, from home or abroad, at the editorial rooms, 2 York street, Covent Garden. We congratulate *The British Journal* upon once more acquiring the services of such an able editor and accomplished writer.

— At the recent meeting of the American Public Health Association, Dr. George M. Sternberg received the only first prize that was given, for an essay on disinfection and individual prophylaxis against infectious diseases. This prize was offered by Mr. Henry Lomb, of Rochester, N. Y., who provided the sum of $2,800 to be distributed in prizes for essays on specified subjects. Only $1,100 was awarded in all, and most of the remainder has been offered by Mr. Lomb to be awarded for essays this year.

— Prof. D. S. Holman has been photographing infusoria instantaneously with the oxy-hydrogen light. He has successfully photographed the living *Amœba* in its various forms, with exposures said to be about the hundredth of a second, with a magnification of 250 diameters. Lantern transparencies were made from the negatives and the images thrown upon a screen at the Franklin Institute, showing the organisms magnified ten thousand diameters. The instantaneous photographing of infusoria was successfully done years ago, but at the present moment we are unable to recall the facts with sufficient clearness to give any further particulars.

—In a recent lecture on 'Matter, Including Radiant Matter,' by A. E. Outer-

bridge, jr., before the Franklin Institute, some striking statements were made concerning the extremely minute size of the ultimate molecules. The lecturer said:— 'The gold-beater, as you doubtless know, will hammer out the metal into leaves so thin that more than 4,000 are required to make a pile one millimetre in thickness. But vastly thinner gold leaves may be obtained in another way. By electroplating a known weight of gold upon one side of a sheet of copper foil of given dimensions, a coating of gold may be obtained upon the copper whose thickness is readily ascertainable by a simple calculation; then, by using a suitable solvent, the copper may be removed, when the leaf of gold will remain intact.

'After a series of careful experiments, I have obtained, in this way, sheets of gold, mounted on glass plates, which are not more than $\frac{1}{400000}$ of a millimetre thick; and I have some specimens to show you which I have good reason to believe are not more than $\frac{1}{1000000}$ of a millimetre. To give you an idea of this thickness, or, rather, thinness, I may say that it is about $\frac{1}{200}$ part of a single wave-length of light.

'Taking Sir William Thomson's estimate of the size of the final molecules, and considering that each layer corresponds to one page of a book, our thinnest film would then make a pamphlet having more than a hundred pages.'

— Among the many gorgeous objects for the polariscope, the ethyl ether of gallic acid, or ethyl gallate, first brought to notice by Dr. Christopher Johnston (see this Journal, vol. iv, p. 192), cannot be surpassed by any crystals we have seen. The finest crystals of this compound that have come to our notice are those prepared by Prof. W. H. Seaman, of this city, who may have some preparations that he would exchange for first-class mounts. The method of preparing the compound is described in this Journal, vol. v, p. 82.

— We would like to know for what reason Dr. T. B. Redding, in the *Physio-Medical Journal*, is abusing eminent scientific gentlemen so unreasonably. Really, we cannot see any good to come of such articles as he has been writing upon 'The Molecular Theory of Sound,' and it is a great pity that so much ink and paper should be wasted in such a manner. To characterize a correct explanation of physical phenomena as a 'fraud' is not very elegant, to say the least; and as for such specious language as we find in his apparently interminable discussion of this subject, it can only mislead the ignorant. Yet for that reason it should not be printed. The truth seems to be that Dr. Redding does not understand what he so roundly condemns and ridicules. It would seem he has founded his knowledge upon Professor Tyndall's excellent book, which is a published course of popular lectures on the subject. These have been entirely misunderstood by the writer, or wilfully misconstrued. No one who is not a scientific man should criticise a subject in physical science. It is useless to give serious attention to such articles. It is the height of absurdity for a writer to declare that a man like Tyndall has given publicity to statements 'erroneous from beginning to end.' Which is the greater, Tyndall or his critic? Which is the more competent to deal with this subject? We can only protest against the publication of such nonsense. It is somewhat consoling, however, to think that in this enlightened age pseudo-scientific cranks cannot do much harm to the progress of science.

— It is frequently desirable to have a liquid preservative of the same specific gravity as water. Probably the nearest approach to such a medium is the one recommended to be used with Deane's gelatin medium, having the following composition:— Rectified spirit, 1½ oz.; Water, 1½ oz.; Glycerin, 5 fl. dr. This can be used as a preservative, or a specimen may be placed in the medium under a bell-jar until most of the alcohol has escaped, leaving the denser glycerin and water.

— At the 36th meeting of the Washington Microscopical Society, held Dec. 22d, Dr. J. M. Flint, Surg. U. S. N., who is assigned to professional duty of the Fish Commission steamer 'Albatross,' made an interesting exhibition of a collection of foraminifera, obtained during the cruises of the 'Albatross,' from the dredgings and soundings off the eastern coast. The specimens, which had been carefully selected and mounted as a type-series on the rotary object-carriers described last year,* attracted much attention, and were greatly admired both for their perfect form and the excellent manner they were mounted.

The rotary object-carrier is not merely a convenient device for the display of objects, but it is a most excellent device to aid the systematic student. A large number of forms or varieties may be mounted together in the most favorably condition for study and comparison.

* Vol. vi, p. 204.

CORRESPONDENCE.

Is it Codonella?

To the Editor:—In Mitt. aus der Zool. Stat. zu Neapel VI, p. 196, Professor G. Eutz describes a ciliate infusorian with the name *Codonella lacustris*, n. sp. The descriptions and reasons for referring it to the genus *Codonella* were drawn from a study of specimens, 'wenn auch nicht ganz gut,' prepared by Dr. E. Daday, and which were collected in a fine net from Mezö-Záh in Siebenbürgen and from a pond at Budapest. He considers the species the same as that described, the shell only being known, by Dr. Joseph Leidy, in Fresh-water Rhizopods of North America as *Difflugia cratera*, but which he supposed might pertain to a species of Infusoria of the genus *Tintinnus* rather than to the Rhizopoda. In the fall of 1880 I was fortunate enough to take the animal living from the water supply of Buffalo, and in October of that year I advised Dr. Leidy by letter that I had so taken it and that his conjecture as to its infusorial affinities was correct. I have taken it sparingly at different times since, and from such examination as I have been able to give it and from a consideration of its characters and habits presented by Mr. Vorce in the paper cited below, I regard the species more properly classified with the *Tintanni* than with the *Codonellæ*, and have so recorded it in my notes under the name *Tintinnus cratera*.

In vol. ii, p. 223 (1881), this Journal, Mr. C. M. Vorce reported the living animal taken from the Cleveland, O., water supply, and gave an account of its appearance and behavior. Mr. Vorce has also referred to it under the name *Tintinnus sp.* in the Proc. Amer. Soc. of Micr., vol. iv, p. 193 (1882) and Pl. III, fig. 34.

If it is in fact a species of *Tintinnus*, whose species?

D. S. Kellicott.

Buffalo, N. Y., Nov. 5, 1885.

—o—

Preserving Urinary Casts.

To the Editor:—Regarding urinary casts, as also pus, epithelium and spermatozoa, I have quite a number of specimens of each, in as many different preserving media. In each case the mother liquid (urine) has outlived all others, and now, after a lapse of four years, they are just beginning to disintegrate.

In my experience there is no better medium than the mother liquid for such specimens.

Boston, Mass. C. P. Pengra.

—o—

Restoring Mounts

To the Editor:—Can any reader of the Journal tell me how to remove beads of moisture from a dry slide of *P. angulatum?*

—o—

A New Find of Fossil Diatoms.

To the Editor:—At a late meeting of the Philadelphia Academy of Sciences, Dr. George A. Köing called attention to the occurrence of diatoms in clay taken from a railroad cutting within the limits of that city, and that he had identified three species of *Pinnularia* therein. I wrote to him for a sample of the clay, and found that the material was quite rich in diatoms, and that the following genera were well represented, viz:—*Pinnularia, Stauroneis, Navicula, Surirella, Nitzschia, Cocconema, Encyonema, Cymbella, Epithemia, Gomphonema, Eunotia, Fragillaria, Cocconeis, Cyctotella,* and several small species of genera not identified; also sponge spicules of various forms.

K. M. Cunningham.

Mobile, Ala., Jan., '86.

MICROSCOPICAL SOCIETIES.

Washington, D. C.

Thirty-seventh meeting, January 12th, 1886. Prof. W. H. Seaman read a paper on Mounting Media of High Refractive Powers, which is published in full on another page. He showed specimens mounted in the two new media described, and also in several other of the newer media of high refractive powers. He thought the solutions of phosphorus in oil of cassia, and sulphur in anilin were new.

Mr. Hitchcock said that sulphur had been used as a mounting medium, but not in the manner proposed by Prof. Seaman.

Dr. Taylor asked as to the practicability of using an alcoholic solution of balsam as a mounting medium.

Dr. Schaeffer said that he had begun to use alcohol balsam in 1872 and had continued to use it ever since. The solution should be made by heating the hardened balsam and adding to it, while hot, absolute alcohol.

Mr. Hitchcock showed a specimen of *A. pellucida*, mounted in Prof. Smith's

stannous chloride medium, and resolved by a Zeiss $\frac{1}{12}$ homogeneous immersion objective, with an A eye-piece. The markings were clearly and distinctly shown over the whole length of the diatom.

Thirty-eighth meeting, Tuesday, January 26, 1885. The Society took up for consideration the discussion, continued from a preceding meeting, of the preservation and mounting of urinary deposits.

Dr. Caldwell showed crystals which had been mounted in alcohol balsam since last May which showed no signs of change. Dr. Schaeffer said :—For temporary preservation, allow the urine to stand in a conical glass till the sediment has settled, draw of the supernatant fluid and replace it by a mixture of alcohol, glycerin and water in equal parts. Agitate the contents of the glass, again draw off the fluid and replace it by more. Continue this process until there can be no trace of urine left. For permanent preservation and mounting he had found this mixture to answer as well as anything for casts, epithelium, etc., though he could not boast of great success. For crystals he advised the use of an aqueous alkaline solution for phosphates, and balsam for other forms. In response to a question by Prof. Seaman, he said that he had never used acetate of alumina to preserve casts.

Mr. Hitchcock read an extract from a letter from Dr. C. P. Pengra, of Boston, Mass., in which the writer stated that he had numerous mounted specimens of casts, epithelia, etc., and that he had found no medium so satisfactory as the mother liquid itself. Mr. Hitchcock said that this corresponded to his own experience, and that he had had best success with urine to which a little carbolic acid had been added than with any other medium.

Prof. Seaman showed a slide containing a mixture of several of the more common forms of uric acid, and also slides of uric acid from some of the larger moths.

Dr. Flint presented for distribution some diatomaceous material dredged by the 'Albatross' from a depth 1,440 fathoms.

E. A. BALLOCH, *Secr.*

—o—

SAN FRANCISCO, CAL.

Regular meeting, January 13th. A slide of *Bugula* (*Cellularia*) *avicularia*, one of the marine polyzoa, was donated by Mr. Howard, and shown under polarized light.

The subject appointed for discussion, 'Culture Methods used in the study of Micro-organisms,' was introduced by Dr. C. P. Bates. He stated that the absorbing interest attending the study of unicellular organisms during the past few years, especially of that group known by the generic term bacteria, and the variable conditions under which they require to be observed, had necessitated the use of numerous fluid and semi-fluid culture media. A brief description of some of these was given, together with the modes of preparation and preservation usually employed. The respective merits of fluid and of gelatinous media were alluded to, Dr. Bates being evidently inclined to follow Pasteur, in giving preference to the former. By means of apparatus constructed by himself, he demonstrated his method of sterilizing and preserving culture fluids. Various forms of culture tubes were shown, and also numerous other devices. At the conclusion quite an animated discussion arose as to the respective merits of the gelatin method of culture and that of Pasteur, who still employs fluid media in his investigations.

A. H. BRECKENFELD, *Secr.*

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Wanted: Cleaned St. Vincent material, for cash.
E. A SCHULTZE,
Tompkinsville, Staten Island, N. Y.

For Exchange: Eyes of *Limulus*, and leaves of *Deutzia scabra*, rich and beautiful stellate hairs, for finely mounted slides of diatoms or polycystina.
W. E. DAMON,
Care of Tiffany & Co.,
New York City.

Seeds of *Orthocarpus purpurescens* in exchange for other objects, mounted or unmounted.
EDWARD GRAY, M. D.,
Benicia, California.

Diatomaceous clay from this place, and fine slides of Foraminifera, for fine slides, material or back numbers of A. M. M. Journal.
E. H. RICHARDS,
Woburn, Mass.

Wanted: Well cleaned and selected Foraminifera, for which cash will be paid or slides given
EDWARD G. DAY,
Riverside, Conn.

Hundreds of varieties of fresh-water Algæ, including Volvox, Desmids, Rivularia, Draparnaldia, Tetraspora, &c., &c., for selected exchanges by list.
J. M. ADAMS,
Watertown, Md.

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The Microscopical Study of Rocks.*

BY J. S. DILLER, ASST. GEOLOGIST, U. S. GEOL. SURVEY.

The speaker began by calling attention to the extensive use of the microscope in the study of rocks, and briefly reviewed the history of its application in the development of modern petrography.

The earlier observations pertained chiefly to precious stones and their inclusions, but M. F. Ledermüller and H. Baker soon after the middle of the eighteenth century called attention to the structure and genesis of crystals. In 1780 C. A. Gerhard studied mineral sections under the microscope in discovering the structure of chiastolite, but it is important to note that these sections were studied only in reflected light. The preparation and study of the first really thin sections in transmitted light was effected by William Nicol, who, in 1831, discovered the calcite prism that bears his name. The investigations of Nicol, in connection with those of Sir David Brewster and Sir Humphrey Davy, concerning the optical properties of minerals, were of prime importance in the development of petrographic research.

There are two ways in which a rock may be prepared for microscopical investigation. It may be pulverized or it may be sliced. As the preparation of thin slices of rocks is attended with considerable difficulty and their pulverization is easily accomplished, the earliest microscopical observations of rocks were made upon their powder. Before the close of the eighteenth century Dolomieu and others had used the microscope in studying pulverized rocks. These observations were soon followed by those of Zincken in Germany, but it was not until many years later that the microscope was systematically employed in petrographic research. This important application was made by Henry Clifton Sorby, who was the first to fully appreciate the value of the microscope in studying rocks. He published in 1858 in the *Quart. Journ. Geol. Soc.*, London, a paper 'On the microscopical structure of crystals, indicating the origin of minerals and rocks,' and may be considered the chief initiator of modern petrographic methods. The seed sown by Sorby in England soon bore abundant fruit in Germany, for in 1863 we find F. Zirkel publishing the first of a number of books which mark the beginning of an epoch in geologic investigations. A host of enthusiastic Germans who were well prepared for the work then took it up, and micro-petrography developed with wonderful rapidity. To Prof. H. Rosenbusch, who in 1873 published the first volume of his Mikroskopische Physiographie (der petrographisch wichtigen mineralien), and a second volume (der Massigen Gesteine) in 1877, the greater portion of this rapid development is due. These masterly works have laid open such fertile fields for investigation, and inspired so much enthusiasm into their cultivation that it is not surprising to find petrography one of the most progressive of all the branches of science.

* Abstract of a communication to the Washington Microscopical Society, Feb. 9th, 1886.

The first important petrographic work done in this country was by Zirkel for the Fortieth Parallel Survey, but at the pesent time there are nearly a score of investigators, most of whom were students of either Zirkel or Rosenbusch, actively engaged in research.

Although it will hardly be admitted by microscopists generally, nevertheless the microscope appears to be a much more important instrument in the study of inorganic than organic nature. The molecular structure brought about by vital force is not of such a sort as to impress its character upon transmitted light. On the other hand the inorganic bodies which occur in nature as minerals have each its peculiar form of crystal, and each so modifies the light transmitted through it as to indicate the system of its crystallization. The great value of the microscope in the study of petrography arises largely from the facility it affords for observing minerals in transmitted light.

The speaker remarked that it would not be appropriate at this time to enter into a discussion of the great geologic problems, the solution of which depends so largely upon the revelations of the microscope. He had, however, brought with him several microscopes of French and German patterns showing the modifications which especially adapt them to petrographic work. Besides the ordinary parts of a compound microscope, the instruments exhibited had each a polarizing apparatus, a rotating stage, and a lens beneath the stage, so that when desirable investigations may be made in converging light. It is very important to have the objective so adjusted to the axis of the stage that when the latter is rotated the object under examination may not be turned out of the field of vision. In the German instruments made by Voigt and Hochgesang in Göttingen, and Fuess in Berlin, either the objective or the stage is adjustable to the other, but in the Nachet microscope a much better plan has been adopted of separating the tube into two parts, and supporting the objective from the rotating stage in such a way that both rotate together about the same axis. The French instrument has a great advantage over all others in the use of a spring clamp for fastening the objective to the tube, and an arrangement for swinging the analyzer in and out of the tube, which greatly facilitate rapid examinations.

The speaker then exhibited some small specimens illustrating the way in which thin sections of rocks are prepared for microscopical investigation. The rock chips are first ground perfectly flat upon one side and then cemented by Canada balsam upon a thick slip of glass. The other side is then ground down, the preparator holding the slide by the slip of glass to which it is cemented. The coarse grinding is done upon a cast-iron plate by hand or upon rotating disks of the same metal, using in both cases No. 60 emery. The section is finished upon a smooth glass plate with FFFF best English washed emery. It is then detached by heat from the thick slip, transferred to a thin transparent one and permanently mounted in Canada balsam.

——o——

Occurrence of Red Snow.

I was interested in the paper recently read before the Biological Society on the '*Chlamydococcus nivalis*,' which tinges the Arctic snows red.

All the observations of naturalists point directly to the higher mountain slopes as the birthplace of the plant from which the red deposits originate, although they are mentioned by many of the relators as being found near glacier cliffs, as at Beverly and Baffin's Bay, in the Arctic seas, by Kane and Ross. In all countries where glaciers exist, an exuberant growth of lichens immediately follows the denudation of the rocks from which a high midsummer tempera-

ture has rapidly melted the snow; and in all the crevices soil and moisture enough collects to induce a prolific vegetation, which passes from germ to maturity in a very brief period. The deposits of red vegetable matter would be readily and naturally attributed to the landwash from the melting, except for the fact that they are often found many miles away from the mountain valleys—farther than they could travel before they lost their color by weathering.

I don't know that my observations will be of the slightest value, but will say that while cruising along the Labrador coast in lat. 53°, in company with Prof. Elliott Coues and others in 1860, we saw a large gothic iceberg of opaque dead white, whose façade was crossed by a transverse vein of brilliant crimson. The complexion of the ice, and the situation of the red streak on the face of the berg, indicated plainly that the position of the latter was on the surface of the superficial or topmost stratum of the glacier from which the berg was broken off, and therefore that the red deposit was of recent origin, and probably of the previous summer, because the rate of progression of the glacier toward the sea is only a few inches an hour, and its source was several miles back among the mountains. The section of ice which formed the berg was not far back from the front when the red deposit was made.

The phenomenon of red snow should not be a mystery to sub-Arctic travellers, who are perfectly aware that prolific vegetation is not incompatible with boreal meteorology. The requisite conditions of heat and subsoil moisture are present to a superlative degree during the short midsummers which have no long interval of night to chill the earth, and maturity is reached in an incredibly short time by a sort of forcing process which is even now being imitated by advanced agriculturists, as far as a practicable application can be made. Readers of Arctic narratives are apt to gather the impression that the polar belt is always frigid, and that ice is perpetual and the only product. I've seen strawberries growing beside an ice-field in latitude 60 degrees.

I have never noticed any red seams in the South Alaskan icebergs like the one described in the Labrador berg, but the source of Atlantic icebergs is much farther to the north, all of them being formed north of latitude 60 degrees, which is the birthplace of the most famous of the Alaska glaciers. It is likely that the boreal faunas are different in respect to lichens and mosses, as they certainly are in respect to other forms and orders.

CHARLES HALLOCK.

Staining and Double Staining Vegetable Tissues.

[We have been asked from time to time by correspondents to give references to good processes of staining and double staining vegetable tissues. Various excellent processes have been published in these pages to which the reader may refer through the indexes, but in addition to these we have been quite at a loss to give satisfactory replies to such inquiries. We have therefore decided to republish the methods of Dr. George S. Beatty, which were given ten years ago in the *Pop. Sci. Monthly* and reprinted in the *Amer. Jour. Micr. and Pop. Sci.*, believing that they will serve every purpose. Of these methods we may say that, so far as we are aware, they are as good as any since devised. Dr. Beatty's stainings, even at the present day, command a high market value when they can be found for sale, which is seldom the case. We may also add that we can vouch for the excellence of the processes as given, from personal experience.

The reader who may wish to experiment in this fascinating work will

find invaluable aid in the articles on 'Staining Tissues in Microscopy' which Prof. Seaman has translated for the journal.—Ed.]

All vegetable sections, and some leaves, may be prepared for staining by soaking them in alcohol, or in a mixture of dilute nitric acid and chlorate of potash; but I much prefer the results obtained by first bleaching them in 'Labarraque's solution of chlorinated soda,' and then treating them with alcohol for a few hours. In half an ounce of the soda solution a large number of sections may be placed, but not more than a dozen half or one-inch leaves, or parts of large leaves cut into inch pieces. Leaves in greater number adhere to each other, and thereby take longer to bleach.

Sections of matured wood should be kept in this solution from twelve to eighteen hours; sections of stems, leaves, and petals from six to eighteen hours; pistils and stamens, and sections through the gynæcium and receptacle of flowers, from two to six hours.

Leaves and petals should not only be bleached by the Labarraque, but should also be rendered translucent. This is accomplished in from six hours to six days.

If delicate leaves show evidence of disintegration after they are bleached, but before they have become translucent, they should be removed to alcohol, after washing them in water as described below. This renders them translucent within two days.

After removing from the Labarraque, put them into half a pint of clear water. Change the water five times during twenty-four hours, acidulating the third washing with five or ten drops of nitric acid. Sections can be washed in half the time required for leaves.

Next, put into alcohol, which in a few hours prepares them for staining.

In alcohol, tissue may be kept for months without turning yellow.

I.—STAINING LEAVES AND PETALS.

For staining leaves and petals the best dyes are anilin blue and hæmatoxylin.

Other anilins than the blue may be used, but they are not so pleasant to the eye, and are harder to work, as they fade out in both alcohol and oil of cloves.

Red anilin may be used, one quarter of a grain to an ounce of alcohol; violet, one-half grain; and green, three grains.

To make the blue anilin dye, dissolve in a mortar half a grain of 'Nicholson's soluble blue pure' in one ounce of 90–93 per cent. alcohol, which has been acidulated with half a drop of nitric acid; then filter.

Dilute a portion of this with alcohol to obtain a quarter-grain solution.

The formula for the hæmatoxylin dye is given further on.

A bright purple dye, good for leaves and sections, is made by steeping fresh berries of the *Phytolacca decandra* in alcohol. The stainings are quite permanent, but the dye does not keep over six weeks.

To Stain Leaves and Petals in Anilin Blue.

1st. Transfer several small leaves from alcohol to about half a drachm of the quarter-grain blue.

If not stained of sufficient depth of hue in one hour—

2d. Transfer to the half-grain blue for a quarter or half-hour.

3d. Brush in 93 per cent. alcohol with camel-hair pencil, and trim the edges of cut leaves. Any excess of color may be soaked out in this dilute alcohol.

4th. Put into half a drachm of absolute alcohol for half or one hour. In this but a trace of color will be lost.

5th. Put in oil of cloves for one hour, or until ready to mount in Canada balsam and benzole.

To Stain Leaves and Petals in Hæmatoxylin.

1st. Transfer from alcohol to water for five minutes.

2d. To 3 per cent. alum-water for ten minutes.

3d. To hæmatoxylin dye, diluted with an equal part of 3 per cent. alum-water, for one hour.

4th. To full strength dye, if necessary, for half or one hour.

5th. To alum-water for a moment, or until any excess of color is soaked out.

6th. Brush thoroughly in water, and put into one ounce of clean water for fifteen minutes, to remove alum crystals.

7th. To 93 per cent. alcohol for fifteen minutes.

8th. To absolute alcohol for two hours, or longer.

9th. To oil of cloves for one hour, or until ready to mount.

Some leaves, chiefly ferns with sori, may be double-stained with hæmatoxylin and anilin blue; the former going to sori and spirals, the latter to other parts. The process is first to stain in hæmatoxylin, and then to soak the color in part from the body of the leaf by putting it in alum-water. Next carry through pure water and alcohol to a half-grain anilin blue solution for thirty or forty-five seconds, and proceed as you do with a single blue staining.

II.—DOUBLE STAINING OF SECTIONS.

For double stainings I use hæmatoxylin and carmine, and blue, green, and red anilins.

Of the red anilins I prefer that known under the head of magenta or roseine pure, though fuchsin, ponceau, and solferino may be used. These anilins are manufactured at the Atlas Works of Brooke, Simpson & Spiller, London.

The anilin dyes are made by dissolving the quantity given in each process with aid of mortar and pestle, in one ounce of 93 per cent. alcohol and filtering.

The hæmatoxylin and carmine dyes are made according to the following formulæ:

Hæmatoxylin Dye.

Ground Campeachy wood,	½ ounce.
Pulv. alum,	1 "

Mix and triturate in a mortar for twenty minutes, then add five ounces of hot distilled water, and let it stand for two days. Filter, and to each ounce of the dye add two drachms of 75 per cent. alcohol. In twenty-four hours again filter to remove precipitated alum. This dye is made somewhat after Dr. Arnold's formula; he using the extract instead of the wood. It keeps, with occasional filterings, in well-stoppered bottles for two months.

Borax Carmine Dye.

Pulv. carmine,	7½ grains.
Saturated aqueous solution of borax,	7½ fl. dr.
Mix and add absolute alcohol.	15 drachms.

Filter and collect crystals when dry. Dissolve nine grains of crystals in one ounce of distilled water.

This is Dr. J. J. Woodward's formula; but not so strong, as his is a saturated solution.

Ammonia Carmine.

Pulv. carmine,	7½ grains.
Water of ammonia,	20 drops.
Absolute alcohol,	½ ounce.
Glycerin,	1 "
Distilled water,	1 "

Put the pulverized carmine in a test-tube, and add the ammonia. Boil slowly for a few seconds, and set aside, uncorked, for a day, to get rid of excess of ammonia. Add the mixed water and glycerin, and next the alcohol; then filter.

Process I.—*To Stain Sections with Magenta and Blue Anilin.*

1st. Transfer from alcohol to magenta dye (one quarter of a grain to the ounce), and let it remain from fifteen to thirty minutes.

2d. Soak in alcohol for about the same time, or until the color is entirely, or in great part, removed from parenchymal tissue.

3d. Place or hold in a quarter or a half-grain anilin blue solution from fifteen to forty-five seconds.

4th. Shake in absolute alcohol for a few seconds.

5th. Put in oil of cloves for ten minutes.

6th. In clean oil of cloves for ten minutes.

7th. In half a drachm of benzole for five minutes.

8th. Mount in Canada balsam softened with benzole.

The benzole may be omitted, as it sometimes slightly contracts delicate tissue, but it causes the mounting to harden much more rapidly, and, perhaps, is beneficial in preserving the magenta.

Process II.—*To Stain Sections in Magenta and Blue Compound.*

1st. Mix seven drops of a one-grain solution of magenta with five drops of a two-grain solution of blue (non-acid).

2d. Into this purple mixture put your section for five or ten seconds.

3d. Shake rapidly in absolute alcohol for a few seconds.

4th. Treat with oil of cloves and benzole, as in Process I.

Process III.—*To Stain Sections in Green Anilin and Carmine.*

1st. Put your section in a three-grain solution of iodine-green, and let it remain for one or two hours.

2d. Soak in alcohol for five or ten minutes, for reasons given above.

3d. Put in water for a minute.

4th. In the borax carmine from thirty to forty-five seconds.

5th. Shake rapidly in water, and soak out any excess of carmine that may be taken up.

6th. Put in alcohol for five minutes.

7th. In clean alcohol for ten minutes.

8th. In absolute alcohol for ten minutes.

9th. In oil of cloves for fifteen minutes.

10th. Mount.

Process IV.—*To Stain Sections in Green Anilin and Carmine Compound.*

1st. Mix fifteen drops of borax carmine with fifteen drops of the three-grain iodine-green solution.

2d. Transfer section from alcohol to water for a minute.

3d. Put in the dye from thirty to sixty seconds.

4th. Shake rapidly in water, and soak out any excess of carmine that may have been taken up.

5th. Treat with alcohol and oil of cloves as in Process III.

Ammonia carmine may be used in the same proportion as the borax. Formerly, in Process III, I used the carmine before the green, but I now follow Dr. B. W. Barton's plan of using the green first, as far better results are thereby obtained.

To stain sections in hæmatoxylin and anilin blue, the mode of procedure is the same as for leaves; but they stain more rapidly, and only require the dilute dye.

Whether sections are stained by the alternate, or by the compound methods, the selection of colors is the same. The red and green anilin and the hæmatoxylin go to spirals, bass cells, scattered thickened cells, and, sometimes, to thick epidermis and hairs.

The blue anilin and carmine always go to parenchymal and often to thin epidermic and hypodermic tissues. The selection of color in matured wood is different, as will be seen further on.

It is not possible, I think, to give a satisfactory explanation of double staining of either animal or vegetable tissues. We can only say that certain dyes seem to have an affinity for certain cells. This is best shown by soaking single stainings in a fluid that removes their color. If sections stained in red or in green anilin be soaked in alcohol, and those stained in hæmatoxylin in alum-water, the color will rapidly leave the loose parenchyma, but will be retained for many days by the denser cells, as spirals, bass, etc.

On the other hand, specimens stained in blue anilin, if left in alco-

hol, and those stained in carmine, if left in water, lose the color much more slowly in the parenchymal than in other parts.

In my previous paper on double-staining of wood, etc., I said, if the blue was used before the red anilin, the selection of color was reversed. This is true as regards matured wood, but does not hold good when stems and midribs are under treatment.

Matured wood is better stained by the alternate methods. In longitudinal cuts, the first color used goes to longitudinal woody fibres, the second to spiral vessels, ducts, and bark. Sections of stems and leaves not infrequently give better results by the compound methods. These results are superior to those obtained in wood, for the reason, I think, that in the latter there are not the same extremes of hard and soft tissues.

Double stainings should be examined by artificial light. Compound dyes should be used immediately after they are made.

Care should be taken to obtain a good article of absolute alcohol. That manufactured by Dr. E. R. Squibb, of Brooklyn, N. Y., gives me perfect satisfaction, while a German article I have used bleaches blue and green anilin stainings as though it contained some alkali.

Benzole instantly fixes those anilins that fade in alcohol and oil of cloves; but it does not do to transfer objects from alcohol to benzole, except through the medium of oil of cloves, on account of the injurious contraction it causes.

It should be borne in mind that chlorinated soda acts somewhat injuriously upon starch and protoplasm. This is not the case with dilute nitric acid and chlorate of potash, nor with alcohol.

In regard to fading, an experience of eighteen months enables me to speak quite favorably.

Some few leaves stained in blue anilin and in hæmatoxylin fade injuriously; others lose little or no color. Sections double-stained in green and carmine have perfectly stood the test of twelve months. Those in magenta and blue as a rule hold well.

If the effects produced by staining properly prepared vegetable tissues, with one or two colors, were more generally known and availed of, the study of vegetable histology would be even more attractive than at present. So striking and precise is the manner in which certain dyes seize upon certain tissues, that it must be seen in order to be fully appreciated.

A word about the cutting of sections, for much depends upon this preliminary step. They must be cut thin and even.

Vegetable parts cut into pieces should be kept in alcohol for a week or two before sectioning. If leaves become crisp, which rarely occurs, a few minutes residence in water renders them pliable.

In making sections of leaves, longitudinal cuts of midribs may be made, or vertico-transverse cuts through the midrib, including one-third of an inch of leaf on either side, or through several veins; leaves and small stems held against a piece of potato or turnip that has been hardened in alcohol may be cut with a razor flat on the side, which is inferior when the back is held towards you. Alcohol should be poured over the object and razor while cutting. Large stems are better cut in a section machine, using paraffine as an imbedding agent. The object should be flooded with alcohol while cutting, and the paraffine should be trimmed to a cone-shape around it after every two or three cuts.

A knife I use with my section cutter acts so satisfactorily upon both animal and vegetable tissues that I will describe it. It weighs $7\frac{1}{2}$ ounces (avoirdupois). The handle is stout, and is $4\frac{1}{2}$ inches long, the blade is $7\frac{1}{2}$ inches long by $1\frac{1}{4}$ inches wide, the back being $\frac{1}{4}$ inch thick. The infe-

rior side, holding the back towards you, was first ground flat and afterwards slightly concave from back to edge. A similar knife I find is figured in Mr. Rutherford's 'Outlines of Practical Histology.'

A list of some of the vegetable objects I have found most interesting may be acceptable to some of your readers:—

Leaves.—*Drósera rotundifolia*, *Dionea muscipula*, *Hepática triloba*, *Oxalis stricta*, *flava*, *hirsuta*, and *Bowiei*; *Deutzia gracilis*, *cruenta* and *Fortunii*; *Tradescantia zebrina*, *Eucalyptus globulus*, *Buchu serratifolia*, *Cassia acutifolia*, *Rhus Toxicodendron*, *Adiantum cuneatum* and *pedatum*, *Pteris serrulata*, *Elaeagnus*.

Sections of Stems and Midribs.—*Ficùs elastica*, *Strelítzia Regina*, *Althæa rosea*, *Asclepias cornuta*, *Rùbus villòsus*, *Impatiens Balsaminia*, *Pteris aquilina* and *serrulata*, *Paulownia imperialis*.

Sections of Stems.—*Aspidium Filix mas*, *Ricinus communis*, *Mùsa sapientium*, *Euphorbia splendens*, *Datura stramonium*, *Dracæna Braziliensis*, *Ailanthus*.

—o—

Photo-Micrography.—IV.

BY THE EDITOR.

[*Continued from page 10.*]

3. Illumination.

It is not unlikely that some of our readers have been surprised at a remark made in the course of these articles to the effect that, in certain cases, lamp-light may be even better than sunlight. The statement, however, was not carelessly made. In this article we have to consider the various methods of illumination that are used, and it will be well first to briefly notice the peculiarities of the light from different sources. First, it should be observed that the light that acts most rapidly upon the sensitive photographic plate is that which is found in the blue portion of the spectrum, the maximum action upon bromide plates being between the Fraunhofer lines F and G, the exact position varying with the nature of the sensitive emulsion. The usual range of sensitiveness of the ordinary commercial plates is between lines F and H, diminishing almost abruptly below F and more gradually in the violet and ultra-violet, extending as far as N. In other words, the greatest sensitiveness is in the blue and violet, not as some have supposed, in the ultra-violet. For this reason, it may be incidentally remarked, the visual and actinic foci are coincident if we focus with blue light. The ordinary dry plates, however, are acted upon by yellow light if the exposure be long enough. For this reason the plates are handled in ruby light in the developing room.

From this we can understand the reason for the assertion that lamp-light may possess some advantages over sunlight in photographing particular objects. Take, for example, a preparation having much yellow, chitinous structure. Lamp-light being deficient in blue rays, a long exposure can be given with the yellow rays passing through the object before the blue of the transparent field has weakened the other portions of the plate by over-exposure. In practice, however, this will only be found advantageous in particular cases, and we do not advise the use of any artificial light when the sunlight can be used. But probably by far the greater number of those who use the microscope are obliged to work at night, and for them artificial light of some kind is necessary.

We cannot, in consideration of what we have seen, fully agree with the opinions expressed by our able correspondent, Dr. Miller, on page 19. What we need in photography is a light that will affect the sensitive plate, and having that we can take good photographs.

In the days of collodion, plates were far less sensitive than the modern dry plates, and clear sunlight was

quite necessary for high-power work. Now it is no longer so. It is principally a matter of time. There is nothing about artificial light inimical to photographic action, and while we admit the truth of Dr. Miller's criticism concerning much of the amateur work with flimsy apparatus, the fault, we take it, is not so much due to the imperfections of the apparatus as in the inexperience of the operators. It may be confidently asserted that excellent work can be done with lamp-light with powers up to 1500 diameters; but it requires skill and patience, as well as a powerful light.

We have to consider now the manner of using sunlight, the electric light, and lamp-light. In working with sunlight it is very desirable to have a heliostat. A very expensive form of heliostat is not necessary. Mr. E. Kübel, of Washington, furnishes an instrument that is in all respects satisfactory for this purpose, for a reasonable price. It is represented in fig. 9. Full instructions for setting the instrument are sent with each one, and there is no difficulty in obtaining a practically steady beam of light after the adjustments are once carefully made.

Equally good photographs can be made by reflecting the sunlight from a mirror mounted in any convenient manner, but as the light reflected upon the object is then constantly changing with the position of the sun, one can never be quite sure that the illumination is good when the plate is exposed. The few moments that will elapse between focussing and exposing the plate will sometimes make a surprising difference in the appearance of the object, particularly when a momentary cloudiness causes delay in the exposure. A rapid worker, however, will not lose many plates from this cause, and the want of means to invest in a heliostat need not deter any person from undertaking work with a common mirror, which can be made to follow the sun by a simple mechanism, operated inside the window.

The mirror or heliostat should be mounted on a solid support outside the window, or on a heavy base-board, upon which the microscope and camera are also fixed, thus insuring solidity to the arrangement. At the National Museum the camera, having a bed more than five feet in length, rests upon a 2-inch plank, having a guide running along one side against which the side of the camera-bed rests to maintain it in line. In front of the camera is the microscope, firmly screwed to a block of proper height, and at the outer end of the

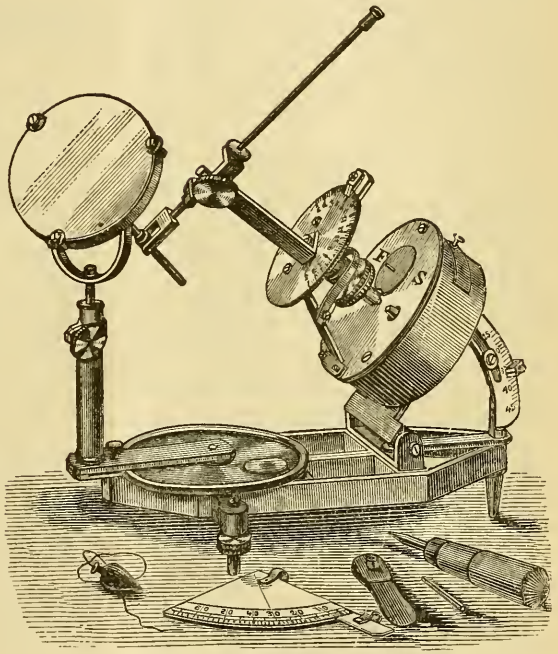

Fig. 9. Heliostat.

board is the Kübel heliostat. The whole apparatus rests upon a solid table-case, with drawers for accessories. When a photograph is to be made the window is opened and the base-board pushed forward until the heliostat is outside in position. The window is then closed, and the apparatus is ready for use.

The light from the heliostat is received upon a convex lens of convenient focal length—the one we use is two inches in diameter and has a focus of twelve inches—and may be directed upon the object either with or without the mediation of a substage condenser. The light should not be focussed upon the object, however, owing to the heat, which would be likely to injure the mount. A short distance either side of the focus the heat will not be sufficient to do harm.

A cell with parallel glass sides, containing a solution of ammonio sulphate of copper should be interposed between the lens and the object, to give a powerfully actinic blue light without the glare of strong sunlight. The cell should be about half an inch in thickness. The solution is made by dissolving blue vitriol in water and adding ammonia until the precipitate which forms at first is redissolved. It is usual to focus the object with bright sunlight, then to interpose the blue cell and make the exposure.

In using the electric light, it will be found most convenient to employ an incandescent lamp, although the arc light is much more powerful. The incandescent light is more steady, more easily managed, and quite as satisfactory. To treat this part of the subject in full, however, would require more space than can be given at this time. We will only add that several manufacturers have introduced lamps well adapted to this work, and no special instructions are necessary.

In using lamp-light the best form of burner is one having a very broad, flat wick, the edge of which should be directed toward the object. A wick three or four inches broad is desirable. Such lamps as are used in the best stereopticons give an excellent light for this purpose. The light should be condensed upon the object by suitable lenses. With a common bull's-eye lens and an Abbe condenser in the substage, excellent work with powers as high as a $\frac{1}{8}$ can be done, using the light of an ordinary hand lamp.

Next month we shall describe the process of taking the picture.

[*To be continued.*]

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Provisional Key to Classification of Algæ of Fresh Water.—VII.

BY THE EDITOR.

[*Continued from p. 31.*]

Family X. COLEOCHÆTACEÆ.

Small disk-like families, light green, forming a flat or cushion-like parenchymatous thallus; cells oblong or expanded in front, sometimes bearing long, colorless bristles on the back or upper surface.

The oogonium is a single cell at the end of a vegetative series. The antheridia give rise to a single spermatozoid in each, which are set free and move by the aid of two cilia. The fertilized oogonia become enclosed in a protecting coat, rest through the winter, and in the spring the contents divide, giving rise to several swarm-cells, which escape and grow into new plants.

Asexual reproduction by means of swarm-spores, formed within any of the vegetative cells, with two cilia.

81. Genus *Coleochæte* Brébisson.

Thallus pale green, forming small disk-like growths on other algæ, dead plants, etc., consisting of series of radially disposed cells, often laterally connected. Some of the cells bear long, hyaline hairs.

[This is a very common genus, representatives of which can be found almost always growing on the

sides of aquaria, where they appear as small, circular specks.]

IV. ORDER ZYGOSPOREÆ.

Cells free or in filaments, green or brown; reproduction by a special act of copulation or conjugation, in which the contents of two cells of similar form unite to form a single primordial cell, which becomes clothed with several envelopes and forms a zygospore.

Without copulation an azygospore may be produced. Asexual propagation by repeated division in the same direction. No swarm-cells.

FAMILIES.

Single cells or filaments unbranched. CONJUGATÆ X.

Unicellular, silicious. BACILLARIACEÆ XI.

The family Bacillariaceæ will be omitted from this classification, as will be also the desmids which have already been so well treated by Mr. Wolle in his excellent book.

Family X. CONJUGATÆ.

Cells single, free, or united in filaments, with green contents; chlorophyll in bands on the cell-walls, in axillary plates, or in pairs of radiate masses. Walls not silicious.

A. ZYGNEMEÆ. Group 1.

Cells cylindric, confervoid, light-green, in somewhat gelatinous filaments. The zygospore forms three successive coats on its surface; the outer being thin soon disappears, leaving the middle thick coat as the outside covering. A single plant germinates from the zygospore, after a period of rest.

a. ZYGNEMINÆ. Sub-group 1.

Chlorophyll in parietal bands, two stellate masses or a single axial plate. Copulation of two cells in three ways:—

1. Ladder-like or scalariform, in which lateral projections from two parallel filaments grow together, their ends meeting, forming a ladder.

2. Geniculate, in which two neighboring cells bend until the convex sides come in contact.

3. Lateral, in which two adjacent cells of the same filament are united by lateral outgrowths from each.

In either case the two cells become united by the dissolution of the cell-walls at the point of junction, so that their contents commingle and a zygospore is formed, either in one of the cells, or between them in the connecting tubes.

b. MESOCARPINÆ. Sub-group 2.

Cells cylindric, with axial chlorophyll plates. Copulation, scalariform, geniculate or lateral, the zygospore never formed of the entire contents of the copulating cells, but is separated in the middle of the double cell as a thick spore, colored green by the entire chlorophyll of the cells, enclosed by two or four membranes.

[In the Zygneminæ the zygospore is formed directly by the conjugation of two cells, and the commingling of their entire contents, which, gathering into a spherical mass, becomes covered by membranes, and passes into a resting condition. This is the typical zygospore, the same as is produced by desmids and diatoms. In the case of ladder conjugation, for example, in this group, the two cells unite to an H-shape, and the contracted zygospore forms free within one of the cells, or in the connecting tube.

In the Mesocarpinæ the process is quite different. The conjugation of the two cells forms the zygospore without any contraction of the contents, the two conjugating-cells together being regarded as the zygospore, which is the shape of the united cells; then in the case of ladder-like conjugation the zygospore is H-shape and not contracted. But the zygospore remains only a short time in this condition. The colored portion of the protoplasm passes into the connecting-tube and becomes surrounded by a membrane which also effects a division of the cruciate

zygospore into 3 or 5 parts, a central green spherical mass, with 2 or 4 outer cells, which are the remains of the original conjugating cells, soon to disappear. The result of this conjugation, therefore, is a very low form of sporocarpium, and the resulting, germinating spore is not a zygospore but a carpospore.]

a. Zygneminæ. Sub-group 1.

Synopsis of Genera.

Cells with spiral green bands.
Spirogyra, 82.

Cells with straight or slightly spiral green bands. *Sirogonium*, 83.

Cells with two green stellate masses. *Zygnema*, 84.

Cell contents irregular; cell-walls thick, or many-layered.
Zygogonium, 85.

Cells with single, axial green band.
Mougeotia, 86.

82. Genus *Spirogyra* Link.

Cells with one or more spiral bands of chlorophyll.

Copulation ladder-like (*Spirogyra* Kützing) or lateral (*Rhynchonema* Kützing). Zygospores smooth, within one of the copulating cells.

83. Genus *Sirogonium* Kützing.

Cells with several straight or slightly spiral chlorophyll bands.

Copulation geniculate; copulating cells of different forms and sizes, the receiving cells (female) elongated, the others (male) short-cylindric. Zygospore formed within the cells.

84. Genus *Zygnema* Kützing.

Cells with two radiating stellate green bodies.

Copulation ladder-like or lateral. Zygospore within one of the cells, as in *Spirogyra;* membrane smooth or rough.

85. Genus *Zygogonium* Kützing.

Cells cylindrical or barrel-shaped, with thick, often many-layered cell-walls. On either side, near the middle, an irregular chlorophyll body with a starch-grain, both often running together into an axillary band.

Copulation ladder-like. Zygospore in the connecting-tube.

Terrestrial and aquatic.

86. Genus *Mougeotia* De Bary.

Cells with single, axial, chlorophyll bands.

Copulation ladder-like. Zygospore in the much swollen connecting-tube.

b. Mesocarpinæ. Sub-group 2.

[The arrangement we have adopted for the Mesocarpinæ is practically the same as proposed by Wittrock, but having retained the genus *Mougeotia* De Bary in the Zygneminæ, we have preferred to regard *Staurospermum*, *Plagiospermum* and *Mesocarpus* as distinct genera, and not as sub-genera under *Mougeotia* (Ag.) Wittr.]

Synopsis of Genera.

Cells thin-walled, endochrome axial; filaments zigzag when fruiting.
Gonatonema, 87.

Copulation geniculate, spore quadrangular. *Staurospermum*, 88.

Pericarpium three-celled.
Plagiospermum, 89.

Copulation ladder-like or lateral; pericarpium two-celled.
Mesocarpus, 90.

Copulation geniculate; pericarpium two-celled.
Craterospermum, 91

87. Genus *Gonatonema* Wittrock.

Cells cylindric, walls thin, ends curved inwards, chlorophyll in an axial band.

Spores agamospores, formed by tripartition without conjugation, in the middle of the fruiting cells. The latter bend at an obtuse angle at the point of spore formation, successive cells of the filament bending in opposite directions, forming a zigzag line.

[The distinctive character of this plant is found in the method of fruiting. The cells, unlike those of the other members of this family, seem not to have the power of conjugation, and the spores are formed in a perfectly neutral way, hence

called agamospores. In other genera, spores may be formed without copulation, but such spores are produced in cells capable of conjugating, and since in these instances the cells may be regarded as possessing certain sexual characters, the spores thus formed are known as parthenospores.]

88. Genus *Staurospermum* Kützing.

Copulation geniculate; sporocarpium formed by quinqui partition of the H-shaped zygospore, short-cylindric, quadrangular in one view, elliptic in the other. Pericarpium four-celled.

89. Genus *Plagiospermum* Cleve.

Copulation by one cell bending in a geniculate manner and the other sending out a lateral tube to the angle, where the spore is formed. Sporocarpium formed by quadripartition of the zygospore. Pericarpium three-celled.

90. Genus *Mesocarpus* Hassal.

Copulation ladder-like, sometimes lateral. Carpospore spherical or oval, between the straight or somewhat curved copulating cells. Pericarpium two-celled.

91. Genus *Craterospermum* A. Braun.

Copulation geniculate; spore with a spherical interior, and short-cylindric, nearly square exterior with an annular furrow and concave ends. Pericarpium two-celled.

[This genus is combined with the sub-genus *Mesocarpus* by Wittrock.]

[*To be continued.*]

Staining Tissues in Microscopy.—IX.

BY PROF. HANS GIERKE.

[*Continued from p. 35.*]

191. Carrière. Kurze Mittheilungen zur Kenntniss der Herbst-'schen und Grandry'schen Körperchen in dem Schnabel der Ente. Arch. mikr. Anat., xxi, 146–164.

Carrière employs a method suggested by von Böhm, as follows:—The pieces are laid in 50 per cent. formic acid till, in about 20 minutes, they become transparent, then washed, and put for about 20 minutes in a small quantity of gold chloride 1 per cent. solution. They are again washed and laid for 24 hours in the dark in Prichard's mixture of amyl alcohol and formic acid each one part to 98 of water.

192. Marchi. Ueber die Terminalorgane der Nerven in den Sehnen der Augenmuskeln. Arch. f. Opthalm., 28, Jahrg. i, 202–21; auch Arch. per le Scienze med., v.

Marchi recommends Manfredi's process, which consists in soaking the fresh tissue for half an hour in a one per cent solution of gold chloride, then in 0.5 per cent. solution of oxalic acid at 36° C. temperature, in which the tissue remains till cold.

Another method, suggested by Golgi, for the examination of nerve endings in the muscles, consists in treating them for three days in a 2 per cent. solution of potassium bichromate, then for 30 minutes in a 1 per cent. solution of arsenious or acetic acid, and for the same time with a 1 per cent. gold chloride liquor, and after washing again with arsenious acid in which the preparation is exposed to the light.

193. Bremer. Ueber die Endigungen der markhaltigen und marklosen Nerven im quergestreiften Muskel. Arch. f. mikr. Anat., xxi, 195.

A slight modification of Lowey's method. Lay first in 25 per cent. formic acid till transparent, then 15–20 minutes in a 1 per cent. gold chloride solution, then again in the formic acid in the dark. The latter is changed for a solution of formic acid of double strength for 24 hours, and finally for 2–3 weeks in 20 per cent. formic acid glycerin till the proper degree of consistency and depth of color is reached.

Treatment with perosmic acid.

194. Max Schultze. Zur Kenntniss der Leuchtorgane von Lampyris splendidula. Arch. mikrosk. Anat., i, 132.

M. Schulze und Rudneff. Weitere Mittheilungen ueber die Einwirkung der Ueber-osmiumsäure auf thierische Gewebe, l.c., p. 300.

In the first article, Schulze gives the results of experiments with a new reagent, $O_3 O_4$, that later was named perosmic acid. Substances easily oxydized like organic tissues become black or blue-black by treatment with an aqueous solution of this acid, showing a lower oxidation of the acid or of the metal itself. F. E. Schulze, in Rostock ascertained first that the various tissue elements acted with unequal reducing power on osmic acid, and he sent a very dilute solution to Max, with request to test its value in histological investigation. On applying it to an examination of the light producing organ of Lampyris, it was found that the trachea stained more readily than the other elements, becoming black while the others were only slightly colored: But the staining took place only in living insects, and vanished on preservation. The application of oxygen gas to the organs made the staining more permanent. The terminations of the air tubes in other organs blackened readily. The staining of fats and albumen is independent of life in the tissues. In the second article, S. and R. relate further experiences with osmic acid. Making use of very weak solutions, $1 \div 100$ and $1 \div 1000$, fat and milk globules were found to blacken rapidly. The gray matter of nerves stains most easily next to fats, but the color is superficial and does not penetrate deeply. When fresh nerves are treated with osmic acid, the vesicles do not become disorganized as usual. The axis-cylinder stains very slightly or not at all. Fibrous connective tissue and muscular substance stain very slowly, the softer protoplasmic cells become dark. Cartilage, the cornea, and similar tissues stain but little, also spongy connective tissue like the fibres of the retina. Striped muscle becomes slowly brown, white blood corpuscles, deep black, the red remain unaltered. The new reagent is most important for the nerves, especially in connection with carmine. In plant tissues tannin material and oil glands are colored, and more slowly cell protoplasm, but not at all starch sugar cellulose and chlorophyll.

[*To be continued.*]

EDITORIAL.

Publisher's Notices.—All communications, remittances, exchanges, etc., should be addressed to the Editor, P. O. Box 630, Washington, D. C.

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CLOUD VESICLES.—It has been assumed by some writers on physics and meteorology that the minute vaporous elements constituting clouds are hollow vesicles—minute spheres of vapor surrounding a central nucleus of air. The microscopical observations of R. Assmann* on the Brocken do not confirm these assumptions. He found the smallest particles in the upper cloud limit, to have a diameter of 0.013 mm. The diameter increased on descending through the cloud until at the lower part it was 0.033 mm. The breaking of a hollow vesicle upon a plane surface would produce a water

* *Zeitschr. f. Meteorologie*, ii, 41. Abstr. in *Zeitsch. f. Mikr.*, ii, 269.

ring, but in no case was such a ring observed.

The author allowed a microscope to freeze to a block of ice, and to the object-carrier a fine hair was attached. It was shrouded in thick mist, and, although the temperature fell to — 10° C., the minute drops of water remained fluid, and were precipitated upon the glass, and quickly evaporated. Those drops that did not evaporate in five or ten seconds retained their form, and froze into solid masses, without a trace of crystalline structure to be seen. These particles, however, were not examined for their optical properties, which it would be of interest to know.

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Pollen Tubes.—Mr. Charles R. Barnes has studied the process of fertilization in *Companula Americana*, and published his results in an interesting paper in the *Botanical Gazette*. He says :—

'When the pollen tubes are emitted on the stigma they sometimes pass straight and sometimes after turning upon themselves downwards between, and not into, the bases of the papillæ. The conducting tissue runs close beneath the stigmatic surfaces. In this tissue I have traced the tubes for several millimeters. The pollen tubes penetrate the strands of conducting tissue and do not enter the canal of the style. A short distance behind the apex of the tubes cellulose plugs are successively formed. These plugs, which have sometimes considerable length, are very prominent objects in longitudinal sections of the style or when the conducting tissue is teased with needles. The latter method permits one to trace the tubes for long distances. The pollen tubes pass down the style and follow the placentæ. When they emerge from a placenta they either enter the nearest micropyle at once or pass further, adhering very closely to the surface of the placenta.

'I have detected the pollen tubes in a number of micropyles. The difficulty of tracing their further course is greatly enhanced by the opacity of the ovules and the consequent necessity of adopting the section method, as hereafter explained. I have been fortunate enough to find one specimen in which the pollen tube had entered the micropyle and penetrated to the synergidæ.

'The main points established regarding the fertilization of *Companula Americana* are these :—

'The tapetal cells of the anther and ovule are unusually large.

'The pollen-spore possesses two nuclei, one of which, the smaller, persists and either with or without division copulates with the female pronucleus.

'The pollen tube penetrates between the cells of the stigma and passes down the conducting tissue and not in the canal of the style.

'There is the usual generative and vegetative apparatus in the embryo-sac.'

The methods of study are given in considerable detail.

——o——

Report of the Postal Club.—The eleventh annual report of the American Postal Microscopical Club has been issued, with an appendix of extracts from the note-books. It is particularly to the feature of the extracts from the note-books that we would direct attention. This portion of the report is of considerable practical value as well as interest, and it is likely to become an important feature in subsequent reports, if the prosperity of the Club continues to increase as it has in the past. Looking hastily through that portion under Microscopy, we note that Mr. Vorce recommends killing insect eggs by placing them in carbolic acid. This may be a better plan than a momentary dipping in hot water. S. G. Shanks recommends mounting starch in Farrant's medium. In regard to wax cells, Mr. Walmsley alludes to one which, after passing through many circuits,

was still perfect; and says, 'the shellac is entirely unnecessary and indeed an injury. The fluid zinc, properly made, is all sufficient.' Wax cells certainly do stand remarkably well, but we do not favor them so much as we did a few years back, for there is almost certain to be a deposit on the cover-glass after a time.

This statement controverts certain others that we have made in the past concerning this subject, for we have repeatedly said that in none of our own mounts with wax has such a deposit occurred. The mounts referred to were all several years old—four or five at least—and we felt tolerably sure that during that time they would have shown all imperfections that would likely develop. Within a year, however, in the climate of Washington, we have observed a disposition toward a clouding of the covers from condensation of something on the under surface. Hitherto we have supposed this defect due to the manner of mounting, perhaps from imperfect drying of the specimen, or possibly from the cement. It appears, however, to come from the wax itself.

A paragraph is devoted to white zinc cement, which gives us considerable satisfaction in view of the round abuse we have received from various quarters for stating the results of our observations concerning the value of this cement, for all we have said is confirmed in a most unquestionable manner. The experience of the Club at large is of far more value than individual prejudices in a matter of this kind. Let the reader consider that we refer not to what may be done with this cement, but to what is done with it by many who use it.

Dr. Ward says that 'curtain-ring mounts regularly go to pieces in the circuits.' This, we believe, need not be. Curtain-rings are exceedingly useful in mounting, and it will be a pity if we must give them up. Certainly they can be securely attached to the glass. Cannot some reader give some valuable experience in this matter?

—o—

Micro-organisms of Milk.—Herr F. Hueppe has studied* the various micro-organisms which develop in milk, cultivating them on gelatin by Koch's method. In the early stage of souring, when the milk curdles, if a needle be dipped into it and drawn over a prepared gelatin surface, in the course of two days fine white points of growth will be observed. Pure cultures obtained in the usual manner from these reveal the presence of several distinct species, but the true bacillus of fermentation of milk has been isolated and followed through numerous successive cultures. The individuals, stained with anilin colors and observed with an oil-immersion lens appear as plump rods, 1–1.7μ in length by 0.3–0.4μ in diameter. They seem to be motionless during life. The bacillus develops slowly at a temperature of 10°–12° C., reaches a maximum between 35° and 42° C., and ceases to grow, losing also its specific effect, at about 45°.

A micrococcus is also abundant in the gelatin culture taken from the milk in the manner above described. It has been shown, however, that this organism does not produce lactic fermentation.

It has already been observed by others and confirmed by the author, that milk which is prevented from undergoing lactic fermentation may, nevertheless, become curdled, and later manifest an alkaline reaction. In such cases the author has invariably found only large bacilli, which must undoubtedly be regarded as the butyric acid ferment.

The organism of blue milk obtained by gelatin cultures is also a motionless bacillus, which in the original gelatin culture is readily distinguished by its color, at first yellow-

**Zeitsch. fur Mikroskopie*, ii, 110.

ish, afterward greenish about the border of the growing colony. Growing in sterilized milk this organism imparts to it a bluish green color.

——o——

A New Objective.—Messrs. H. R. Spencer & Co. have recently produced a $\frac{1}{16}$ homogene immersion objective that deserves more than a passing notice. The lens was sent to us by the makers, without any special remark, with the request that we should test it. As a specimen of the latest work of those opticians, we were much pleased with the opportunity thus afforded to observe the progress they have made in perfecting lenses of this kind. An objective must needs be very good indeed, in these days of fine lenses, to receive special commendation in this place, but the new $\frac{1}{16}$ is worthy of it.

The numerical aperture is 1.35, balsam angle as marked by the makers 125°. As a resolving lens it is superior to any we have seen, and for work on the bacteria it is fully equal to the best in use. This statement is not made upon casual examination, but from practical work in the laboratory along with other objectives of well-known excellence.

It is with much satisfaction that we tender our congratulations to Messrs. Spencer & Co. upon producing such a creditable objective. It remains now for them to produce an equally good lens of the same power with a greater working distance. This they will no doubt soon accomplish.

——o——

Fresh-Water Bryozoa.—An important contribution to the literature of the bryozoa of fresh water has recently been published by Dr. J. Jullien.* This valuable monograph is based upon studies of specimens found in the vicinity of Paris and Bourgogne, and in foreign countries. With a brief review of the systems of classification previously adopted by authors, the writer criticizes very freely, and finds not one of them to accord with the results of his observations. He then proceeds to establish a system of classification of his own, based principally upon that of Dumortier. The memoir covers about 120 pages, with numerous illustrations in the text.

——o——

Postal Club Boxes.—Box T^2 was received January 19th.

1. Intra-ocular growth. Geo. E. Fell.

2. Stem of *Aristolochia*. Ada M. Kenyon.

3. Membrane from branchial chamber of the cray-fish with examples of *Cothurnia variabilis*. Henry Mills.

4. Parasite from muscles and gills of cray-fish. D. S. Kellicott.

5. *Spirillum undula*. J. M. Adams.

6. Sections of *Polygonum orientalis*. Mary F. Hall. One of the finest specimens of section cutting of vegetable stems we have seen in the boxes. A really excellent piece of work.

Box C came to hand February 8th.

1. Basalt. H. C. Lewis. With a good description. Basalt, the writer states, is an eruptive rock, composed of augite, olivine and plagioclase, and he then describes each mineral so it may be recognized in the specimen. For this reason the specimen is one of the most instructive the Club has seen.

2. Lung of cat injected. G. C. Morris.

3. Baycura Root. W. H. Walmsley. Transverse section. Mounted in camphor water with Walmsley's white zinc cement. A very good mount.

4. Elaters or threads of *Trichia chrysosperma*. G. A. Rex. An interesting preparation.

5. Moss. *Bryum annotinum*. L. B. Hall. Interesting and well described.

*Monographie des bryozoaires d'eau douce, in *Bulletin de la Soc. Zool. de France*, 1885.

6. Hair of Bat. E. Pennock. A test object for moderate powers.

Box J[2] came to this circuit Feb. 23d to be filled. We have put in a preparation showing male and female fruiting filaments of *Œdogonium Boscii* prepared in 1882.

Mr. Thomas Christian has contributed a special box, which he very kindly sent to us for examination before starting it on its way through the circuits. It contains six excellent mounts of selected and arranged diatoms, which are deserving of critical examination. The preparer is very expert in this work.

NOTES.

— A new process of double staining has been published by A. Garbini,* particularly applicable to thin sections of animal tissues. Two solutions are used; the first is composed of anilin blue, soluble in water, 1 grm., distilled water 100 c.c., absolute alcohol 1–2 c.c.; the second is composed of safranin 0.5 grm., distilled water 100 c.c., absolute alcohol 50 c.c. The sections, either free or attached to the slide, are placed in the anilin blue for 1–4 minutes, then immersed in a 1 per cent. solution of pure ammonia, until the excess of color is removed, and immediately placed in a 0.5 per cent. solution of hydrochloric acid for 5–10 minutes. After washing in water the sections are placed for 4–5 minutes in safranin, and finally in absolute alcohol.

— It appears from recent experiments that extreme cold does not kill microbes of putrefaction. Even at a temperature of — 80° F. their life is not destroyed, and sealed tins and flasks containing putrescible materials exposed for hours to that low temperature began to decompose when thawed.

— Mr. W. B. Turner, in *Journ. R. Micr. Soc.*, advises the following process for mounting desmids:—

'When quite fresh gathered, wash and place in a solution of chromic acid, so weak that it requires three days to decolorize a large desmid. When the color has gone, wash well in at least two waters and stain with anilin. Fix with a little tartaric or weak nitric acid. Then wash and mount in camphorated or carbolized water (about 10 to 90 per cent. distilled water).' The author states that all delicate algæ may be mounted in this way, even the delicate *Draparnaldia*.

— There is strong evidence, which is likely to prove conclusive when the investigations in progress are completed, that a recent outbreak of scarlet fever in the parish of Marylebone had its origin in milk supplied from a certain dairy. The results are looked for with great interest, as much light may be thrown upon the origin of the disease.

— In a communication to the Société Belge de Microscopie, M.M. Klement and Renard have presented an interesting collection of chemical tests, based upon reactions producing crystalline forms. The full paper will be published in the Annales of the Society, but in the Bulletin a brief résumé is given, which includes a list of the principal reactions of elements and the names of the crystalline compounds obtained by the reactions. This list is of considerable value to chemists and persons working in micro-chemistry.

— Messrs. A. Woodward and B. W. Thomas have studied the foraminifera of the boulder-clay from a well-shaft at Litchfield, Minn. Their results are published in the report of the geological survey of Minnesota. The foraminifera belong to the cretaceous shales which are found in the clay. Two plates are given, the genera figured being *Textularia, Spiroplecta, Gaudryina, Bulrissina, Globigerina, Lagena, Operculina, and Uvigerina.*

CORRESPONDENCE.

To the Editor:—In answer to Mr. Bulloch's first question in the December Journal, I should say the magnifying power would be $\frac{1}{9}$, *i.e.*, the image would be smaller than the object in proportion of 1 to 9.

As to the formula of a 2-inch eye-piece, I give the following measurements of one belonging to a large Beck stand which is practically a 2-inch eye-piece:—

Focal length of field-lens, small central pencil, in inches, . . .	2.460
Focal length of eye-lens, central pencil, ...	1.384
Thickness of field-lens, ...	0.203
Thickness of eye-lens, ...	0.122
Inside distance between lenses, .	1.975
Focal length of eye-piece, . . .	1.96

* Di un nuovo metodo per doppia colorazione. Zool. Anzeiger, ix, (1886), 26.

Taking ten inches as the distance of distinct vision, the magnifying power of the lens, $f = 1.96$, is 6.1.

The companion eye-piece varies a little in all the above measures from this one and its focal length is some .02 or .03 less, say 1.93.

As a test of the correctness of the above calculated power of the eye-piece, I measured the power of a Beck's ⅔ with the eye-piece, using a camera lucida 10 inches from the axis of the tube to the paper, and found it to be 71 or 72 times. Using the formula of Prof. Abbe, as given in the *Journ. R. Micr. Soc.* by Mr. Frank Crisp, and in this JOURNAL, vol. v, p. 21, I find the 'optical tube length' was 8.7 inches and the power between 68 and 69 times.

LEWIS H. NOE.

[We have received a communication from Mr. Bulloch discussing this subject from his own point of view, which we are obliged to hold over until next month.—ED.]

MICROSCOPICAL SOCIETIES.

WASHINGTON, D. C.

At the 39th meeting, February 9th, Mr. J. S. Diller made a communication on the Microscopical Study of Rocks, an abstract of which is published on another page.

In response to a question by Mr. Hitchcock, the speaker stated that he had never made sections of anthracite.

Prof. Seaman said that in his opinion the use of polarized light was of as much value in organic as in inorganic microscopy, and cited the use of this agent in differentiating starches, and in detecting the presence of horn, teeth, etc. He related an instance where he had been asked to examine a piece of pillow-ticking which it was supposed had been in use so long that the feathers had become incorporated with the cloth. The use of polarized light enabled him to distinguish the threads of cotton from those of the feather fibre, and upon investigation it was found that the cloth had been woven of a thread composed of mixed fibres of cotton and feathers. Shortly after, he had seen a notice that this kind of cloth was being made in Paris as an entirely new product.

Dr. Caldwell called attention to the use of polarized light by Prof. Taylor in distinguishing genuine butter from its imitations.

Dr. Schaeffer said that he had been told by a former president of the Erie railroad, that the microscope was of the greatest assistance in the laboratory operated in connection with that road, in determining the value of the various deposits of rock along the line.

At the 40th meeting, February 27th, Dr. E. P. Howland gave a short talk on polarized light, illustrating his theme by numerous pieces of apparatus. He also showed a new projecting microscope, arranged for him by Queen & Co., having the lens combination beyond the focus and accompanied by an amplifier.

Mr. Hitchcock showed specimens of *Palmella* (*Tetraspora bullosa*), gathered during the week, and also a mounted specimen of *Œgodonium Boscii* showing male and female filaments.

E. A. BALLOCH, *Secr.*

WELLESLEY COLLEGE.

We have a number of notices of recent meetings of this flourishing Society which we are unable to publish for want of space—it is quite as much as we can do to publish the reports of meetings as they are held, so it is with regret that we must set aside these interesting notices. The Society was established in 1877. Meetings are held monthly during the College year. The membership varies from 25 to 40. The officers for 1886 are:—Miss Alice Ames, President; Miss Mary Mosman, Secretary; Miss Lucia Clark, Cor. Secretary.

The Society has at command the hundred and twenty microscopes belonging to the College, the College library, a large number of periodicals bearing on microscopic subjects, and a collection of nearly seven hundred slides. It is mostly composed of students. Two or three lectures each year are given under its auspices to the whole College by distinguished lecturers, and at least one exhibition.

BUFFALO MICROSCOPICAL CLUB.

The programme for the current year has been issued. The officers are as follows:—President, L. M. Kenyon, M. D.; Recording Secretary and Treasurer, John F. Cowell; Corresponding Secretary, Ada M. Kenyon; Advisory Council, D. S. Kellicott, Geo. E. Fell, M. D., Lee H. Smith, M. D.

Regular meetings are held on the second Tuesday of each month.

MINNEAPOLIS, MINN.

After a brief address by the President, Dr. P. L. Hatch, Mr. H. G. Carter pre-

sented a slide of *Stomoxys calcitrans*, and gave the characteristic differences of the two genera, *Stomoxys* and *Musca*, especially of the mouth-parts as adapted to biting. He also called attention to the position of the teeth and their distinctive arrangement. The entire evening was devoted to the subject, and slides of a large number of species of different genera were exhibited.

JOHN WALKER, *Secr.*

SAN FRANCISCO.

At a meeting held January 27th, microscopes by Bausch and Lomb and by Zeiss were shown and commented upon. Dr. Ferrer gave an account of Koch's method of gelatin culture. After alluding to the disadvantages of the fluid media method, still adhered to by Pasteur and his followers, a brief sketch was given of the gradual evolution of the gelatin method, from the first tentative efforts of Krebs and Brefeld up to the perfecting of the present admirable system by Koch, who was the first, practically to realize the advantages offered by a culture medium sufficiently transparent to admit of direct microscopical examination, and at the same time sufficiently non-fluid to facilitate the growth of different germs in separate colonies. After giving formulæ for the preparation of the gelatin, and describing the methods of its sterilization, Dr. Ferrer outlined the subsequent procedure, which is briefly as follows:—A small portion of the bacterial material about to be studied is transferred by means of a previously-heated platinum needle to some culture-gelatin placed in a test-tube and rendered fluid by warmth. The germs thus introduced are distributed as evenly as possible throughout the liquified gelatin, and this is then poured upon a glass plate about 4–5 inches square, and is there spread out in a thin layer. The plate is then covered by a bell-glass to exclude dust and undesired germs. The gelatin solidifies on cooling, and the various germs contained therein multiply into separate colonies. The growth of these can be watched at any time under the microscope. While some accidentally introduced forms will occasionally be found, yet the majority of the colonies will be seen to be those of the organism specially inoculated. From the latter a small portion is taken by a sterilized platinum needle and with this is inoculated a previously prepared test-tube partially filled with sterilized gelatin. In this the organisms thrive and multiply and thus is obtained an absolutely pure culture of the desired germs. The mouths of the test-tubes are closed with cotton, previously sterilized; the platinum needles are intensely heated just before use, and in fact at every step of the process the very greatest precautions are taken to prevent the introduction of undesired germs.

It is an interesting and very important fact that nearly all bacterial organisms show distinctive peculiarities in the methods of their growth in gelatin. Some liquify the culture medium, others do not, and those of the latter class are especially characteristic in the appearance of the colonies.

A. H. BRECKENFELD, *Rec. Secr.*

NOTICES OF BOOKS.

The Physiological Action of the Differential Pneumatic Process on the Circulation. By E. Fiegel, M. D.

Pneumatic Therapeutics. By Alfred S. Houghton, M. D., and P. C. Jensen, M. D.

Two pamphlets reprinted from the *Journ. Amer. Med. Ass.*

The Physics of Pneumatic Differentiation. By Joseph Ketchum, and the Present Status of the Pneumatic Treatment of Respiratory Diseases. By E. Darwin Hudson, Jr., M. D.

Pneumatic Differentiation. By Herbert F. Williams, M. D.

Antiseptic Treatment of Pulmonary Diseases by means of Pneumatic Differentiation. By Herbert F. Williams, M. D.

Three pamphlets reprinted from The *Medical Record.*

The five pamphlets afford an excellent summary of the theories and results of pneumatic treatment of disease.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Wanted: Fine pc' ns foraminifera, diatoms (cleaned preferred), and all kinds of good material for mounting. Lists exchanged and a full equivalent given.

M. A. BOOTH,
Longmeadow, Mass.

Wanted: Cleaned St. Vincent material, for cash.

E. A. SCHULTZE,
Tompkinsville, Staten Island, N. Y.

For Exchange: Eyes of *Limulus*, and leaves of *Deutzia scabra*, rich and beautiful stellate hairs, for finely mounted slides of diatoms or polycystina.

W. E. DAMON,
Care of Tiffany & Co.,
New York City.

WILLIAM BENJAMIN CARPENTER

THE AMERICAN
MONTHLY
MICROSCOPICAL JOURNAL.

VOL. VII. WASHINGTON, D. C., APRIL, 1886. No. 4.

Notes on the Biological Examination of Water, with a few Statistics of Potomac Drinking Water.*

BY THEOBALD SMITH, M. D.

It is well known that micro-organisms belonging to the class bacteria or schizomycetes are incapable of being nourished by inorganic substances alone; they require, in addition to certain inorganic salts, substances derived from animal and vegetable organisms. According to Nägeli the nitrogen is obtained from compounds having the structure of amides and amines, the carbon from compounds which contain the group CH_2 or CH.

From this it follows that the more bacteria a certain quantity of water contains, other conditions remaining the same,† the more organic matter it holds in solution or suspension. To determine the number and kinds of bacteria which a given water contains has been of late termed the biological analysis of water. Dr. R. Koch was the first to suggest and apply this biological test to drinking water. The enumeration of bacteria was only made practicable by his method of gelatin plate cultures, as the elaborate and tedious processes of Miquel, Fol, and others by means of liquid cultures in tubes can never become generally useful.

The method consists briefly in adding to a quantity of sterilized nutritive gelatin, liquified by gentle heat, a certain quantity of the water to be tested, thoroughly mixing the two, and pouring the mixture upon a glass plate where it rapidly solidifies. The individual micro-organisms are thus separated from one another; each multiplies into a colony, which becomes visible to the naked eye in one to three days, and each colony, the progeny of the germ originally sown, is therefore to be counted as one. Finally, it is customary to calculate from the results obtained the number of germs in 1 c.c.

The quantity of water to be taken depends on the number of bacteria probably present, and must be so chosen that this number is conveniently and correctly estimated.

An important fact in connection with this mode of analysis is the rapid multiplication of germs in water after it has been kept in tubes or bottles at the ordinary temperature of a room for a short time. A specimen of water containing about 3,000 germs at the time it was collected, when kept in the laboratory one day, contained at least 60,000 germs. Several causes may be assigned for this increase: 1. There may be some organic residue in the collecting tubes which has survived a temperature of 150°–170° C., to which they are exposed for the purpose of sterilization. This source of error may, I think, be avoided by thoroughly flaming the collecting tube before use. It seems reasonable to suppose that by this means all organic compounds will be broken up. 2. Natural waters usually

*Abstract of a communication presented to the Biological Society of Washington, March 20th, 1886.

†This limitation must always be borne in mind. Thus distilled water, from which small quantities were occasionally siphoned out, kept in the laboratory undisturbed for one or two months, contained 18,750 bacteria in 1 c.c One month later the same water contained 41,512 in 1 c.c. If distilled water can sustain such a large number of germs the number which natural waters would contain under like circumstances must be enormous.

contain living forms, both animal and vegetable. When collected in test tubes or stoppered bottles, these forms of life usually perish, and then become the prey of bacteria, which feed upon their dead bodies and multiply. Standing water therefore becomes an organic infusion comparable to artificial culture liquids.

It is therefore essential that water be examined immediately after it is collected, or else placed in conditions which will prevent the multiplication of the bacteria. The collecting tubes should be placed upon ice, or kept at a temperature at least below 50° F.

The relation of minute vegetable and animal forms, such as unicellular and higher algæ, rhizopods and infusoria, to the healthfulness of water is still a matter of conjecture. It is well known that the richest microscopic fauna and flora are to be found in standing and very slowly flowing waters, while in fresh water from springs there is very little life of any kind. According to Magnus* the presence of algæ is not detrimental to the quality of drinking water provided the volume of water is at no time diminished to such an extent as to cause the death of these algæ and thus furnish food for bacteria.

The effect upon water of a prolonged stay in reservoirs needs also careful examination. The algæ which require sunlight, and probably some animal forms which live in flowing streams, when suddenly brought into deep reservoirs may die and furnish food for bacteria. At the same time this bacterial vegetation may thrive only on the bottom where the organic debris subsides, and if the temperature be low bacterial multiplication may be retarded. These factors will counteract each other more or less so that it is difficult at present to state definitely how flowing water is affected when collected in reservoirs until comparative experiments have been made.

There are two reasons why waters containing a large number of bacteria should be looked upon with suspicion: 1. The source of the bacteria may, at some time, prove a source of disease germs, since bacteria in general come from decomposing organic matter. 2. Waters which are able to support a large number of bacteria may be able to sustain pathogenic bacteria. The latter may even multiply in the water before it is consumed.

It is now generally believed that the specific microbes which are the cause of cholera and typhoid fever, and we may add some of the milder forms of intestinal disturbances, are usually introduced into the system in the water consumed. It is not unreasonable to suppose moreover that drinking water may be the vehicle of other diseases under exceptional circumstances. From this it follows that the water supply of communities should be under constant, careful observation and that any changes in its quality from time to time should be noted and investigated, and that the best methods of purifying and filtering should be employed before it is distributed for consumption.

The final test in the biological examination of water consists in the actual demonstration of disease germs in the water. Here we meet with great difficulties. In the first place it is highly improbable that even a bad water contains disease germs, excepting in times of epidemics. In the second place, most of the disease germs with which we are acquainted grow very poorly, or entirely fail to develop on gelatin. And nearly all disease germs multiply far more slowly than the putrefactive bacteria among which they grow and by which they are soon overgrown. Thus the bacillus of tuberculosis grows only at the temperature of the body, and hence would not appear in the gelatin layer, assuming that its spores are present.

There is, however, another class of microbes not yet fully understood,

*Wolffhügel: Wasserversorgung, 1882. S. 131.

which produce disorders of the digestive processes by setting up fermentations. These fermentations, in turn, develop gases and products of an irritating character which may cause local catarrhs, or be absorbed into the blood, and produce symptoms of poisoning. This class of bacteria is as yet hypothetical, so far as our knowledge of special forms is concerned, yet it should merit the attention of students of hygiene, and deserves careful investigation.

How we shall test the disturbing action of bacteria found in drinking water is another difficult question. The usual experimental animals, such as rabbits, mice, guinea-pigs, pigeons, etc., show different powers of reaction to certain disease germs, not only with reference to man, but also among themselves. Gaffky* found none of these animals susceptible to the microbe of typhoid fever both when introduced subcutaneously or with the food. Consequently this germ can only be determined by its mode of growth in various culture media and its microscopic characters. This is virtually true of the cholera-bacillus also, since it requires in guinea-pigs the use of caustic potash and opium to make the animal organism a favorable medium for the multiplication of this germ.

The biological examination of water to-day is therefore merely quantitative, but it covers a ground very imperfectly covered heretofore by chemical analysis. The fact that microorganisms can be removed from water by filtration points out to us the direction in which this method of analysis can be made useful. We must keep the sources of our drinking water as pure as possible in the first place, and subject it to careful filtration before use. This will set aside the hunting for disease germs when the damage has been done and will give us the comforting assurance that the only real elements of danger have been almost entirely removed.

The effect of filtration on the chemical and biological ingredients of drinking water, and the efficiency of the filters employed, has been carefully noted from day to day for more than a year past at Berlin. The following table* gives the monthly average of bacteria in one cubic centimeter of drinking water before and after filtration :—

	River water—before filtration.	After filtration.	In one of the city houses.
July	1064	265	409
Aug	1440	277	157
Sept	2496	63	114
Oct	3251	21	50
Nov	466	27	26
Dec	811	57	34
Jan	864	39	29
Feb	685	98	84
Mar	1843	16	34

Potomac water, as is but too well known, becomes exceedingly turbid after prolonged rains or storms. The suspended matter, chiefly inorganic, slowly subsides after a time, leaving the water comparatively clear. Efforts are now being made to obtain an appropriation for the purpose of subjecting the water to thorough filtration. This is certainly very desirable when we consider the amount of earthy matter which the water holds in suspension after every severe rain, not to speak of the large increase in bacteria at this time, pointing to a large accession of organic matter. The table below gives the number of bacteria in one cubic centimeter of water and shows how the number of bacteria rises and falls with the turbidity. Each determination is the average of two closely agreeing independent plate cultures of the same specimen of water taken from a constantly flowing faucet in the basement of the Agricultural Building.

* Mittheilungen a. d. Kais. Gesundheitsamt, Berlin, ii, 395.

* Arbeiten a. d. Kais. Gesundheitsamt, Berlin, i, 7.

Date.	Bacteria in 1 c.c.	Liquefying bacteria in 1 c.c.	Remarks.
Jan. 8	3321		very turbid.
" 11	4228	338 = 8 p. c.	
Feb. 4	3151		
" 8	1997		
" 15	3225	290 = 9 p. c.	
" 22	1772	140 = 7.5 p. c.	
Mar. 2	3459	192 = 5.5 p. c.	
" 10	1069	107 = 10. p. c.	becomes clear.
" 16	385	53 = 14 p. c.	
" 18	338	47 = 14 p. c.	
" 25	806	87 = 9 p. c.	
Apr. 1	2033	56 = 2.7 p. c.	very turbid.
" 6	2961	214 = 8 p. c.	(heavy rains).

From these figures it will be seen that on March 18 the comparatively clear water, owing to continued dry weather, contained about 338 bacteria. Soon after, heavy, prolonged rains brought the water into a very turbid condition and the number of bacteria rose quickly to 2961.

It will also be observed that the number of germs which liquify the gelatin does not necessarily grow larger with the increase of the total. They are most abundant proportionately in the clear water and are presumably the natives of the water, the other bacteria being washed in by the rains from decaying vegetation.

From one city pump 600 bacteria in 1 c.c. were obtained. From another two examinations gave respectively 3,162 and 857 bacteria. The slightly turbid water of the Potomac is therefore more trustworthy than the very clear water of these pumps. It is quite probable that the wooden barrel of these ancient structures contributes a fair quota to the whole number in the water.

How these figures should be interpreted remains a very delicate question until water from a large variety of sources shall have been examined. The application of this method is still in its infancy and premature conclusions can only bring it into discredit. It now becomes necessary to furnish for it a practical basis by examining what we consider the best as well as the poorest waters according to a strictly uniform process. In this connection the carefully weighed words of the author of this method might be of service. It being questioned at the last cholera conference at Berlin as to what he considered good water, Dr. Koch* said:—

'A large number of micro-organisms indicates that the water has received admixtures in a state of decomposition and loaded with micro-organisms, impure tributaries, etc., which might contribute, in addition to the many harmless bacteria, also pathogenic forms, that is, infectious matter.... Experience thus far has shown that in good waters the number of germs capable of development varies between 10 and 150. As soon as the number considerably exceeds this limit, the water must be suspected of receiving contributions from polluted sources. If the number reaches or exceeds 1,000 I should not permit its use as drinking water, at least not in times of a cholera epidemic. The number 1,000 is chosen by me as arbitrarily as has been the case in selecting the limiting values in chemical analysis, and I allow each one to change it according to his convictions.'

—o—

A Method of Mounting Several Groups of Small Microscopic Objects Under one Cover.

The following directions for mounting pollens will suffice for other small objects:

The pollens should be gathered from freshly opened flowers, and may be teased from the anthers with a needle into small bottles, which, after the pollen is thoroughly dry, should be kept corked.

Prepare a card marked with three, four or five spots, all arranged within the limits of a three-fourths of an inch cover-glass, place a glass slip upon the card, and put a minute drop of turpentine on the slip over one of the marked spots. A needle with a little turpentine on it will serve to

* Deutsche Med. Wochenschrift, 1885, Sept. 12.

convey a small amount of pollen from the bottle to the drop of turpentine on the slip. Cohering masses of pollen should be separated with the needle and spread as evenly as possible over one-eighth of an inch of space on the slip. A small drop of balsam, just sufficient for the purpose, is then dropped on the pollen.

The next specimen of pollen is similarly arranged over another spot, and a small drop of balsam applied as before. When the several pollens are in place the slide should be set aside and covered with dust for twenty-four or forty-eight hours, or until the balsam has become somewhat hardened and the pollens fixed in their respective places. A drop of fresh balsam may then be placed in the centre between the groups and a cover applied with very gentle pressure, and all allowed to harden as usual. If the first balsam drops are not sufficiently hard when the cover-glass is adjusted the fresh balsam will liquify all too rapidly, and the pollens will run together or creep out with the surplus balsam.

Too strong a pressure will also cause the pollens to mix by producing currents in the balsam as the cover settles into place.

The names of the flowers from which the pollens were gathered should be written on the label in small characters and occupy the same relative positions as the specimens do under the cover. This will enable one to find a given specimen or name quickly.

This method may be employed for foraminifera seeds, diatoms, scales, or any other small objects which might be placed together for the purpose of comparison.

S. G. Shanks.

—o—

The Mounting of Diatoms.*

BY E. DEBES.

Regarding mounting media, I wish to remind the reader that, notwithstanding the high refractive index of monobromide of naphthaline, Thoulet's solution or phosphorus, on account of the many difficulties in manipulation and the great uncertainty as to durability, the use of these media cannot be recommended. I have obtained very good results from styrax and liquidambar, refractive index about 1.63, and after considerable experience am fully convinced that both media possess very desirable qualities, and are as easily manipulated as Canada balsam, but never become as brittle as the latter. The brown color, especially of styrax, does not much exceed that of old Canada balsam and is said to disappear entirely on bleaching in direct sunlight.

Styrax or storax, *Liquidambar orientalis* Miller, is a native tree of Asia Minor and Syria. Gum styrax, the product, contains cinnamic acid and styracin, both soluble in petroleum ether or petroleum benzine. By adding either of these to the gum in a shallow vessel over a hot-water bath, and stirring well with a glass rod, both components are easily got rid of. The styrax has to be thoroughly dehydrated after pouring off the solution. A bottle contained sixty grams, price two francs and a half, but was found not to be perfectly free from styracin, and had to undergo a short process.

Liquidambar styraciflua L. is a native tree of the United States, similar to styrax in all respects, and has to be treated the same. Balsam of tolu, recommended by Mr. C. H. Kain, I found in my experiments in no way superior to Canada balsam; its refractive index is slightly above it, but can never reach, far less exceed, that of styrax. In mounting the more robust and all convex and strongly curved forms, Canada balsam, owing to its lighter color, is preferable. Before using, Canada balsam ought to be heated in a shallow vessel over a hot-water bath, stirred well with a glass rod, up to

* Translated and condensed from *Hedwigia* by F. Dienelt.

twenty-four hours, until after cooling it is found to be very brittle; it will dry a great deal faster in mounts afterwards.

In general mounting, transfer with a pipette the quantity needed from the previously well-cleaned material to a bottle, and fill up with distilled water. After the diatoms have settled, drain off the water and renew, and continue this process till the last trace of alcohol in which the cleaned diatoms had been kept is removed. Now place the well-cleaned covers on a smooth, preferably black, plate of glass or hard rubber; by breathing on the glass before placing each cover and lightly pressing them down, they will adhere sufficiently. After agitating the material, take up and drop on each cover sufficient to fill the whole surface, and protect them from floating dust under a bell-glass, and let them remain till they are dry. To prevent jarring the settling diatoms and secure an even distribution, it is safest to let the covers remain where they have been filled. Treated thus the diatoms will settle very uniformly, and all annoyance from the tendency diatoms not freed from alcohol have to form clusters and run together on applying heat will be avoided. Attention has to be paid to the proper density of the material. If the covers, as has been recommended, have been placed on a dark surface, one soon gains experience enough to be able to tell whether things appear about right. As soon as the covers are dry, transfer them on a slide to the mounting microscope and examine for particles of dust that may have settled on them. Remove them to the glass plate as before and put a drop of the mounting medium on each; let them dry under the bell-glass to the consistency of syrup. Now put them on the well-cleaned and centered slides, apply gentle heat and the covers will settle level, and the medium will distribute itself evenly to the edge if the right quantity has been used. In using a chloroform solution the covers may be transferred to the slides at once. Remove the mounted slides to a tin case with removable shelves of stiff cardboard that have strips pasted on them, and place them covers downward. This will tend to keep the diatoms in contact with cover and insure free circulation. To facilitate drying, the tin case may be placed on a stove or in an oven, but care must be taken not to let the temperature rise above 50° Celsius.

If the material has been well cleaned, the often recommended burning of diatoms on the covers becomes not only unnecessary, but often proves injurious, as many of the finer forms, also polycystina and sponge spicules often present in fossil material, are apt to warp and crack or turn black. In mounting diatoms as test objects burning is advantageous, as it brings the diatoms in closer contact with the cover, and the cracks are not of as much consequence if the structure is well preserved.

For dry mounts, it is well to always have a number of slides ringed with shellac cement, or Canada balsam in chloroform on hand, to insure the thorough hardening of the cells. Place the covers on the cell and run a hot glass rod around the cover to soften the surface of cell; this will attach the mount firmly.

In mounting selected diatoms, transfer the material freed from alcohol to large covers, protect them from dust, and let the water evaporate; place the cover containing the material and another to hold the selected forms on a slide, and put it under the mounting microscope, using powers of from thirty to sixty diameters. The bristles from the eyelash of the hog, fastened to wooden handles, make a good instrument for transferring. They are very stiff, elastic, and taper to fine points. A number of these mounters ought to be prepared, as it is an easy matter to select them from finest to coarse, and have them ready as occasions require. The selected

forms ought to be placed close together, and laid, as far as practicable, in the position most suitable to mounting afterwards, for instance, *Eupodisbus* and similar forms with convex side down, always working with great care, as a single careless motion may destroy the work of hours. By using a piece of cardboard of convenient size, pierced on opposite sides to hold a string, the string to be grasped by the teeth, a very good shield is formed, and all danger from losing or disturbing the selected diatoms by breathing avoided.

In selecting the robust or convex forms, and preventing loss from flying of the bristle or cover, the cover may be moistened with kerosene diluted with benzine, which may be easily evaporated afterwards.

To mount the selected forms, the cover has to be coated with a thin film of bleached shellac dissolved in ether, well filtered through bone-black; place the cover on a warm slide, and apply a small drop of the shellac solution; attach it and the cover containing the selected material to a slide, and transfer it to the mounting microscope; moisten the clean cover with kerosene as above, and transfer the diatoms; place them carefully; they will move freely on the moist surface. When the cover is filled, remove it to a slide, evaporate the kerosene slowly over a lamp flame. The diatoms will become firmly attached to the softening shellac film; apply the medium. Of course alcoholic or chloroform solutions are out of question, and benzine, benzole, toluol or xylol solutions have to be used. On mounting the cover, a small drop of the medium must be first placed on the slide, the cover put on it and gently pressed down, and the medium that may exude removed with brush moistened with chloroform on the turn-table. Glass or zincfoil cells cemented to the slides afford a safe protection against crushing or displacement.

To attach selected forms to the cover in dry mounts, pure glycerin diluted with alcohol and distilled water answers well. The film will stay moist a good while, but may be perfectly evaporated by heat afterwards, the diatoms becoming fixed securely. For the more robust forms a little gum-arabic may be added, but care is necessary not to overheat and discolor the gum in solution afterwards.

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Photo-Micrography.—V.

BY THE EDITOR.

[*Continued from page 50.*]

The focussing of the image upon the ground glass is now to be considered. The importance of careful focussing is obvious to every one, but it should be remembered that in the case of objects of a particular kind, a perfectly sharp focus may not be the correct focus. This is due to the difference between the focus for vision and the focus for photography. Mr. J. D. Cox has shown* that in photographing diatoms he would occasionally get a positive photograph instead of a negative, the lights and shadows being reversed, just as they are when we focus up and down while looking at the markings directly. This is particularly noticeable when using lenses not specially made for photography; but as it is purely a matter of focus, such errors can be avoided with any lens by moving the objective back from the slide with the fine adjustment, after the image on the screen is sharp to the eye. The extent of the movement should be ascertained by experiment, probably not more than half a turn of the milled head will be required, but obviously no rule can be given as it will depend upon the lens, the microscope, and the length of the camera. It is more for low powers than for high. First take a picture of a diatom or other delicate object with the focus sharp to the eye. Then, if the picture

*The Actinic and Visual Focus in Photo-Micrography, etc., vol. vi, p. 193.

is not sharp, try changing the focus until a satisfactory result is obtained, and note the correction required for all subsequent work.

It is by no means an easy matter to focus a delicate microscopic object on the ordinary ground glass of a camera, because the grain of the glass interferes, particularly when a magnifying glass is used. To overcome this difficulty, several methods may be adopted. Perhaps the simplest is to substitute a plate of plain glass for the ground glass, and mount a simple lens as a focussing glass, with its focus adjusted to the plane of the surface upon which the image is received. An ordinary bank-note detector will serve the purpose perfectly well. Instead of removing the ground glass to substitute a plain one, the latter may be used in an ordinary plate-holder.

An excellent plan was described two years ago in these columns by Mr. George O. Mitchell.* This device consists of a strip of wood carrying an ordinary eye-piece. The focussing screen is removed, and the eye-piece adjusted to receive the image while the strip of wood rests across the end of the camera. First focus an object on the ground-glass, then remove it and adjust the ocular, by sliding it out or in, until the image is sharp. The device is then ready for use. If it be found that the picture is not sharp, although carefully focussed, because of the reasons already mentioned, it will be advisable to change the position of the ocular so that when the object is sharply focussed for the eye it will give also a sharp photograph.

Having focussed the object the sensitive plate may be introduced and the exposure made. In filling the plate-holder in the dark room the plates should be removed from their box, held in the left hand, being careful not to touch the sensitive surface with the fingers, and the surface lightly brushed with the soft brush to remove particles of dust which would show in the picture. Place them immediately in the holders, and as a precaution, when working by daylight, wrap the latter in a dark cloth, as some plate-holders are not absolutely light proof.

As regards the length of exposure it is almost useless to give any instructions, as this must be learnt by experience. Mr. Walmsley gives the following times of exposure for his apparatus, which may be suggestive to beginners using lamplight:—

1½	inch,	3 to 45	seconds.
¾	"	¼ to 1½	minutes.
1/10	"	½ to 3	"
⅕	"	2 to 7	"
1/10	"	5 to 10	"

In using sunlight the exposures must be made exceedingly short. For objectives lower than a ⅕-inch a mechanical shutter is almost indispensable with bright sunlight, for an 'instantaneous by hand' exposure would spoil the plate with too much light. Still, this depends upon so many conditions that it is almost useless to say this. Experience alone can teach the proper exposure.

4. Developing.—Before attempting to develop a plate the beginner will do well to refer to the remarks on page 202 of the preceding volume, briefly explaining the chemical operations involved.

A word of caution to the amateur photographer may not be amiss. Not everything that is published, even in the journals devoted to photography, can be accepted without question. The practical photographer may well smile at the impractical schemes and devices of the amateur, his wonderful achievements with new developers of complex composition, and his remarkable discoveries of the effect of microscopic quantities of various inert chemicals in the developer. It is safe to say that a large proportion of photographic literature is very useless reading. It is rarely that the new developers, that are constantly being brought forward, are in any

* Vol. v, p. 81.

respect better than those that have served for years. Therefore, as a general rule, the amateur who cares to save plates would do well to avoid new developers. The principle of most of them is this:—Jones thinks he will make his developer different from any other, and experiment with it, so he weighs out so much sodium carbonate, and so much sodium sulphite, and the proper amount of pyro. He now mixes his developer and perhaps gets a fine picture. The next thing is to write a paper to read before the photographic society, and exhibit a negative developed with Jones' developer. The story he relates is about like this:—'The plate was under exposed, so that I did not expect to get anything, but the negative shows every detail of a fully exposed plate.' It is noticeable that in all such communications the pictures are remarkably good, but the exposures very much over or under-timed!

One peculiar feature of such communications is that the plates are never properly exposed.

We have read a great deal of such palaver—a great deal too much of it. Either the authors of it are themselves very much deceived, or they are far more expert operators than we ever hope to be.

Still, it is our firm conviction, in spite of the voluminous testimony on the other side, that nothing is more incorrigible than a plate that is really under exposed. Granting that careful development will do much to bring out very faint detail, no amount of fussing will make a good picture out of a plate that has not received approximately the proper exposure. This is said for the encouragement of those who, placing their faith upon accomplishments that are less remarkable in fact than in the telling, are led to attempt what is impossible, and, disappointed at their failures, lose confidence in themselves.

On the other hand, an over-exposed plate can be restrained in development to a wonderful degree; but even here there is a limit beyond which it is not possible to get brilliant negatives.

But it is not only the amateurs who are at fault in this matter. The teaching and, if we may judge from their writings, the practice of professional photographers is very irrational in regard to development, and many a writer from this class has added his full quota of absurdities, and given instructions for developing plates not properly exposed which we are morally certain would ruin any picture under the conditions named.

The beginner may accept any kind of developer whatever, so long as the proportions of the ingredients are within reasonable bounds, and learn to make good pictures with it.

Without having experimented to prove it, the writer is of the opinion that the time of exposure must be regulated by the composition and strength of the developer; in other words, that to obtain the same result with two different developers the exposures must be different. In this way only does it seem possible to reconcile the practice of different operators, some of whom, for example, use developers twice as strong in pyro or iron as others.

The formulas we shall give are such as we can recommend from practical use, not that they are any better than others, but that they will make pictures equal to any we are perfectly certain. If the reader will be satisfied to use them, or any others that are recommended by competent authorities, and not waste time in trying to discover the merits of new mixtures which are quite as likely to be bad as good, success is sure to follow; but having adopted a developer that is known to be good, do not change it until successful in its use, for failures are more likely to be due to inexperience than to the developer.

We should not fail to direct the attention of readers to the method of

taking negatives on paper which has been perfected by the Eastmann Company, of Rochester. A holder carrying either twelve or twenty-four paper plates is provided to fit any camera. Full descriptions of the apparatus are given in their circulars, so that it is not necessary to more than refer to it here. We can say, however, that the paper negatives are very convenient, and particularly desirable for field work, because of their lightness and compact arrangement.

[*To be continued.*]

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Staining Tissues in Microscopy.—X.

BY PROF. HANS GIERKE.

[*Continued from p. 54.*]

195. Owsjaunikow. Ueber die Wirking der Osmiamid verbindungen Fremy's auf thierische Gewebe. Mélanges biol. tirés du Bull de l'Acad. de St. Petersb., vii.

Recommends Fremy's osmiamid verbindung 1–1000 of water in place of perosmic acid. That has the same advantages as the latter, and is destitute of the smell and injurious action on the skin.

196. M. Schulze. Arch. mikr. Anat., vii, 180.

Potassium acetate is recommended to mount preparations of osmic acid in, for glycerin is seldom pure enough, usually containing lead salts. Potass acetate is used like glycerin.

197. Ranvier. Sur les éléments conjonctive de la moelle épinière. Compt. Rend., lxxvii, 1024.

A complete isolation of the nerves of the spinal marrow occurs when treated by a solution of perosmic acid 1–300 injected, and after some time pressed out.

198. Pouchet. De l'emploi des solutions concentrées d'acide osmique. Robin's Journ. de l'Anat., 1876, p. 525.

Contains nothing new on osmic acid.

199. Broesicke. Die Ueberosmiumsäure in Verbindung mit Oxalsäure als mikroskopisches Farbemittel. Centralbl. f. d. med. Wiss., 1878, No. 46, pp. 833–836.

Fresh or recent material is laid for an hour in a one per cent. perosmic acid solution, then after washing in a cold saturated solution of oxalic acid for 24 hours, it may be examined in water or glycerin, but the two should not be mixed. Mucin, cellulose, amylum, bacteria, the outer layer of fungi, the membrane of Schwann, bony fibres and bones, and the axis-cylinder of nerves remain colorless. Intercellular substance, the cornea, walls of the capillaries, vitreous humor, and vitelline membrane dye a crimson red. Muscles, sinews, hyaline cartilage, and other elements rich in albumen, stain darker. The gray matter of nerves, cell protoplasm, and neuclei stain a wine-red.

200. Parker. On some applications of osmic acid to microscopic purposes. Journ. R. micr. Soc., ii, 381–383.

Perosmic acid is recommended for tender objects, as crustacea, insects, plant tissues, etc., followed by the action of alcohol.

OTHER METALLIC SALTS.

201. Landois. Die imprägnation der Gewebe mit Schwefelmetallen. Centralbl. f. d. med. Wiss., 1865, No. 55.

The tissues are first put in solutions of metallic salts, and when thoroughly soaked the metal is precipitated by dilute solutions of hydrogen sulphide, or ammonium sulphide, after careful washing. Salts of lead, iron, copper, platinum, and mercury give the best results.

202. Polaillon. Etudes sur la texture des ganglions nerveux périphériques. Journ. de l'Anat. et Phys., 1866, iii, 43.

The organs are hardened in a solution of ferric chloride, then thoroughly washed, and treated with tannic acid

till sufficiently black. Applied to ganglia, the nerve elements are stained while connective tissue remains colorless.

203. Fr. Eilh. Schulze. Eine neue Methode der Erhärtung und Färbung thierischer Gewebe. Centralbl. f. d. med. Wiss., 1867, No. 13.

Palladium chloride is particularly recommended for hardening and staining, especially for muscular tissue, also for the cells of glands and of epithelium containing granular protoplasm, while all connective tissues, fat, etc., remain colorless. Pieces of material as large as a bean are put in a solution of 1–800 to 1–1500; about 1–1000 is best. In 24 hours they may be cut into sections, and will be found a golden yellow. They may afterward be stained red with ammoniacal carmine.

204. Bastian. Recommends palladium highly when used according to 117, 1869.

205. Leber. Zur Kemstniss der Imprägnations-methoden der Hornhaut und ähnlicher Gewebe. Arch. f. Opthalm, xiv, 300.

In examinations of the cornea, various metallic salts besides silver were employed. A combination of potassium ferridcyanide and ferrous salts was deemed preferable. The fresh cornea of a frog is laid for five minutes in a ½ to 1% solution of a ferrous salt, carefully deprived of epithelium, thoroughly washed and transferred to a 1% solution of potassium ferridcyanide in which it is shaken till deeply blue. The same result may be attained by precipitation from a 2% solution of ammoniocupric sulphate with slight excess of ammonia and a 5% solution of potassium ferrocyanide. Plumbic acetate and potassium chromate give a yellow stain.

206. Henle und Merkel. In Henle's Handbuch des Nervenlehre des Menschen. 1871.

Sections of large nerves are laid in solutions of palladium chloride, 1–300 to 1–600, till they acquire a straw yellow color, which takes 1–2 minutes. They are then placed in ammoniacal carmine.

207. v Thanhoffer. Das Mikroskop und seine Anwendung. 1880, p. 143.

Recommends palladium chloride to stain the nerves of the cornea.

208. Golgi. Un nuovo processo di tecnica microscopica. Rendic. R. instituto Lombardo, xii, 206–210.

Pieces of the larger nerves 1–2 cm. in diameter are hardened in Möller's fluid or in potassium bichromate. After 15–20 days they are put in 0.25 to 0.5% solution corrosive sublimate. This must be renewed daily for 8–10 days, when the reaction is complete. The pieces are colorless and have the appearance of fresh horn. The finished sections are well washed and mounted in glycerin or balsam. The reaction affects the ganglion cells and their processes, also unstriped muscle. The elements appear white by reflected, and black by transmitted, light. The best results were obtained from the cortex of the cerebrum, less satisfactory from that of the cerebellum, and none from the spinal marrow.

COMBINATION METHODS.

209. M. Schulze und Rudneff. See 194.

Preparations of Osmium are stained in ammonia carmine.

210. Fr. Eilh. Schulze. See 203.

Preparations of palladium chloride are tinged with carmine.

211. Henle und Merkel. See 206.

Nerve sections treated as per 210 in strong solution of ammonia-carmine become bright red in the central axis while the gray matter remains yellow.

212. Schwarz. Ueber eine Methode doppelte Farbung mikroscopischer Objecte und ihre Anwendung, etc. Sitzber, d. k. Acad. d. Wiss. Wein, lv.

The preparations are treated first with carmine then with picric acid. The material is then placed in a mixture of 1 part creosote, 10 pts. vinegar, and 20 pts. water, boiled one minute, dried and cut into sections, which are put for an hour in dilute vinegar, then washed and stained with a rose color solution of carmine, washed again and laid for two hours in a solution of picric acid 0.066 gm. to 400 c.c. water. Mount in dammar. Muscles, cell contents, vessels, and nerves will be yellow, connective tissue and nuclei red.

213. Ranvier. Technique mikroscopique. Arch. de Phys., 1868, No. 2, p. 319; No. 5, p. 666.

Highly recommends a mixture of picric acid and ammoniacal carmine. The fluid should look like gooseberry juice and, as it is liable to mold, should be kept corked with a cork soaked in camphor tincture.

214. Strelzoff. Zur Lehre der Knochenentwickelung. Centralbl. f. d. med. Wiss., 1873, No. 18, p. 277–78.

Derselbe. Ueber die Histogenese des Knochens. Unters a. d. pathol. Inst., Zürich, 1873, p. 1–94.

In the study of the development of bone, neutral carmine and hæmatoxylin are found to dye calcified substance blue, new formed material red. (Unfortunately these beautiful preparations are not permanent, the hæmatoxylin bleaching in a few years.)

215. Rouget. Cfr., 162.

Preparation treated with silver are placed for 2–3 hours in a mixture of ammonia carmine, glycerin, and alcohol.

216. Merkel. Technische Notiz. Unters. a. d. Anat. Anst. Rostock, 1874, p. 98.

Dyes the brain and spinal marrow in a mixture of carmine and indigo carmine. The gray matter becomes blue, blood corpuscles green, the rest red. Bones decalcified in Möller's fluid and hydrochloric acid become blue in the formed material, the rest red.

217. Baber. E. Cresswell. Note on picrocarminate of ammonia. Quart. Journ. micr. sci., 1874, p. 251–3.

Repeats the statements of Schwarz and Ranvier.

218. Duval. Procédé de coloration des coupes du système nerveux, Journ. de l'Anat. 1876, p. 111–112.

Applies carmine the usual way, transfers to alcohol, then for 10–12 minutes in anilin blue (10 drops sat. sol. to 10 grains absolute alcohol) and mounts in balsam. Nerve cells and nerve axis stain reddish violet, the vessels violet blue. Connective tissue, the pia mater and its projections become blue.

219. Norris and Shakespeare. A new method of double staining. Amer. Journ. Med. Sci., 1877, January, and, —

220. Merbel. Double staining with a single fluid. Monthly Micr. Journ., 1877, Nov. and Dec., p. 242.

Two solutions are made. A, carmine 2, borax 8, distilled water 130 parts. B, indigo carmine 8, borax 8, distilled water 130. Rub in a mortar, filter and mix equal parts of the two solutions. Lay sections a few minutes in alcohol, then 15–20 minutes in this mixture, and an equal time in a saturated solution oxalic acid, wash and mount in balsam. The fundamental part of connective tissue, cartilage and bone will be blue, cell structure red, ganglion cells purple, their nuclei red, and the nucleoli blue, the sheath of the nerve axis blue or green, the axis cylinder green.

221. Schiefferdecker, Kleinere histologische Mittheilungen, II Ueber eine neue Farbungs methode des Central nerveusystems. Arch. Mikrosk. Anat. xv, 38.

Henle and Merkel published in the

Handbuch der Anatomie the first method of double staining with palladium chloride and ammoniacal carmine. Schiefferdecker replaces the last by sodium picrocarminate, in a cold saturated solution of which the sections remain for 8–10 minutes after 1–2 minutes treatment with palladium chloride. Mount in shellac or balsam. The preparations darken after mounting. The sodium picrocarminate alone is good for staining ganglion cells.

222. Klemensiewicz. Beiträge zur kenntniss der Farbenwechsels der Cephalopoden. Sitzber. d. Acad. d. Wiss. Wien, xxviii, (1878).

Rub together 1 grn. carmine with 30 drops concentrated ammonia and dilute with 200 c.c. water. Mix two parts of this carmine with one part cold saturated solution of picric acid and heat on the water bath 8–10 hours. Add dilute ammonia to replace loss if necessary and evaporate to $\frac{3}{4}$ or $\frac{1}{2}$ of first quantity. Little or no precipitate should appear on cooling. The clear liquid when finished should be dark red in deep layers with a yellowish cast in their strata.

223. Lang. Eine neue Tinctions methode. Zool. Anz. ii (1879), 45.

Double staining by eosin and picrocarmine is much praised, since it penetrates whole animals and differentiates not merely nuclei and similar bodies but also the protoplasm of ganglia cells and nerve fibres. Mix a 1% solution of picrocarmine and a 2% solution of eosin in water. Soak whole specimens (Planaria) in this mixture 4 days, then in 70% alcohol, then in 90% till no more color is extracted.

224. Seiler. Practical hints on preparing and mounting animal tissues. Am. Mo. Micr. Journ., i, 220.

The solutions, (a), carmine 1.0 grn., borax 3.5 grn., aq. dest. 150 c.c., 95% alcohol 330 c.c.; (b), hydrochloric acid 1.0 grn., alcohol 4 c.c.; (c), solution sodium sulphindigotate 2 drops, 95% alcohol 330 c.c. Sodium sulphindigotate is made by digesting the best Bengal indigo with fuming sulphuric acid, washing out excess of acid, and precipitating with salt. The well-washed precipitate is dissolved in warm distilled water to saturation. The preparations are cleared up with benzol and finally mounted in alcohol balsam.

225. Gage. Preparation of Ranvier's picrocarmine. Amer. Monthly Micr. Journ., i, 22.

Dissolve 1 pt. carmine in 50 pts. strong ammonia, and 1 part picric acid in 100 pts. water. Mix both solutions, evaporate at 45° C. to $\frac{1}{4}$ volume, filter through double paper and dry. A solution of powder, 1 pt. to 100 should be clear. If not after filtering, standing several days and again filtering, add the ammonia in equal quantity again, and evaporate. If clear add to each 100 c.c. 25 c.c. pure glycerin, and 10 c.c. 95% alcohol. This solution is very permanent.

226. Mayer, P. See No. 28.

Picrocarmine is recommended as staining more precisely than any other color. It is prepared by adding a concentrated water solution of picric acid to ammoniacal carmine (2.25) till a precipitate begins to fall.

227. Neumann. Die Pikrocarminfarbung und ihre Anwendung auf die Entwickelungslehre. Arch. Mikr. Anat., xviii, 130–161.

To avoid the occasional failures of picrocarmine, treat sections stained by Ranvier's method with acidulated glycerin (1 pt. hydrochloric acid to 200 glycerin), and control the reaction by the aid of the microscope, and then mount in glycerin.

228. Richardson. Section of larynx of human fœtus. Quart. Journ. Micr., 1880, p. 113.

Describes a combination of carmine, picric acid, and madder.

[*To be continued.*]

EDITORIAL.

Publisher's Notices.—All communications, remittances, exchanges, etc., should be addressed to the Editor, P. O. Box 630, Washington, D. C.

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MOUNTING MEDIA.—The several articles that have been published in this journal during the past year* have drawn attention to this important subject, and we hope to hear of beneficial results from the application of some of these media in special investigations. Their value is not fully appreciated by most observers, but when it is fully recognized some of them will come into extensive use.

There are some peculiarities which cannot escape notice when mounts in the various media are compared. For example, as Prof. Seaman has observed, in the medium prepared with anilin and sulphur there is a brilliancy about the diatoms not observed in the other media. Probably this is somehow related to the dispersive as well as the refractive power of the medium. The fact is important, and deserves more attention than it has received.

A medium of still higher refractive index than any hitherto described has been prepared by Dr. Morris, of New South Wales. He has used sulphur alone, which has a refractive index of 2, by melting it upon the slide and pressing the cover with the diatoms attached down upon it. A mixture of selenium and sulphur, used in the same manner, gives a medium with a refractive index of 2.3, and selenium alone can be used, having an index of 2.6. The *Amphipleura* was shown more than a year ago in sulphur by Mr. G. D. Hirst, with a $\frac{1}{8}$ water immersion objective by Zeiss, 'in a manner scarcely to be surpassed by the new oil immersion, thus proving Dr. Morris' theory that a highly refracting mounting medium enables low-angled objectives to compete in resolution with the new oil immersions.'* It seems scarcely necessary to point out the error that this language might convey. The mounting medium cannot increase the limit of resolution of a lens, since this is a function of the angular aperture. What it does do is to make certain objects, or the resolution of fine details, more distinctly visible when viewed with an objective capable of resolving them. Thus, while mounting media do not add to the resolving power, they nevertheless may add very much to its effectiveness as an instrument of research. This is clearly seen in the case of minute markings on diatoms, for, with Prof. Smith's new media, the *Amphipleura* is as easily resolved, with suitable objectives, as the *Pleurosigma angulatum* is with a good $\frac{1}{5}$-inch. But, apart from resolutions, the visibility of any minute object is also greatly increased by using the proper medium for mounting, and the advantage of the new media can be as well demonstrated with an inch objective as with a twentieth.

* Vol. vi (1885), pp. 161, 182, 217; vii (1886), 3, 21.

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INVESTIGATIONS OF MICROBES.—It is a pity that persons in high places do not more frequently consider the evil consequences of undertaking investigations which they are utterly incompetent, either by training or knowledge, to conduct. There seems to be an opinion prevailing among many that any one can make investigations on microbes and their relations to disease; so here and there a professor in a college in some distant educational centre suddenly springs

* Proc. Roy Soc. N. S. W (1884).

upon the unsuspecting public with a new microbe which he has discovered, and immediately the news is spread abroad by the press, and the published discovery, utterly without the slightest foundation, which has perhaps involved a few hours of superficial observation, requires months of arduous systematic labor before it can be absolutely refuted.

If men occupying positions as college professors court notoriety in this way, utterly regardless of the requirements of such work, or of their own responsibility as students of science to assist rather than retard the progress of scientific discovery, it is proper that their pretensions should be freely criticised.

Those who are even slightly familiar with the literature relating to microbes and their connection with diseases will freely acknowledge that M. Pasteur is a reasonably good authority upon certain parts of this great subject. Indeed there are very few men who have worked as carefully and thoroughly as M. Pasteur. One of the results of M. Pasteur's work has been the discovery of a method of preventing the disease known in France as rouger by inoculation. Now, Dr. Julius Gerth, State Veterinarian of Nebraska, obtained some of M. Pasteur's vaccine last October, and in November he inoculated twenty-six pigs with it. We will not give the details of the experiment; suffice it to say that after the inoculation, microscopical investigations were made by Prof. Charles E. Bessey, 'with the aid of the university microscope, the only one in this section of the country with which reliable scientific work can be done,' as the *Nebraska Farmer* puts it, and the identical germ described by Pasteur was found. Unfortunately, Prof. Bessey's name is mixed up with this work, but we can hardly believe that he is in any way responsible for it. Well, when these hogs, after inoculation, were exposed to the contagion of hog cholera, by allowing them to come in contact with diseased animals, most of them died.

As a result of this laborious investigation by Dr. Gerth, extending over nearly the whole of four months, the work of years by Pasteur is declared to be overthrown, and we find an article in The Breeder's Gazette headed 'Inoculation for Hog Cholera a Failure!'

Let us now consider the facts in the case. The experiment has proved absolutely nothing. If Dr. Gerth had chosen to inform himself concerning this matter before undertaking his experiments, he might have learned, by application to the Bureau of Animal Industry, that the swine-disease of France, which Pasteur has studied, is not the hog-cholera that affects our animals; and for this reason it is not to be expected that inoculations by Pasteur's virus would confer immunity. Moreover, he might also learn that the microbe of the disease in this country is not *Bacillus suis* but a species of the genus *Bacterium*, a discovery that has recently been made in the laboratory of the Bureau in this city, the credit of which is due to the painstaking researches of Dr. Theobald Smith, under the direction of Dr. D. E. Salmon, chief of the Bureau. He might also learn something about inoculations from the same source.

The case above mentioned is bad enough, but we have one other that for downright quackery and charlatanism exceeds anything else that has recently come to our notice. We cannot characterize it in any other way. If it be more charitable to attribute it to want of knowledge, then we ask, what business has any man to pose as an investigator of germ diseases who is so absolutely ignorant of the necessary conditions for such work as to ask for samples of blood collected and dried on bits of cloth to be examined for specific germs?

We regret to see that such a valua-

ble and widely read paper as the *Prairie Farmer* has been led to support such pretensions, but we must quote a few lines from that paper to show the matter in its true light. The article is headed 'Hog Cholera..Important!' and refers to the losses already sustained by reason of the prevalence of the disease, and then continues as follows:—'Dec. 4th we announced that Dr. J. A. Sewell, formerly Professor of Natural Science in the Illinois State Normal University and now President of the Colorado University at Boulder, Col., proposed to go into a thorough investigation of hog cholera, and had special facilities for doing so, without cost to the public. All he asks is many small specimens of blood from diseased animals.....

'All that is necessary is to slightly prick the diseased hog, anywhere in its body, with the point of a penknife or large needle, so that a few drops of blood will start out. Catch these in a little clean vial.....

'If a vial is not at hand, catch a few drops on a bit of clean, unstarched cotton cloth, dry it without heat, and enclose it in a letter.'

Was there ever more arrant humbug in the guise of science? Professor Sewell proposes to study the microbe of this disease, which has proved one of the most puzzling and difficult of germ diseases to experienced observers, without the slightest training for the work. Does he not even know that microbes are constantly in the air and everywhere, and that blood cannot be collected in a bottle or on a cloth (!) without contamination? Is it strange that 'He has discovered a new microbe in every blood specimen received?' Only one, indeed, why not say a dozen, for they were certainly present—but they are probably not new to science.

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American Society of Microscopists.—The *Proceedings* of the eighth annual meeting of this Society, held last year at Cleveland, have recently been issued, comprising a volume of 258 pages, quite fully and well illustrated. There is a heliotype plate illustrating Mr. J. D. Cox's article on the actinic and visual focus in photo-micrography; a plate of infusoria by Professor Kellicott, and another heliotype plate illustrating Dr. Detmer's article on poisonous dried beef. This plate might as well have been omitted, since, while it does suggest *Micrococci* in a general way, it is no special aid to the imagination, and besides, the significance of those organisms is at least uncertain.

Mr. Kruttschnitt also gives a well executed plate in explanation of his work on pollen-tubes. Among the other illustrations we notice three by Dr. L. M. Holbrook, which, since they represent not what is seen by the eye, but what all pupils of Dr. Heitzmann are taught to believe should be seen, and therefore must be delineated, are only misleading and should have been excluded. The structure represented has not been shown in any photo-micrograph, and can only be discovered by a few misguided individuals. Why, then, should a large, representative body of microscopists encourage and propagate such erroneous ideas?

We do not attempt a comprehensive notice of the volume for the reason that already some of the articles have appeared in these columns, and those who wish to see the others can obtain the volume from Dr. J. E. Fell, of Buffalo, for $1.50 if we recollect aright. A practical form of home-made heliostat for photo-micrography is described and figured, which may prove of value to those who prefer to construct rather than to buy their apparatus.

The volume is a very creditable one and the editorial work has been well done.

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New Objective and Ocular.—Dr. Henri Van Heurck has recently

described* a new objective constructed by Mr. Zeiss with some new glass of high refractive power which has resulted from numerous experiments conducted by Professor Abbe. From the article referred to we compile this brief notice. The desired qualities of glass not being obtainable from manufacturers, Mr. Zeiss, aided by a liberal subsidy from the government, courageously undertook to make it. He put up a glass furnace and finally produced what was required.

The objective is a $\frac{1}{8}$-inch, N. A. 1.4. This is not so high a numerical aperture as has been obtained in England, where 1.5 has been reached; but the Zeiss objective is decidedly superior to the other because the new glasses permit of more perfect correction of the aberrations. With the vertical illuminator the silvered *A. pellucida* is resolved in beads over its entire surface with such purity that each bead may be counted. In addition to the objective, Mr. Zeiss has also made several oculars with the new glasses which also possess great advantages over those in use, partly due to the construction. One of them, intended to be used instead of the ordinary amplifier for projection and photography, is composed of a slightly biconvex field lens combined with a plano-concave at a proper distance, with a diaphragm above. The distance between the two lenses is regulated by a delicate adjustment. After focussing with an ordinary ocular, the latter is replaced by the projecting ocular and, without changing the focus, the image is made perfectly sharp on the screen by moving the upper lens of the ocular.

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The Rotifera or Wheel Animalcules.—This is the title of a valuable and elegant work now being published by Messrs. Longmans, Green & Co., London. The authors are C. T. Hudson and P. H. Gosse, both well-known workers in this interesting field. In the publishers' announcement it is stated that:—'The two authors, independently of each other, had for many years been accumulating materials for a monograph on the Rotifera, or Wheel-Animalcules, and had almost abandoned the intention when they chanced to become acquainted with each other's design, and then found that, by a great piece of good fortune, their respective stores of notes and drawings to a large extent supplemented one another, and that they had thus between them observed and drawn the whole of the known British species.

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Some New and Rare Diatoms.—We are indebted to Messrs. W. C. Walker, of Utica, and H. H. Chase, of Geneva, N. Y., for the first part of a folio publication which they propose to issue as occasion may require, describing new and rare diatoms. The part before us includes seven folio pages of printed text descriptive of the species, and two photograph prints from drawings, mounted on cards of the size of the pages. The authors do not undertake this meritorious work with the intention of making money by it, but they are, nevertheless, we believe, not averse to receiving numerous orders, which will materially aid in paying the expenses of what must be a rather expensive undertaking. The illustrations are certainly entirely satisfactory, but we cannot understand why the negatives are not taken directly from the objects instead of from drawings. No doubt there are good reasons for the plan adopted, but at first thought it would seem to involve considerable unnecessary labor in making drawings. Orders should be sent to either of the authors whose addresses are given above. We bespeak a hearty support of this enterprise by microscopists generally, and especially by the large number of those interested in diatoms.

* *Moniteur du Praticien*, February, 1886.

NOTES.

— Messrs. Emmerich & Son have received copies of the English catalogue of Zeiss, which they will send to any address for ten cents, as announced in their advertisement. We have no doubt this new catalogue will attract much attention. Mr. Zeiss is so well known among the microscopists of this country that a description of his stands and apparatus in English will be of great interest.

— Mr. W. G. Blish, in the *Scientific American*, states, that to preserve paste eels, the paste should be kept in a wide mouth bottle, loosely stoppered, placed in a cool place. If the eels are not doing well, he adds a piece of bread, or prepares some fresh paste, preferably of rye flour. Paste containing a good supply of eels will keep for weeks without moulding.

CORRESPONDENCE.

Magnification.

To the Editor:—Sufficient time has been given for answers to the series of questions propounded on page 240 (vol. vi), in reference to magnification. Without wishing to be at all personal, the questions evidently were not understood, or no measurements were made. Were it not for the signature, the so-called answers on page 20 of the current volume would not be worthy of serious consideration. It would be well to have more practical measurements and less theory. It is a 'poor rule that does not work both ways.' In answering the first question he says a one-inch lens magnifies 7.9 diameters, and on page 11 of the catalogue which he refers to a one-inch eye-piece magnifies 11 diameters, and on page 12 a one-inch objective magnifies 9 diameters.

I am pleased to know that a 10-inch tube is just 10 inches long (254 mm.), but after 30 years' experience I have never seen a microscope with a tube of that length—a full length tube of a majority of microscopes is about 9 inches.

I am acquainted with the different theories in reference to it, but would it not be better to define what is meant by giving the distance from the front of the objective to the top of the eye-piece, or from the front of the objective to the diaphragm of eye-piece? Not one person in a hundred can locate the posterior focus of his objective and measure the distance from the diaphragm of the eye-piece.

In regard to the first question, the nearest lens which I have is $\frac{99}{100}$ of inch focus, and it magnifies 9.23 times; a 1-inch lens would magnify about 9.2 diameters. The focus was found by measurement with a focometer. The theory on which it is constructed is that the distance between conjugate foci of a lens is just four times the focus for parallel rays.

In regard to the second question, Mr. Tolles' formulas for a two-inch eye-piece have been given as follows:—

1. Field glass, radius 1.5, aperture 1.2.
   Eye glass, radius 0.8, aperture 0.59.
   Distance apart 2.6, flat sides.
2. Field glass, radius 1.4, aperture 1.12.
   Eye glass, radius 0.8, aperture 0.59.
   Distance apart 2.5.
3. Field glass, radius 1.3, aperture 1.12.
   Eye glass, radius 0.79, aperture 0.59.
   Distance apart 2.42.

In reply to the third question, I would say the nearest lens I have has a focus of 2.05, and magnifies 3,873 times. The estimated magnifying power of a 2-inch lens is about 4.5 diameters. The first formula for a 2-inch eye-piece I have not measured, but I believe it would magnify about 4.25 diameters. The second formula gives magnification of 4.5, and the third 4,348 diameters.

The fourth and fifth questions are still open.

Walter H. Bulloch.

Chicago, Ill.

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Durability of White Zinc Cement.

To the Editor:—Some two years ago I bought Mr. A. C. Cole's Series No. 3 Educational Preparations, including 24 slides. The slides are perfect models of neat mounting, cell rings of white zinc. In no case has the cement run in. I found the other night that a slide of adipose tissue had begun to spoil. On holding the same to the light, I found on examining the ring with a small lens a great number of transverse cracks, caused by shrinkage. I have turned a fresh ring of marine glue in fusil oil overlapping the white zinc on all the slides.

What would you suggest?

Fr. Dienelt.

[White zinc cement, when it hardens so much that it cannot run in, is very likely to crack after a while. The best remedy is a coat of shellac in alcohol, and a fresh ring of white zinc cement outside of that if the color is objectionable. The preparation is then perfectly secure.—Ed.]

To the Editor:—A friend here, who has attained celebrity as a cleaner of marine muds, has recently received from Vienna a slide of which I think an account will be of interest to your readers. The design is formed on the cover-glass, and consists of three hundred and forty-one distinct objects placed in position with an almost absolute degree of perfection, and are as follows:—In the centre is an *Arachnoidiscus*, around which are grouped forty wheels of *Chirodota*, twenty red, green, and blue-tinted diatoms (*Actinocyclus*), twenty scarlet butterfly scales, alternating with twenty diatoms (*Surirella*), forty red, green, and blue-tinted diatoms (*Actinocyclus*), one hundred wheels of *Chirodota*, in twenty groups of five each, twenty plates of *Synapta*, twenty anchors of *Synapta*, alternating with twenty groups of diatoms, three in each (*Surirella*).

Along with this slide came a type-plate of thirty-five selected diatoms of the Richmond fossil earth, and a beautiful thin section of Jutland cement-stone showing many species of diatoms *in situ* in the rock section.

Mobile, Ala. K. M. Cunningham.

MICROSCOPICAL SOCIETIES.

Washington, D. C.

Forty-first regular meeting.

Dr. T. Taylor addressed the Society on the subject of artificial butter. The speaker stated that an item had recently been going the round of the papers purporting to come from Prof. Weber, of the Ohio State University, to the effect that the so-called St. Andrew's cross, hitherto supposed to be peculiar to butter, could be produced in any fat by the addition of salt and water, and that therefore the microscopic tests for butter were valueless.

He had had some correspondence with Prof. Weber, and had also received photographs of various fat globules, showing the cross, made by Prof. Detmers of the same institution, which he exhibited. As he had expected, the newspapers had made Prof. Weber say more than he intended to say, and had not given the real purport of his experiments. In absence of full information he could not say just what the scope of Prof. Weber's experiments was, but in his opinion the specimens which Prof. Weber had examined consisted of various fats which had been triturated with water until the mass consisted of globules of fat surrounded by thin films of water. Each globule, under these conditions, was a polarizing body, and, accordingly, showed the cross. The use of salt and water was not essential.

But the tests for butter rest upon an entirely different basis, the presence of the cross being only incidental. In butter we have a perfectly clear body having a definite structure by transmitted light.

Prof. Weber's specimens show simply a semi-solid fatty mass, structureless by transmitted light. Again, if we find in any given specimen, the crystals peculiar to lard or other fats, that fact is enough to prove adulteration, so far as the law is concerned, whether the cross be present or not.

Dr. Schaeffer asked whether it would be correct to assume that any fatty globule showing the cross must be from the milk of a ruminant animal, or, in other words, that such a globule must be butter. Dr. Taylor replied that no such assumption could be made.

Dr. Taylor further stated that the cross found on the globule of boiled butter was peculiar to butter only as relating to the stellar crystals of lard and the foliated crystals of beef, employed in the manufacture of oleomargarine, and this proposition, Prof. Weber admits—that is to say, the Professor admits that butter crystals of globose form always exhibit a cross, while those of lard and beef do not. Thus far he admits, in his official report, Dr. Taylor's experiments are confirmed. The speaker stated that the microscopic test of oleomargarine had no direct relation to the question of the butter crystal, but is founded on the fact that normal butter is not a polarizing body while oleomargarine is. Therefore, when in practice, a pure butter is examined under polarized light and selenite plate, the only color observed is that produced by the use of the selenite. Now remove the butter and substitute for it a slide of oleomargarine of commerce, when it will be observed that the color is no longer visible, but instead a great profusion of prismatic colors appear, combined generally with the crystals of lard. In testing oleomargarine for lard crystals or amorphous fats, I examine it as I find it. I do not boil it; it is the foreign fats I look for first. Should I desire to know the character of the butter in the compound I boil the specimen.

Prof. Weber's first step was to boil his oleomargarine; hence, he got only butter crystals, the fats were absorbed.

Dr. Howland showed slides of antipyrin evaporated from alcoholic solution.

E. A. Balloch, *Rec. Secr.*

San Francisco, Cal.

The annual meeting was held February 10th, when the President, Dr. Mouser, read his annual address, expressing much satisfaction in the condition and prospects of the Society, and briefly reviewing the work of the past year.

The officers of the present year are: President, S. M. Mouser; Vice-President, E. J. Wickson; Treasurer, A. M. Hickox; Corresponding Secretary, Charles W. Banks; Recording Secretary, A. H. Breckenfeld.

At a meeting held February 24th, Mr. Payzant showed the well-known but ever-interesting spores of *Equisetum*, and called attention to the wonderful sensitiveness to moisture possessed by the spirally-coiled 'elators' with which each spore is furnished.

A piece of wharf timber, completely riddled by the perforations of *Teredo navalis*, the ship-worm, was shown by F. L. Howard, who read a short paper descriptive of the structure and habits of this destructive mollusc, and also of *Limnoria terebrans*, a marine crustacean of the order Isopoda. The latter organism is almost as destructive to submerged timber as the teredo, but is much smaller, its length being only about one-sixth of an inch. It is of ash-gray color, eyes black, each composed of about seven ocelli, thorax 7-jointed, each joint bearing a pair of short legs. It has two pairs of jaws, and a pair of strong mandibles, used for boring the wood. When touched or disturbed, the animal rolls itself into a ball. Its method of boring differs from that of the teredo. The latter bores smooth cylindrical perforations, which become lined with a calcareous incrustation. These excavations are always made in the direction of the grain of timber, and only deviate from the course when an obstacle is met with, such as a hard knot, or the calcareous tube of a neighboring toredo. But *Limnoria* appears to prefer cutting the timber across the grain. Living specimens of both animals were shown to those present, and were examined with much interest.

The Recording Secretary stated that he had brought a number of slides which he proposed to show under the micro-polariscope. Briefly alluding to the nature of polarized light, he drew attention to the rapidly increasing employment of the polariscope in microscopical research.

Under his new 'universal' binocular, A. S. Brackett exhibited various preparations.

At a meeting held March 10th, a slide of *Spirogyra crassa*, in fruit, was handed in by Mr. Breckenfeld, who stated that Dr. Cooke, in his recently-published work on 'Fresh-Water Algæ,' gave .16 mm. as the largest recorded diameter of the filaments of this interesting species — the largest of its genus. But in the slide under consideration, careful measurements showed the average diameter of the filaments to be 1–150 of an inch (=.17 mm.), while in many cases the diameter exceeded .18 mm. The California variety was, therefore, the largest in the world, owing probably to 'our glorious climate.' The plant was found growing in a ditch near Napa.

Under a Spencer dry ¼-inch objective, of 115° angle, were shown specimens of the exquisite diatom, *Cestodiscus superbus*, and also the striæ, or markings on the valves of No. 18, on Möller's probe-platte of diatoms, mounted in phosphorus. The latter diatom was also shown with a Gundlach fifth.

The 'Improved Beck Microscope Lamp,' just received by Dr. Selfridge, was exhibited by him to the members present. It has facilities for changing the direction, angle, color, and intensity of the illuminating beam, and seems in every way excellently adapted to the requirements of the working microscopist.

A number of objects were splendidly shown with Dr. Stallard's fine one-twelfth-inch oil immersion lens, of 1.43 numerical aperture, made by Powell & Leland.

At the meeting of March 24th, Mr. E. H. Griffith, of Fairport, N. Y., was present. His reception was very cordial, and the use of the Society's rooms were tendered him during his stay in the city. Mr. Griffith extended a warm invitation to the San Francisco Society to attend the coming meeting at Chatauqua, N. Y.

Mr. Griffith presented to the Society a handsome Griffith self-centering turntable.

A slide of the fossil deposit at Barbadoes was shown by Mr. Norris.

A most interesting demonstration of the capabilities of the oxy-hydrogen microscope was then given by Mr. Edward W. Runyon. The microscopical attachment was of Mr. Runyon's own designing, and is screwed to the front of the lantern. The nose-piece, to which the objectives are attached, slides on three polished steel rods, as does also the stage with its substage, and both can be clamped in any desired position. The objectives used in the exhibition were a half-inch and an inch by Bausch & Lomb, and also a half-inch by Gundlach.

A. H. Breckenfeld, *Rec. Secr.*

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Notices of New Fresh-Water Infusoria.—V.

BY DR. ALFRED C. STOKES.

Physomonas elongata, sp. nov. (Figs 1 and 2).

Body elongate-ovate, somewhat changeable in shape, twice as long as broad, often widest posteriorly, and somewhat curved toward one side anteriorly; free-swimming or temporarily attached by a short, inconspicuous, posteriorly developed pedicle; frontal border obliquely truncate, the lip usually prominent; primary flagellum sub-equal to the body in length, the secondary one about one-third that length; contractile vesicle single, small, spherical, situated in the anterior body-half near the lateral border; endoplasm colorless, slightly granular. Length of body, $\frac{1}{225}$ inch. Habitat.—Swamp water with decaying vegetation, from South Florida.

This conspicuously differs from the previously recorded forms in the absence of the subspherical contour commonly considered characteristic of the genus. The very short, temporarily developed pedicle is another well-marked point of divergence between this and the other two species. Frequently no distinct pedicle can be discerned, the attachment appearing to be accomplished by a slight extension and conspicuous acumination of the posterior extremity. Reproduction takes place by longitudinal fission, the smaller more nearly spherical resultant zooids being abundant in the same infusion with the larger ovate individuals. The species was abundant in its habitat. The contractile vesicle is placed on one side near that part of the frontal border opposite to the lip-like projection. Its movements are quick and snapping.

Tetramitus variabilis, sp. nov. (Figs. 3, 4, and 5).

Body soft, changeable in shape, obovate, with the anterior border obliquely excavate, a short lip-like prominence at its upper angle, or subpyriform or subspherical, the frontal border rounded, the posterior extremity obtusely pointed or evenly convex; flagella four, subequal, exceeding or equalling the body in length, inserted near the centre of the anterior extremity; contractile vesicles two, situated near the frontal border, not close together; nucleus obscured by the granular endoplasm; food engulfed at any portion of the surface; body without grooves. Length, $\frac{1}{1125}$ to $\frac{1}{1500}$ inch. Habitat.—Standing water with decaying vegetation.

This form markedly differs from the three previously described species in the entire absence of the longitudinal grooves and flattened cuticular surfaces characteristic of those animalcules. The species here described was observed among decaying vegetation with water from the cypress swamps of South Florida. It was accompanied by very many forms familiar in our more northern waters, and is itself probably not restricted to Florida.

Urceolus sabulosus, sp. nov. (Figs. 6 and 7).

Body flask-shaped, soft, flexible, and elastic, normally compressed

and somewhat gibbous, about twice as long as broad, widest centrally, obtusely pointed posteriorly, the entire surface more or less covered, often almost concealed, by adherent, irregular and angular sand grains; anterior extremity constricted to form a short neck-like prolongation, the circular border thickened, expanded, and obliquely truncate; flagellum large, equalling or exceeding the body in length; nucleus not observed; contractile vesicle (?) single, laterally placed near the anterior extremity; pharynx apparently extending to near the body-centre. Length of body, $\frac{1}{500}$ inch. Habitat.—Fresh water with Algæ.

The movements of this remarkable infusorian are usually rather rapid, resembling those of *Urceolus cyclostoma* (Stein) Meresh. (*Phialonema cyclostoma* Stein), the obliquely truncate anterior extremity being applied to the submerged surface, and the body lifted at an acute angle, the vibrating tip of the flagellum appearing to be the only means by which an advance is made. The oral region and the entire body are very soft and elastic, but scarcely changeable in shape. The food particles and frequently small aggregations of minute fragments are drawn into the oral aperture with some force, often being quite violently dragged away from their attachment. The pharyngeal passage and nucleus were obscured by the abundance of the cuticular coating of sand grains; the former, however, appeared to reach the centre of the body.

The cuticular investment of sand grains which is almost unique among the fresh-water Infusoria, seems to be entirely under the creature's control, so far as the amount and arrangement of the constituent particles are concerned. The process of obtaining these grains is, so far as I have observed, simply one of adhesion. The infusorian passes above a coveted particle and it adheres to the presumably viscid surface. This is, at least, the process which takes place on the stage of the microscope, the silicious and other fragments adhering wherever they come in contact with the body surface. Their subsequent arrangement into the semblance of a protective sheath I have not been able to satisfactorily observe. It seems, however, to be accomplished by a slow movement or superficial and deliberate circulation of the ectoplasm, by means of which the grains are gradually moved into their places according to their size and shape.

For several years I have frequently met with small, ovate, actively-moving, uniflagellate organisms, the entire surface being more or less abundantly clothed with minute sand grains; and now that this remarkably interesting infusorian has been observed, to associate these little uniflagellate sand-bearers with it is an irresistible impulse; but, although the supposition of their intimate connection is plausible, it has no other than an imaginary basis. The particular organism from which figure 7 was made was $\frac{1}{150}$ inch in length, and its load of sand was unusually large. Similar but very much smaller forms have been repeatedly observed from widely-separated localities. These very small uniflagellate bodies, however, are generally the bearers of very few sand particles, which are often aggregated at the rounded summit or on one lateral border. I now suspect an intimate connection between these little creatures and the mature *Urceolus sabulosus*. If they are not immature or developing forms of Urceolus, then they must be a unique species of Monas.

Chrysopyxis triangularis, sp. nov. (Fig. 8.)

Lorica triangular, sessile, compressed, the height slightly exceeding the breadth, the posterior extremity truncate, the basal angles rounded; lateral margins converging, with a more or less conspicuous sub-central convex projection;

aperture apical, the border produced as a short, subcylindrical neck, the anterior margin truncate, not everted; enclosed animalcule subspherical, yellowish. Height of lorica $\frac{1}{1800}$, width at base $\frac{1}{1500}$ inch; diameter of enclosed zooid $\frac{1}{6000}$ to $\frac{1}{4500}$ inch. Habitat.—The cypress swamps of South Florida; abundant on various confervoid Algæ.

Chrysopyxis macrotrachela, sp. nov. (Fig. 9.)

Lorica somewhat bottle-shaped, the body triangular, about twice as high as wide, the posterior border truncate, the basal angles rounded, the lateral margins converging, slightly convex; aperture apical, the border produced as a long, narrow, subcylindrical neck-like prolongation, in length equaling or slightly exceeding the height of the lorica-body, the anterior margin truncate, conspicuously everted. Height of lorica without the neck $\frac{1}{3000}$, width at base $\frac{1}{1800}$ to $\frac{1}{1500}$; length of neck $\frac{1}{3000}$ to $\frac{1}{2250}$ inch. Habitat.—In company with *Ch. triangularis*, but less abundant.

Chrysopyxis ampullacea, sp. nov. (Fig. 10.)

Body of the lorica subhemispherical, the posterior border truncate, the lateral margins rounded; aperture produced has a neck-like prolongation in length equalling the diameter of the lorica, narrowest at its origin, the lateral borders gradually diverging to the truncate frontal margin. Height and diameter of the lorica body and length of neck $\frac{1}{225}$ inch; diameter of the enclosed animalcule $\frac{1}{600}$ inch. Habitat.—The cypress swamps of South Florida.

Prorodon limnetis, sp. nov. (Fig. 11.)

Body ovate, subcylindrical, soft and flexible, twice as long as broad, slightly curved toward one side anteriorly, the lateral borders gently concave, both extremities rounded; cuticular surface longitudinally striate finely and entirely ciliate; oral aperture eccentric, the oral cilia more conspicuously and abundantly developed than those of the general surface; pharyngeal passage a conical rod-fascicle extending to near the body centre; contractile vesicle single, spherical, postero-terminal, frequently leaving after systole a number of small, spherical vacuoles; nucleus ovate, laterally placed in the posterior body-half; endoplasm semi-opaque by the inclusion of numerous dark corpuscles. Length of body $\frac{1}{200}$ inch. Habitat.—Standing water, with decaying vegetation from the cypress swamps of South Florida.

This form seems to most nearly approach *P. teres*, Ehr., differing from it chiefly in the somewhat eccentric position of the oral aperture in the well marked antero-lateral curvature, and the slight but noticeable concavity of the lateral borders. The movements are rotary on the longitudinal axis.

Trachelophyllum clavatum, sp. nov. (Fig. 12.)

Body elongate, flask-shaped or subclavate, somewhat flattened, five to six times as long as broad, elastic and flexible, the neck-like anterior portion scarcely distinguishable from the body proper; cilia vibrating irregularly and somewhat independently; oral aperture terminal; pharynx an obconical fascicle of fine rod-like elements, extending through the anterior one-third of the body; nucleus single, ovate, subcentral; contractile vesicle single, spherical, postero-terminal, frequently leaving two or more smaller vacuoles after systole; endoplasm granular. Length of body $\frac{1}{125}$ inch. Habitat.—Standing water on decaying vegetation from South Florida.

The animalcule's movements are rather slow and smoothly gliding, with frequent bending and curving of the anterior region as the creature searches heaps of detritus for food. The pharyngeal fascicle is distinct even during life, but after death by iodine poisoning, the body becomes diffluent and the pharynx floats out

as a disarranged cluster of extremely fine hair-like rods. There seems to be no connecting membrane. During life the infusorian has the power, which it frequently exercises, of expanding the posterior portion of the fascicle and thus apparently separating the constituent rods. After death the latter become entirely free, except at the anterior points of attachment around the oral aperture. The species is the only one thus far recorded with a single nucleus.

Perispira strophosoma, sp. nov. (Fig. 13).

Body elongate ovate, often somewhat curved toward the right-hand side, about four times as long as broad, bearing a ridge-like elevation extending as a single long spiral from the left-hand corner of the obliquely truncate anterior border to the evenly rounded posterior extremity; cilia long and fine, arranged in a row on each side of the spiral elevation; contractile vesicle single, spherical, postero-terminal; nucleus ovate, near the centre of one lateral border; oral and anal apertures not observed; endoplasm crowded with small, oblong, dark-bordered corpuscles. Length $\frac{1}{300}$ inch. Habitat.—Standing water with Sphagnum. Movements rotary on the longitudinal axis.

The cilia of the general cuticular surface are very fine and extremely difficult to see when the infusorian is swimming; only when weakened by prolonged confinement beneath the cover-glass, or when dying from the effects of dilute solution of perchloride of iron, can the observer positively determine their existence.

Lacrymaria teres, sp. nov. (Fig. 14).

Body elongate-clavate, subcylindrical, very soft and flexible, six to seven times as long as broad, narrowest and somewhat attenuate and depressed anteriorly; posterior extremity rounded; anterior border obliquely and convexly truncate; cuticular surface finely striate longitudinally; cilia in the apical groove and on the general cuticular surface not conspicuously differing in size; contractile vesicle consisting of two conspicuous spherical vacuoles, one postero-terminal, the other situated in the anterior body-half near one lateral border, the two connected by a narrow, tortuous, canal-like channel penetrating the endoplasm, and often laterally developing spherical or irregular lacunæ; oral aperture terminal; endoplasm granular. Length of body $\frac{1}{150}$ to $\frac{1}{125}$ inch. Habitat.—Standing water with decaying vegetation from the cypress swamps of South Florida.

This species differs from *L. truncata* Stokes, not only in size and more cylindrical contour, but chiefly in the possession of the complex contractile vesicles, and in the absence of the remarkably convoluted nucleus characteristic of that infusorian. The animalcules abounded in the habitat mentioned, but in none, even after the repeated application of reagents and staining fluids, could a nucleus be observed.

The oral aperture is remarkably expansile. Repeatedly the infusorian has been observed to seize *Dexiotricha plagia* Stokes, so that the latter animalcule was at right angles to the body of the Lacrymaria, yet the oral aperture expanded until its width almost equalled the length of the captured zooid, a length equal to about $\frac{1}{400}$ inch.

Leucophrys curvilata, sp. nov., (Fig. 15).

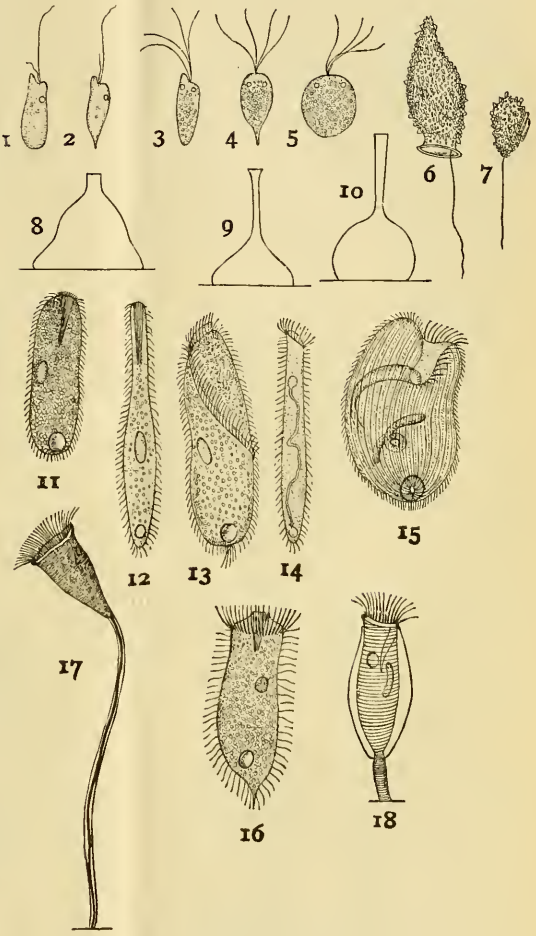
Body ovate, one and one-half to twice as long as broad, slightly widest posteriorly, somewhat curved toward the left-hand side, the right-hand border longest, the left-hand margin anteriorly concave, the dorsal surface convex, the ventral flattened; anterior border obliquely excavate, the posterior evenly rounded; the cuticular surface longitudinally striate; cilia of the posterior border longest and most conspicuous; peristome field extending through the anterior one-fourth of the ventral aspect; oral aperture

ovate; pharyngeal passage long, tubular, curving toward the right-hand side and extending to the centre of that border, apparently ciliated; nucleus band-like, convolute, subcentral; contractile vesicle posteriorly placed, with a channel like diverticulum extending to the centre of each lateral border; endoplasm colorless, transparent, or containing numerous dark granules; anal aperture in close proximity to the contractile vesicle. Length of body $\frac{1}{150}$ to $\frac{1}{200}$ inch. Habitat. — Standing water with decaying vegetation.

Occasionally a posteriorly developed emargination is temporarily developed, due probably to the position of the anal aperture. Conjugation has been frequently observed, union taking place by means of a portionof the antero-ventral region, and apparently involving the oral aperture, the zooids then swimming with the ventral surfaces parallel. No trace of the animal chlorophylle which so crowds the subcuticular region of *L. emarginata* Stokes, is here visible, the endoplasm being almost hyaline.

Strombidinopsis acuminata, sp. nov. (Fig. 16).

Body elongate-ovate, subcylindrical, slightly constricted anteriorly, less than three times as long as broad, somewhat gibbous posteriorly, that extremity terminated by a short, conspicuous, eccentric acumination; anteriorly somewhat laterally curved, the frontal border centrally elevated, the oral aperture surrounded by a slight depression and followed by a conical, longitudinally plicate pharynx; adoral ciliary wreath circular, the cilia but slightly longer than those of the general surface; contractile vesicle near the posterior extremity; endoplasm granular. Length of body $\frac{1}{45}\frac{1}{50}$ to $\frac{1}{65}\frac{1}{50}$ inch. Habitat.—Standing



New Fresh-water Infusoria.*

* Explanation of figures.

Fig. 1, 2. *Physomonas elongata.*
Fig 3, 4, 5. *Tetramitus variabilis.*
Fig. 6, 7 *Urceolus sabulosus.*
Fig. 8. *Chrysopyxis triangularis.*
Fig. 9. *Ch. macrotrachela.*
Fig. 10. *Ch. ampullacea.*
Fig. 11. *Prorodon limnetis.*
Fig. 12. *Trachelophyllum clavatum.*
Fig. 13. *Perispira strophosoma.*
Fig. 14. *Lacrymaria teres.*
Fig. 15. *Leucophrys curvilata.*
Fig. 16. *Strombidinopsis acuminata.*
Fig. 17. *Vorticella Floridensis.*
Fig. 18. *Colhurnia Canthocampti.*

water with decaying vegetation from South Florida.

Usually the prominent acumination projects suddenly from the rounded extremity; with other individuals from the same infusion the part more gradually tapers from the body. The movements of the zooid are rapid, irregular, and difficult to follow. The structure can be satisfactorily studied only after death by poisoning, or when the animalcule is taking food. In the latter case the body is shortened and broadened, while the oral aperture is greatly dilated, easily engulfing, as repeatedly witnessed, the comparatively large *Chilomonas paramœcium* Ehr.

Vorticella Floridensis, sp. nov. (Fig 17).

Body conical-campanulate, changable in shape, less than twice as long as broad, very finely striate transversely; peristome exceeding the body in width, the border everted but scarcely revolute; ciliary disc elevated; pedicle three or four times as long as the body, the muscular thread stout; endoplasm colorless, finely granular; contracted body subpyriform, the posterior extremity invaginate. Length of body $\frac{1}{300}$ inch. Habitat. — Standing water from the cypress swamps of South Florida.

The change in the form of the body consists chiefly of elongation and compression with irregularly developed lateral depressions.

Cothurnia Canthocampti, sp. nov. (Fig. 18).

Lorica ovate somewhat gibbous, less than three times as long as broad, widest centrally, the anterior border truncate, not everted, the aperture circular; pedicle straight or slightly curved, transversely plicate, from one-third to one-fifth the length of the lorica; enclosed zooid transversely striate, attached posteriorly by a short continuation of the external foot-stalk; when expanded, only the peristome border usually extending beyond the lorica. Length of sheath $\frac{1}{300}$ inch. Habitat.—On *Canthocamptus minutus*.

This differs from *C. astaci* Stein, which it somewhat resembles, in the absence of eversion of the anterior border, the transverse striation of the cuticular surface, and in the very short distance to which the expanded zooid extends beyond the lorica margin. In size the two are very similar.

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Mosses.*

The mosses are humble plants, but they have no insignificant part to play in the economy of Nature, or in the coloring of the landscape; trees, rocks, and old ruins lookgrand under their covering; whilst the various species of Sphagnum, which grow in boggy places, perform an important part in the formation of turfy soil. These aquatic mosses grow very rapidly, so as in a very short time to occupy the whole of the pools which they inhabit. The genus *Phascum* are very minute species, found plentifully in fallow fields, but the large family of Hypnums are the most conspicuous, and often elegant plants, commonly seen on tree trunks, old walls, &c. The mosses can be gathered all the year round, although they vary in their period of flowering; for example, the *Funaria* is always in good condition for examination; on the other hand, the *Phascum* blossoms in early summer, and is ripe in the autumn, but the *Hypnum*, in many instances, takes twelve months to form the mature capsule, or theca.

The specimen selected for examination is the *Funaria hygrometrica* L. First make a section of the stem (fig. 10), and compare with any vascular cryptogam, such as the fern; it will be seen to differ widely, in the absence of vascular bundles. In most mosses we find an outer layer of thick walled cells which passes into a mass of tissue in the centre. These are not sharply defined, and are said to perform the function of a vascular bun-

* Reprinted from *Science Gossip*.

dle, in the conduction of sap. Now note the leaves of *Funaria* (fig. 11), by plucking off any of the upper ones, and place beneath a cover slip in a drop of water. They are of a sim-

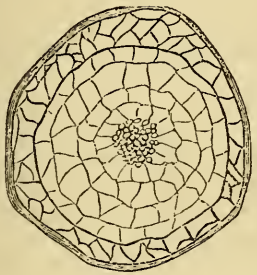

Fig. 10.

ple structure, with the exception of the midrib, and consist of a single layer of parenchyma, containing granules of chlorophyll; it originates from the bulging of a stem cell, afterwards separated by a lon-

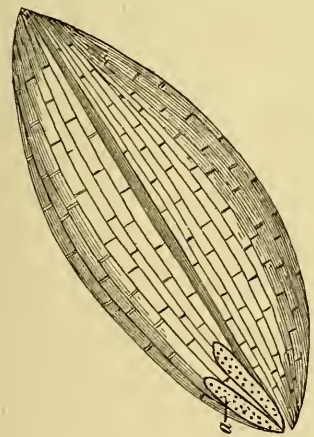

Fig. 11.

gitudinal partition. Then carefully look out a stem bearing in the apex a quantity of differentiated leaves in a circular tuft; this is the perigonium, amongst which we shall find the reproductive organs. Pluck off a few of the leaves with a fine pair of forceps, near the centre, and search for the antheridia (fig. 11, *a*), or a longitudinal section may be made; but I have found it far easier to point out the male organs as directed above. The student must be careful not to mistake the paraphyses for the antheridia; the former are filiform structures, or abortive leaves, the antheridia are on short stems. Place the antheridium beneath a higher power (fig. 12). It is seen to be a stalked sac, composed of a layer of chlorophyll, bearing cells when young, but they assume a red dish tint before bursting. They are filled with very minute antherozoids. On another stem, but taller than the last, will be found the archegonia (fig. 13). Make a section by holding the stem betwixt the thumb and finger, and gently pushing the razor from you, then float out the sections in in a bowl of water, select a few,

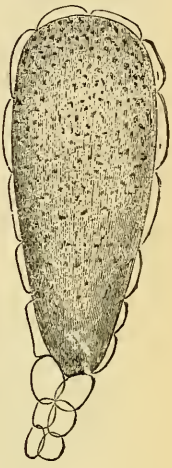

Fig. 12.

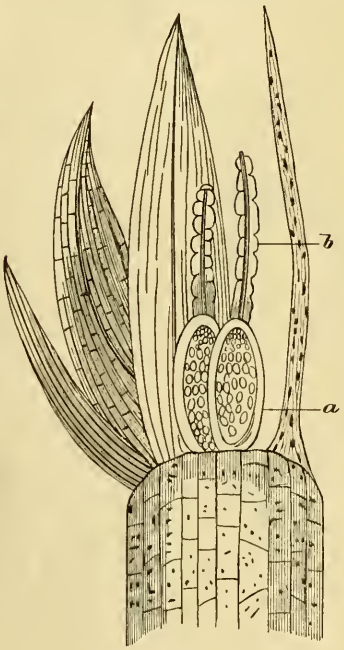

Fig. 13.

carefully spreading them out with a needle on the slide, then search for the archegonia. It consists of two portions, the lower ovate (fig. 13, *a*), and the upper, or neck, of archegonium (fig. 13, *b*). The archegonium is ruptured by the fertilized oosphere, often in such a way that, while the lower part remains as a sheath, the neck is elevated as a cap now known as the calyptra on the top of the theca or capsule. On the top of the theca is a small lid, or operculum. When this is removed, the mouth or stoma is seen surrounded by a beautiful series of teeth called the peristome (fig. 14);

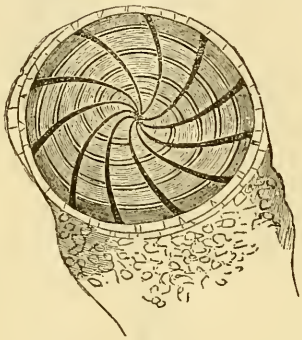

Fig. 14.

the stalk supporting the theca is the seta. Now prepare a section of the theca. Fig. 15 *a* is the columella, and fig. 15 *b* the operculum, beneath which is the peristome. When the spores germinate its ends out a filiform body, known as the protenema, or proembryo, on which the young plant is developed. The root hairs, which will be found at the base of the stem and which take the place of true roots, are called rhizoids, play an important part in the economy of these plants. Detached leaves of the Funaria placed on moist soil will produce the protenema.

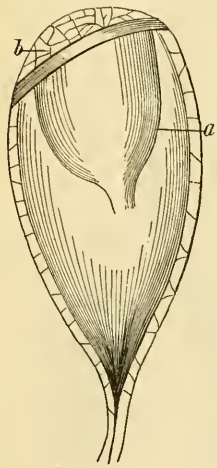

Fig. 15.

J. F. R.

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The New Objectives and Oculars.

Since our last issue, in which a notice of the new objective and oculars by Mr. Zeiss was published, we have received the advance sheets of the *Journ. Royal Micr. Soc.*, with an article giving more detailed information concerning the subject, from which we quote the following paragraphs:—

'For some months past it has been known that we were on the eve of an important advance in objectives, depending mainly on the elimination of the secondary spectrum, leaving only a small tertiary spectrum....

'Two objectives have now been received in this country, and their examination has fully borne out the expectation formed of them, and has shown that however trifling the improvement might at first sight be thought to be on theoretical grounds, it is very distinctly appreciable, so that the high power work of the future will almost necessarily be done with these glasses.

'The objectives in question are both $\frac{1}{8}$ inch. The special point in their construction is that they are made of new kinds of optical glass, which Prof. Abbe and Dr. Schott have been working for the last five years to perfect. The objectives are composed of ten single lenses, combined to five separate lenses, with a single front lens. Their working distance is 0.25 mm., and in order to secure this the aperture is limited to 1.40 N.A. With the length of tube engraved on the setting (taken from the nose-piece to the eye-lens), the objectives have their best correction for a cover-glass of 0.16–0.18 mm. Much thinner covers require a lengthening of the tube by 10–25 mm. further. They are very sensitive in re-

gard to length of tube, and the change in this length is the simplest, and in fact the best, means for slight corrections for different covers—the reason being that a change of that kind does not alter the proper balance of the various corrections (spherical, chromatic, and sphero-chromatic), whilst an alteration in the distance of the lenses of the objective from one another, as is done by a screw-collar, does disturb that balance to the injury of the performance of the objective. It may be possible to find a formula which will be less sensitive in regard to this question of correction, but until it is found, Dr. Zeiss, by whom the objectives are made, will not supply any with correction-collars, so as to convert a good objective into a medium one for the sake of a non-essential convenience only.

'A novel point in connection with the objective is that its performance is improved by the use of special eye-pieces, of which two are supplied, of 25 mm. and 15 mm. focal length. Their function is to compensate for certain aberrations outside the axis, which cannot be compensated for in the objective. With these eye-pieces, particularly with that of 25 mm. focal length, the field of view is surprisingly uniform.

'Of the ten lenses of which the objective is composed, two only are of siliceous glass, the other eight being made of borates and phosphates. The crown and flint glass now used by opticians does not contain (as essential components) more than six chemical elements, O, Ca, K, Na, Pb, and Si, whilst the new objective contains not less than fourteen elements.

'The optical principle on which the objectives have been constructed is indicated in a paper by Prof. Abbe,* "On new methods for improving spherical correction," &c. In fact, all the work of Prof. Abbe and Dr. Schott during the five years has been solely directed to finding the proper means for the realization of the desideratum there mentioned, viz., doing away with the secondary chromatic aberration, and with the chromatic difference of spherical aberration. The proper means was found in special kinds of glass, which allowed of proportional dispersions in different parts of the spectrum, and which at the same time exhibit different relations between the refractive indices and dispersive powers. By these means a more perfect concentration of all the rays emanating from the object is obtained. With the old kinds of crown and flint glass two different colors only could be collected to one focus, a secondary spectrum remaining uncorrected, whilst the new objectives collect three rays of different colors to one focus, leaving a small tertiary spectrum only. Moreover, spherical correction has hitherto been confined to rays of one color, being made for the central part of the spectrum, the objective remaining under-corrected spherically for the red rays and *over*-corrected for the blue rays. In the new objectives, however, the correction of the spherical aberration is obtained for *two* different rays of the spectrum, that is, practically for all colors at the same time, and the objective shows the same degree of chromatic correction for the central as for the marginal part of the aperture. All this requires greater complication in the construction, hence the use of five lenses instead of the four hitherto employed. In addition, uniformity of amplification by the various zones of the clear aperture has been obtained in a higher degree than could hitherto be done.

'The objectives will be specially useful in photo-micrography where the correction of the secondary spectrum will be found of considerable practical advantage. Not only is there no difference in the optical

* Journ. R. Micr. Soc. ii, (1879) 42.

and chemical foci, but the image formed by the chemical rays is in itself much more perfect. This advantage is very clearly verified by experimental trials which have been made. For photo-micrography a third eye-piece magnifying 2½ times is supplied, the lenses of which can be slightly separated for exact adjustment of the image.

'Two series of objectives will be constructed, one adapted for the short Continental body-tube and the other for the long English body-tube, and there will be a corresponding "compensating" series of eye-pieces. The homogeneous-immersion lenses will have apertures of 1.40 N.A. and 1.30 N.A., and focal lengths of 3.0 mm. and 2.0 mm., the latter with much increased working distance. The water-immersion lenses will have an aperture of 1.25 N.A. and a focal length of 2.5 mm., and the dry lenses 0.95 N.A., 0.60 N.A., and 0.30 N.A., with focal lengths of 4 mm., 8 mm., and 16 mm.

'We append what will we think be of interest to many of the Fellows, a brief account of what we understand to be the history of the construction of the new glass, though, as we have not been able to submit it to Prof. Abbe, he must not be understood to endorse it in any way.

'The origin of the matter was Prof. Abbe's Report on the Microscopes of the South Kensington Exhibition published in 1878.* This contained at the end some general considerations as to the unfulfilled requirements of practical optics in regard to the properties of optical glass, and complaints of the unfavorable conditions then existing. Dr. O. Schott (of Witten, in Westphalia), a chemist, but long versed in practical glass-making, and who had made some remarkable researches on the physical properties of glass, read the report, and in the beginning of 1881, having communicated with Prof. Abbe, they commenced a preliminary study of the optical properties of the various chemical elements as far as they admit of "vitrifiable" combinations. This was conducted at first on a very small scale, Dr. Schott working alone at Witten, and the optical part of the research being carried out at Jena. After a year it was decided to continue the experiments on a larger scale, with the object not only to determine the optical effects of various elements, but to try the production of practically useful combinations. In January, 1882, Dr. Schott settled at Jena, and he and Prof. Abbe established a complete melting-laboratory with large gas-furnaces, a gas engine for driving blowers, &c., and with the aid of two assistants for the chemical and the optical part of the work, and of several workmen, the experimental research was continued there for two years.

'The general direction of the work was based on the principles indicated in the Report of 1878, and in the paper in this Journal before mentioned. According to these principles, there were two distinct objects:—(1) To obtain a greater variety of the optical properties of the glass in regard to the relation of the refractive to the dispersive power. The existing kinds of optical glass constituted nearly a line, *i. e.*, the dispersion increasing always with the refraction, with very slight deviations only. The object was to combine glasses which, if arranged according to n and $\triangle n$, would not be confined to a linear series, but would embrace an area of a certain breadth, one value of n admitting various values of $\triangle n$, and *vice versâ*, as far as possible.

'(2) The second problem was:—To procure kinds of glass of different relative dispersions, in which the dispersions should be proportional, as near as possible, in different parts of the spectrum (the problem of "secondary chromatism").

*Journ. R. Micr. Soc., iv, (1884) 291.

'In regard to the general research, Prof. Abbe and Dr. Schott had a predecessor in the late Rev. W. Harcourt, who worked at the subject in conjunction with Prof. G. G. Stokes. They could not, however, use his results, as all that was published about them is very fragmentary and very indefinite, and they were obliged to begin quite anew. Nevertheless, one important fact was brought to a practical result, viz: the very peculiar property of boracic acid in regard to the second problem, the new observations being only a confirmation of Prof. Stokes's account of the glass-samples produced by the Rev. W. Harcourt (though in other essential points the results do *not* confirm the statements of Prof. Stokes).

'Dr. Schott had succeeded, after the first months of his melting at Witten, in obtaining fusions of very small quantities—down to 100 grammes—with a remarkable degree of homogenity, admitting of an exact measurement of the refraction and dispersion by means of spectrometric observation. This was the very basis of advance, because it allowed of a continuous and strict co-operation of the chemical and optical research. Every change of chemical composition could be immediately controlled, in regard to the optical effect, by measurement.

'The fusions were obtained by means of gas-furnaces, and with crucibles of very different kinds—a great number with platinum crucibles and tools—in quantities of from 50 grammes to 12 kilos, according to the particular object, nearly all chemical elements being submitted to trial; there is even glass containing 10 or 20 per cent. of *mercury*.

'A large number of analyses had been executed by the assistants up to the end of 1883, and more than 600 prisms were ground and measured by the spectrometer. Since then this figure has reached 1000. As it would have been detrimental to the progress of the work to depend on the weather, the spectrometer measurements were always made by means of the five bright lines, Kα, Hα, Na, Hβ, Hγ, after the methods described in Prof. Abbe's paper, "Neue Apparate," &c.

'There were innumerable difficulties to be overcome in order to obtain compositions which should not only show the optical properties desired, but at the same time fulfil so many other requirements for optical glass; and many repeated trials were necessary for one and the same subject before a satisfactory result could be obtained. It is due to the ingenuity and energy of Dr. Schott that these obstacles were overcome.

'Towards the end of 1883, Prof. Abbe and Dr. Schott had exhausted the programme, as far as appeared possible in a laboratory-research, and were about to close the affair and publish the results, as showing the possibilities of a series of new kinds of optical glass, and thereby giving an impulse, as was hoped, to its manufacture. At this period, however, several distinguished astronomers and physicists, who had taken notice of these researches, encouraged them to go one step further, and to undertake the practical utilization of the results in the way of manufacture. Through the aid of these gentlemen a subsidy was obtained from the Prussian Government (though Jena is not in Prussia) to continue the experiments, so as to establish a manufacture of optical glass, which did not exist in Germany. Messrs. Zeiss, who had already furthered the work since the beginning in the most liberal manner, by putting all the personal and technical resources of their establishment at Prof. Abbe and Dr. Schott's disposal, united with them, and in the beginning of 1884 glass-works were set up, with a large furnance and machinery. The Prussian Government's subsidy was 3000*l*., and given under conditions as liberal as any government has ever granted

when putting public money into the hands of private persons.

'The new furnace was lighted in September, 1884, and since that time Dr. Schott has been actively engaged, almost day and night, in overcoming the difficulties of the operations. The experiences of other manufacturers being inaccessible to a new competitor, everything had to be learned anew. A year later the first part of the matter was brought to an end—the production of the ordinary siliceous glass, and this, since last autumn, is used by nearly all German opticians. In a few months, it is hoped that the borates and the phosphates will also admit of regular production, and then the Jena manufactory will be opened for the supply of optical glass on a strictly scientific basis.

'This extension of the work has had the effect of delaying the introduction of better glass into microscopical optics by more than two years. In the summer of 1883, sufficient materials had been obtained for the construction of microscope-lenses, and, in fact, the first objectives were made by Messrs. Zeiss at that period, but after it had been decided to establish a manufactory with the aid of public money, Messrs. Zeiss were obliged to abstain from using the new glass, and to wait until the latter should be accessible to other opticians also.

'At present the objectives are not on sale, but it is expected that very shortly both objectives and glass can be purchased in the usual way.'

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Photo-Micrography.—VI.

BY THE EDITOR.

[*Continued from p. 70.*]

4. Developing.

In continuation of this part of the subject we proceed to describe the process of developing an exposed plate, with the ferrous oxalate developer, after which the pyrogallic acid or so called pyrodeveloper will be considered.

a. Ferrous oxalate development.

This developer has always been a favorite one with us, because it works so clean, and gives negatives free from color. Many writers affirm that it is not equal to pyro in bringing out details on a plate, particularly if the exposure has been insufficient for the subject. We can only say in reply to such statements that if a plate has been exposed long enough to give a picture of any value, it can be developed perfectly well with ferrous oxalate, and when the ferrous oxalate will not develop the details, an attempt to bring them out with pyro will result in a fogged plate. Such a proceeding is never to be advised, for a plate not sufficiently exposed cannot yield a good picture by developing with a strong developer. In passing, however, it may be remarked that this is precisely the course recommended by many writers in the photographic magazines—a course fatal to success in every case.

That the beginner may know when the exposure has been about right it may be said that in a properly exposed plate the picture develops slowly, and gradually increases in strength while the contrasts between light and dark parts are decided, and as clear as in the subject. If the white parts become covered and the plate looks as though it was developing all over at once, it is an indication of over-exposure, and the beginner would do well to discard it and repeat the exposure. Sometimes beginners try plate after plate and fail to get good pictures, and cannot understand the reason for such failures. Usually the fault is in exposing too long. A good way to get the proper time is to draw the dark slide say one-third out and expose about one second, then draw it a little further out and expose another second, then draw it entirely out and

expose as quick as possible. This is for landscape work. For photo-micrography do the same but give longer exposures. On developing it will be seen what part of the plate is properly exposed.

The composition of the developing solutions is given in formula 1 below.

Place the plate to be developed, film side up, in the developing pan in the dark room lighted with ruby or orange light, and pour over it sufficient solution to cover it. Then keep up a rocking motion, causing the developer to flow constantly over the plate. In a few seconds the image will appear, and gradually grow in strength. Continue the operation until all the details of the subject are visible on the film side. This may require five minutes or half an hour, according to the exposure given. The beginner will find it difficult to tell when the development is carried far enough. In an ordinary landscape, watch the shadows, which are the light parts on the developing plate, and if there are any details in the deep shadows of the subject, continue the development until they appear. If they do not appear the plate requires a longer exposure in the camera. If they do appear, remember in the subsequent operations they will apparently lose some of their strength, so do not cease developing until they are distinctly brought out. The shadows in deep-shaded foliage will sometimes remain quite clear while the remainder of the picture is fully developed. In such cases do not spoil the principal part of the picture for the sake of the detail in the shadows. Judgment must be used in this work, and it will soon be discovered that when a subject has strong contrasts of light and shade, the light parts must be a trifle over exposed to get detail in the shadows. Such a subject requires special work in the developing, which will be subsequently considered. If, instead of a landscape, the picture be taken to portray a special object, a house, or a group of persons out of doors, then the development must be conducted with special reference to the part of the picture desired, and when the details of that part are strong enough, the remainder of the picture is worthy of only secondary consideration.

The detail in the shadows being out, it then becomes necessary to judge of the strength of the picture. This is done by looking through the plate toward the ruby light. The operator soon learns to judge of the density in this way, but here the thickness of the film must be taken into account. When the film is thin the picture may be developed until it can be distinctly seen from the back of the plate by reflected light. When the film is quite thick it is more difficult to judge concerning the density of the image. It is not likely to develop through the film so as to be visible at the back, and the only indication we can have is by looking through it. The beginner is almost sure to stop development of such a plate too soon. A good rule with thick films is to develop until one is sure they are done, and then continue the operation for sometime longer.

When fully developed, remove the plate from the tray, and place it under the tap of running water for a few moments, or in a tray of water to wash off the developer. Then transfer it to a tray containing a solution of alum prepared according to formula 8. The alum solution prevents the irregular swelling up and loosening of the film from the glass, which is sometimes troublesome in warm weather. It hardens the film and makes it less subject to injury. In five or ten minutes remove the plate from the alum tray and wash it quite thoroughly.

Then place it in the hyposulphite of soda fixing solution formula 9. This solution dissolves all the silver compounds in the film that have not been changed by, and are still sensitive to, light. All the white portions

of the negative will disappear in this solution, and when no more white is visible when the plate is examined from the back, it may be removed from the solution, washed thoroughly in water, and set on the rack to dry. When dry the negative is ready for use. It may be protected by a coat of negative varnish, which is applied by pouring it on the slightly warmed plate held horizontal in the hand, flowing it over every part and pouring the excess off one corner back into the bottle. Varnishing is not necessary if the plates are used with reasonable care, but it is strongly advised for valuable negatives.

Pyro development must be deferred until next month, as well as instructions for treating plates not properly exposed.

FORMULAS.

We have selected a few of the best formulas, every one of which we can recommend with the fullest confidence. Get the chemicals from dealers in photographic goods, for they know what is required.

The largest firms in New York are The Scovill Manufacturing Company, 423 Broome st., and E. & H. T. Anthony & Co., 591 Broadway. They have many agents throughout the country. Messrs. Walmsley & Co., in Philadelphia, have everything of the kind, and in Boston the Blair Tourograph Company, Tremont street, do a large business in this line. Send for their price-lists, and order from them, as we have known several instances when beginners have failed in their work by using the wrong chemicals, which were purchased at drug stores.

Formula 1. Ferrous Oxalate Developer.

A. Neutral Oxalate of Potash, Saturated Solution. When dissolved, add concentrated solution of oxalic acid until a piece of blue litmus paper in the solution turns red. Let sediment settle, and pour off the clear liquid.

B. Ferrous Sulphate (Copperas), Saturated Solution.

To each ounce of the solution add about one drop of ordinary sulphuric acid. Keep in a well corked bottle.

For use, pour 1 part of B slowly into 16 parts of A. The mixed developer is of a fine red color, and should be perfectly clear. The proportions given are for fine, soft negatives. Most writers advise 1 to 8, some go as far as 1 to 3. Those who use such strong developers condemn the ferrous oxalate, and say it gives no control over the development. Possibly, the fault is not in the developer. With such proportions we should think not! Any developer will give good pictures if properly used.

Formula 2. Restrainer.

Potassium Bromide, saturated solution in water.

This restrainer can be used with all developers. It is well to keep it in a small-necked bottle with a dropping tube, ready for immediate use.

Formula 3. Dr. Eder's Normal Developer.

A.	Neutral sulphite of soda,	25 grammes.
	Sulphuric acid,	8 drops.
	Pyrogallic acid,	12 grammes.
	Water,	100 c.c.
B.	Neutral sulphite of soda,	25 grammes.
	Carbonate of potash,	90 "
	Water,	200 c.c.

A gramme is equal to about 15.4 grains. $3\frac{1}{2}$ cubic centimetres make a fluid drachm, 28.4 c.c. an ounce.

For use add 1 part of A to 20 of water, and 1 part of B to 20 of water, and mix the solutions in equal parts.

Formula 4. Allen & Rowell's Developer.

A.	Water,	5 ounces.
	Sulphuric acid,	30 drops.
	Ammonium bromide,	60 grains.
	Pyrogallic acid,	$\frac{1}{2}$ ounce.
B.	Water,	4 ounces.
	Crystallized sulphite of soda,	360 grains.
	Potassium bromide,	180 "

	Strong liquor ammonia,	5 drachms.

For use add 1 part of A to 20 of water, and 1 part of B to 20 of water, and mix the solutions in equal parts.

Formula 5. Carbutt's Developer.

A.	Water,	10 ounces.
	Citric acid,	60 grains.
	Crystalized sulphite of soda,	2 ounces.
	Pyrogallic acid,	1 ounce.
	Water to make up to	16 ounces.
B.	Water,	10 ounces.
	Crystalized sulphite of soda,	2 ounces.
	Carbonate of potash,	4 ounces.
	Water to make up to	16 ounces.

Use ¼ to ½ drachm of A and B to each ounce of water to make the developer.

Formula 6. Newton's Developer.

A.	Washing soda,	500 grains.
	Water,	10 ounces.
B.	Oxalic acid,	30 grains.
	Pyrogallic acid,	20 grains.
	Ammonium bromide,	10 grains.
	Water,	10 ounces.

Use equal parts of A and B.

This formula was given before the addition of sulphite of soda to the developer became as universal as it is now. The sulphite can be added to the above without changing the other proportions.

Formula 7. Carbutt's Transparency Developer.

A.	Neutral oxalate potash	8 ounces.
	Water,	32 "
	Citric acid,	60 grains.
	Potassium bromide,	180 "
B.	Ferrous sulphate,	2 ounces.
	Water,	32 "
	Sulphuric acid,	8 drops.

For use mix equal parts, pouring B into A.

This developer is intended to give clear whites, and is probably as good as any for transparencies.

The Eastmann Dry Plate Company have a pyrodeveloper consisting of a single solution, which they sell. It has only to be mixed with the proper proportion of water, when it is ready for use. This is a very convenient developer, especially if one is travelling: the only objection we can see to it is that one can scarcely have as perfect control over the progress of development as when the pyro and alkali are in separate bottles, to be used as required. Still, by changing the strength of the solution one can exercise some control, and probably enough for most cases. This developer also possesses the advantage that it can be used several times, so there is economy of pyro. The developer probably does not materially differ from others except in the large quantity of sulphite it contains.

Formula 8. Alum Solution.

	Alum,	1 ounce.
	Water,	10 ounces.

This solution is used for hardening the gelatin film after development. With ferrous oxalate development it is only required in warm weather. When developing with pyro, about one drachm of oxalic acid should be added to the above, the effect of which is to remove the yellow color, which is often very objectionable.

Formula 9. Fixing Solution.

	Hyposulphite of Soda,	4 ounces.
	Water,	20 ounces.

It is just as well to make a saturated solution of the hyposulphite, and to use it full strength or diluted with a fourth its volume of water. The strength of the solution is not of much consequence, unless, as some persons suppose, a strong solution tends to cause frilling.

[*To be continued.*]

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Provisional Key to Classification of Algæ of Fresh Water.—VIII.

BY THE EDITOR.

[*Continued from p. 53.*]

The reader will observe that a mistake in numbering the families was made on page 51; Conjugatæ should be XI and Bacillariaceæ should be XII. We have now completed the classification of the green algæ, and

will proceed to consider the genera known under the general name of nostocs.

V. ORDER SCHIZOSPOREÆ.

Unicellular or multicellular algæ, in the latter case forming simple or branched series of cells or filaments, which increase only by division. Cell wall soft, not siliceous, usually gelatinous; cell-contents bluish green, blue, red, violet, orange-yellow, usually without a nucleus.

No sexual organs or zoospores.

The two families Nostochaceæ and Chroococcaceæ are only distinguished by the filamentous character of the former and the separated cells of the latter.

FAMILIES.

Unicellular.

CHROOCOCCACEÆ XIII.

Filamentous.

NOSTOCHACEÆ XIV.

Family XIII. CHROOCOCCACEÆ.

Unicellular in the strictest sense; after division the two daughter cells separate from each other. Cells solitary or united by gelatin.

Division in one, two, or three directions. Resting cells (spores) observed in a few instances.

[It will be of interest to compare the plants belonging to this family with some of the Palmellaceæ, which closely correspond in structure, differing mainly in the color of the endochrome. This may be regarded as a very trivial distinction to separate so widely in the scheme of classification plants otherwise so closely related; but the great visible distinction between algæ and fungi is in the color of the cell-contents.]

Synopsis of Genera.

a. DIVISION IN THREE DIRECTIONS.

Cells spherical or angular, single, or in small families. Envelopes not confluent. *Chroococcus*, 92.

Cells spherical, envelopes confluent. *Aphanocapsa*, 93.

Cells in families, the mother cell forming a common envelope enclosing the daughter cells. *Glœocapsa*, 94.

Families united in grape-like masses. *Polycystis*, 95.

Cells closely aggregated in solid, spherical families. *Microcystis*, 96.

Cells in spherical, solid families, the peripheral cells wedge-shape. *Gomphosphæria*, 97.

b. DIVISION AT FIRST IN THREE DIRECTIONS, LATER ONLY IN THE TWO RADIAL TO THE SURFACE OF THE SPHERE.

Cells in an irregularly lobed or latticed gelatinous matrix. *Clathrocystis*, 98.

Cells spherical, on the periphery of a structurless sphere. *Cœlosphærium*, 99.

c. DIVISION ONLY IN TWO DIRECTIONS AT RIGHT ANGLES.

Cells in rectangular, tabular families of 8, 16, 32, etc. *Merismopedia*, 100.

d. DIVISION ONLY IN ONE DIRECTION.

Cells cylindric, single or in series of 2–4. *Synechococcus*, 101.

Cells elliptic, in families enclosed by diffluent membrane of parent cell. *Glaucocystis*, 102.

Cells elongate, in structurless gelatin. *Aphanothece*, 103.

Cells elongate, in lamellose membranes, enclosed in a common gelatinous vesicle. *Glœothece*, 104.

[It will be observed that we have genera named *Aphanocapsa* with spherical cells, *Aphanothece* with cylindric cells, *Glœocapsa* with spherical cells, *Glœothece* with cylindric cells. These distinctions are easily remembered.]

a. DIVISION IN THREE DIRECTIONS.

92. Genus *Chroococcus* Nägeli.

Cells spherical or angular from mutual pressure, single or in small families, in gelatinous thallus, irregularly distributed, not enclosed in the

membrane of the mother cell; membranes not confluent. Mucous envelopes clear or lamellose.

93. Genus *Aphanocapsa* Nägeli.

Cells spherical, with thick, confluent envelopes which form a structurless gelatin.

[Compare *Aphanothece*, genus 103.]

94. Genus *Glœocapsa* Nägeli.

Cells spherical, sometimes before division elongated, with thick vesicular membranes, single or in families, the membrane of the mother cell enclosing the daughter cells. Cell contents bluish-green, or red.

Resting cells of the form and size of the vegetative cells, with thick, rough epispore observed in some species.

[See *Glœocystis*, genus 8.]

95. Genus *Polycystis* Kützing.

Cells spherical, united in spherical families which remain united in grape-like masses.

96. Genus *Microcystis* Kützing (extended).

Cells spherical, very many united in solid, spherical families, cells closely aggregated, enclosed in a thin, common envelope.

97. Genus *Gomphosphæria* Kützing.

Cells united by gelatin in spherical, solid families, the inner cells spherical, the outer ones wedge-shaped with the points directed toward the centre of the sphere.

b. Division at first in three distinctions, later in two.

98. Genus *Clathrocystis* Henfrey.

Cells spherical, arranged on the outer surface of hollow balls or sacs, which are afterwards ruptured in places and form latticed or irregularly lobed gelatinous expansions. The cells multiply by division in the gelatinous matrix, and the latter increases in extent.

99. Genus *Cœlosphærium* Nägeli.

Cells spherical, arranged in single layer at the periphery of a structurless, gelatinous sphere. Occasionally the cells appear to be associated in families, but usually the membranes are confluent, and the traces of division entirely lost.

c. Division only in two directions.

100. Genus *Merismopedia* Meyen.

Cells spherical or oblong, connected in a single layer in flat, rectangular families of 4–8–16, etc., by their confluent membranes, in which the cells are arranged in straight, longitudinal and cross lines.

d. Division only in one direction.

101. Genus *Synechococcus* Nägeli.

Cells elongate or cylindric, with thin membranes, single or in series of 2–4.

102. Genus *Glaucocystis* Itzigsohn.

Cells oblong or elliptic, with thin, not gelatinous membranes, in small families enclosed by the expanded and diffluent membrane of the mother cell.

103. Genus *Aphanothece* Nägeli.

Cells elongate, with thick, confluent membranes, forming a structurless gelatin.

[Compare *Aphanocapsa*, genus 93].

104. Genus *Glœothece* Nägeli.

Cells elongate or cylindric, with thick, vesicular membranes, single or in spherical or elongated microscopic colonies enclosed in a single vesicle, with smaller vesicles within surrounding the individual cells. Vesicles lamellose.

[Compare *Glœocapsa*, genus 94, from which this genus differs mainly in the mode of growth due to division in only one direction].

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Staining Tissues in Microscopy.—X.

BY PROF. HANS GIERKE.

[*Continued from p. 54.*]

229. Gibbes. On the double and treble staining of animal tissues. Journ. Royal Micr. Soc., iii, 390–393.

After staining with picrocarmine,

the sections are put in acidulated water, (acetic or picric acid), then in hæmatoxylin solution. This method is very successful for cell division and the development of epithelium and spermatozoa.

Carmine indigo-carmine is also recommended. Take of carmine 2 pts., borax 8, water 30. Soak in this for a few minutes, then in acid alcohol (1–20). If they become a rose red, wash in methyl-alcohol, and treat with indigo-carmine till blue. A saturated solution of indigo-carmine is poured into methyl-alcohol till a deep blue results, and is then filtered. Picrocarmine is also combined with other anilin colors, by treating first with picrocarmine, then with the anilin.

230. Stirling. On double and treble staining of microscopic specimens. Journ. Anat. a Phys., xv, 349–354.

Picrocarmine is recommended for blood corpuscles and epithelium after treatment with osmic acid.

Picric acid may be used for hardening, and afterwards picrocarmine for staining. This method succeeds well with blood corpuscles, elastic tissue, and cartilage which color yellow, while the connective tissue becomes red. Fœtal bones decalcified in picric acid, and bone corpuscles, color red, but the harder parts yellow. In the large arteries, connective tissue becomes red, elastic tissue yellow, unstriped muscle fibres yellow brown. The combination of hæmatoxylin and picrocarmine is recommended for skin, unstriped muscles, and the development of bone, and finally picrocarmine gives excellent results in combination with anilins, as iodine green.

231. Weigert. Zur Technik der mikroskopischen Bacterienuntersuchung. Arch. path. Anat. a Phys., lxxxiv, 275–315.

Four grams ammonia are poured on two grams carmine and protected from dust 24 hours, then 200 g. conc. sol. picric acid is added, and after 24 hours more a little acetic acid till a precipitate appears. At intervals of 24 hours, ammonia is added by drops till the solution is clear. If the stain is too red, add a little ammonia, if too yellow, a little acetic acid.

232. Richardson. Multiple staining of animal tissues with picrocarmine, iodine, and malachite green dyes, and of vegetable tissues with atlas scarlet, soluble blue, etc. Journ. R. Micr. Soc., i, 868–872.

(See No. 228 for an earlier mixture). Three solutions are described for animal tissues:—(a), picrocarmine with a thin transparent solution of equal parts of iodine and malachite greens; (b), the same with malachite green in excess; (c), picrocarmine and malachite green alone.

233. Hoyer. The carmine described in No. 30 is dissolved in a neutral concentrated solution of ammonium picrate.

234. Bonnet. Zur mikroskopischen Technik. Dtsch Zeitsch f. Thiermed, vii, 301–303.

HÆMATOXYLIN AND METALLIC SALTS, ETC.

235. Gerlach. Structur der gefässbäute Sitzber. d. plays. med. Soc. Erlangen, 1872.

Transverse sections of dried vessels are laid in a weak solution of hæmatoxylin to which a little alum has been added, and when they are blue enough they are transferred for a few minutes to pure acetic acid, and then for the same time to dilute picric acid. They are then washed and mounted in balsam or glycerin. Unstriped fibres and nuclei become violet, connective tissue reddish brown, and elastic fibres straw yellow.

236. Eberth. Experimentelle Untersuchungen uber der Entzündung der Hornhaut. Unters d. pathol. Inst. Zürich, ii, (1874), 1–58.

The normal or inflamed cornea is to be treated by a combination of silver and hæmatoxylin. First a ½–1% sol. silver nitrate, then wash and expose 1–3 hours to the action of hæmatoxylin.

237. Toole. A double staining with Hæmatoxylin and Anilin. Quart. Journ. Micr. Sci., 1875, p. 375.

Brain sections are placed for 24 hours in hæmatoxylin washed in alcohol and water, then for ½–¾ minute in anilin blue. After a second washing in alcohol, mount in balsam and the nuclei and cell substance will be differentiated.

238. Bevan Lewis. See No. 94. Brain sections are put first in hæmatoxylin, then in anilin black. (Sankey's anilin blue black, No. 93.)

[*To be continued.*]

NOTES.

— Dr. George A. Piersol has favored us with a photograph of *Bacillus tuberculosis* magnified 1,000 diameters, in which the bacillus is shown as clear and distinct as when viewed with the microscope. It is far superior to anything of the kind we have hitherto seen, but it is a result we have been anticipating for some time. In the present state of photography it may be confidently asserted that whatever can be seen can also be photographed, although it may sometimes require rather more knowledge and skill than is possessed by the ordinary operator. Dr. Piersol will in due time describe his method of working in these columns, and the article may be expected at an early day. It will certainly prove of interest to many workers in this field.

— Mr. Richard Jackson, of Leeds, England, announces the proposed publication of a monograph on The Desmideæ, by W. Barwell Turner, F.R.S., F.R.M.S., etc., to be published in about twelve quarterly parts, of 60–80 pages, with 15–20 plates each, at 10*s.* 6*d.* per part. The publication is made conditional upon receiving a sufficient amount of subscribers before October next.

— Dr. A. C. Stokes has prepared for his own use a key to Mr. Wolle's Desmids of the United States, which he has found so useful that he has decided to send it to us for publication in the Journal. We shall probably have the manuscript in time for our next issue, and it will be published as soon as possible. We doubt not it will be of great assistance to the finders of desmids.

MICROSCOPICAL SOCIETIES.

Washington, D. C.

Forty-second Regular Meeting.

Mr. F. A. Chapman exhibited a light-interruptor, a mechanism devised to produce an intermittent light for viewing rapidly vibrating cilia. The intermission of the light is produced by the rapid rotation of a diaphragm-plate just beneath the stage, by means of a small dynamo-electric motor. The construction of this design was suggested by a paper by Dr. Geo. Hopkins in the *Scientific American*.

Mr. Chapman also exhibited a 2-inch objective of 20° angular aperture, by Bausch & Lomb, which was remarkable for the flatness of its field. Dr. Howland spoke of an Oberhauser lens some forty years old, which he had found to be of the highest excellence for photographic work.

Prof. Seaman, for the purpose of showing the permanency of such mounts, exhibited specimens of uric acid which had been mounted in benzole balsam for several years without change. He also spoke highly of such mounts in copavia balsam.

Forty-third Regular Meeting.

Mr. R. Hitchcock laid before the Society a letter which he had received from Mr. Kruttschnitt, of New Orleans, transmitting two slides of a vegetable substance brought up from an artesian well at a depth of from nine hundred to one thousand feet. The specimens were mounted in chloroform camphor water. Mr. Knowlton took the slides for examination and report. Mr. Hitchcock also showed the following specimens gathered from a pond near the Great Falls of the Potomac: *Spirogyra calospora* in fruit; *Closterium acerosum* with zygospores; *Zygnema insignis* in fruit, and *Spirogyra quinina* in fruit.

He then described the different methods of conjugation and spore formation of the conjugatæ, and gave an outline of Wittrock's classification.

Prof. Edward Burgess showed several water fleas having upon their carapaces masses of *Oscillaria*, and also colonies of rotifers upon their upper and under surfaces.

E. A. Balloch, *Rec. Secr.*

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San Francisco, Cal.

Meeting held April 14th.

Dr. Henry Ferrer showed several slides containing the living, actively moving germs of typhoid fever. He prefaced the exhibition by giving a shore *résumé* of what is known regarding these interesting organisms. Many attempts have been made for a number of years past to detect, in the tissues of typhoid fever patients, some micro-organisms to whose presence could be ascribed the cause of the disease, but it was not until 1880 that Eberth of Halle succeeded in attaining a measurable degree of success in this direction. He found in the spleen, and infiltrated lymphatic glands of typhoid fever patients, a short thick bacillus with rounded ends. Koch had previously found the same organism *in situ* in the tissues, and had obtained photographs thereof, but had not published his discovery. Eberth at first supposed that the bacillus of typhoid could not be stained, or only with great difficulty, but Koch, while corroborating many of Eberth's researches, pointed out various methods by which the staining could be effected, notably with Bismarck brown and with vesuvin. The Koch-Eberth bacillus, as it is now commonly called, forms endogenous spores at a temperature of 30° to 40° centigrade, and these spores do not take the stain in which the bacillus may be immersed. A noteworthy fact in connection with these bacilli is the formation of long threads, which were erroneously considered to be distinct organisms by some of the earlier observers, until Koch showed them to be secondary forms of the typhoid bacillus. Treatment with acetic acid distinctly reveals segments in the threads, and at these points the living organisms eventually break up into individual bacilli. Probably the most distinctive characteristic of the typhoid bacilli is the method of growth in gelatin and other similar media. When a tube containing sterilized peptone gelatin is inoculated with a pure culture of the organism in question, the latter does not liquefy the culture medium, neither do its growing colonies form around the puncture made by the inoculating needle, but they grow entirely at the surface of the gelatin, forming a dense grayish white layer there.

Dr. Ferrer's remarks were illustrated by blackboard diagrams, and in conclusion he showed the living bacilli, in various stages of growth under, two fine 'Zeiss' microscopes, using that maker's 'F' objectives.

Mr. Wickson exhibited a slide of *Trichina spiralis*, sent him by Dr. W. S. Taylor, of Livermore, from a fatal case of trichinosis which occurred in that town last week.

The paper of the evening was read by H. G. Hanks, his subject being 'The So-called Inyo Marble, and California Building Stones in General.'

A. H. Breckenfeld, *Rec. Secr.*

NOTICES OF BOOKS.

Biological Teaching in Colleges. By William G. Farlow, Professor of Cryptogamic Botany, Harvard University. (8vo pamphlet, pp. 10).

An interesting article, particularly to those who are giving attention to the methods of education and their results; reprinted from *The Popular Science Monthly*.

How to Photograph Microscopic Objects. A Manual for the Practical Microscopist. By J. H. Jennings. New York: E. & H. T. Anthony & Co., publishers. (8vo., pp. 32.)

This is a concisely-written brochure, eminently practical, and a reliable guide for the amateur in this work. The publishers, however, need not have gone to England for a competent author of such a work, and a book especially written for American microscopists would undoubtedly have more reference to American apparatus than this one has; indeed we have not met with a single reference to an American microscope or accessory in it. However, this is the only small work we can now call to mind treating particularly of this subject, and as the information and instruction it gives are good and practical, we are glad to commend it to beginners in photo-micrography.

On Koch's Methods of Studying the Bacteria, with Special Reference to the Bacteria causing Asiatic Cholera. By T. Mitchell Prudden, M. D. (Pamphlet, pp. 18).

From the Report of the Connecticut State Board of Health for 1885.

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A Résumé of the Algo-Lichen Hypothesis.*

BY F. H. KNOWLTON, B. S.

In the light of modern science it is hardly necessary to say that one of the most interesting biological problems of the day, in so far at least as relates to vegetable morphology and physiology, is connected with the theory usually known under this name, or, as it might more correctly be called, the Algo-Fungal-Lichen Hypothesis. To prove this we have but to turn to the now extensive literature of the subject or glance for a moment at the extended discussions to which it has given rise.

The object of the present paper is to bring before the Society the results of some recent European investigations, particularly those of Rev. James M. Crombie (*Jour. Linn. Soc.*, xxx., pp. 259–283), and to sum up briefly the principal arguments used in defence of the autonomy of the plants called lichens.

I will first give, very briefly, the history of this hypothesis, and the causes which lead to its adoption by so many of the Continental investigators.

If we cut a thin, transverse section through the thallus of a lichen, and examine it under a moderately high power of the microscope, we shall find it to be readily distinguishable into several parts or layers; an upper and under cortical layer of long, slender, and closely interlacing cells, the *hyphæ*, and a central layer, or irregular chain, of larger green cells, the *gonidia*. Now, the problem to be solved is, What is the origin of the gonidia, and in what relation do they stand to the thallus? If it can be shown that they have their origin outside of the organism, and are subsequently entrapped, then parasitism has proved its case: but if, on the other hand, it can be proved that they have their origin in the hyphal layer, and are self-developed organs of the thallus, then, of course, this hypothesis must go to the wall.

As might be supposed, in pre-microscopical days nothing was either known or written on the subject, for, as a matter of fact, the gonidia were not discovered until 1825, when they were made out by Wallroth. In Koerber's dissertation, De Gonidiis Lichenum, published four years later (1839), they were treated more fully than in any previous work, but nothing authentic was adduced as to their genesis. Bayerhoffer seems to have been the first to give any explanation of the matter, and in 1851 he stated that the 'threads of the fibrous stratum swell up at the top, which swellings afterward become the male gonidia.' This was confirmed, with slight modification, by Speerschneider in 1853, by Schwendener in 1859, as also by De Bary in 1865.

This view of the genesis of the gonidia from the hyphæ was for some time the accepted explanation, but in 1868 Prof. Schwendener, reviewing the original notion on this subject, towards the end of a paper entitled Unterschungen über den

*Read before the Washington Microscopical Society May 11th, 1886.

Flechten-thallus, and more particularly in a subsequent article, Die Algen-typen der Flechten Gonidia, rightly affirms that the actual development of a gonidium from the terminal cell of a hypha had not, with certainty, been observed, but only assumed by authors. Accordingly, he proposed an entirely new theory on the subject, which has since attained a wide notoriety as the Schwendenerian hypothesis. This, stated in his own words, is as follows: 'As the result of my researches, all these growths are not simple plants, not individuals in the usual sense of the term; they are rather colonies, which consist of hundreds and thousands of individuals, of which, however, only one acts as master, while the others, in perpetual captivity, provide nourishment for themselves and their master. This master is a fungus of the order Ascomycetes, a parasite which is accustomed to live on the work of others. Its slaves are green algals, which it has sought out, or, indeed, caught hold of, and forced into its service. It surrounds them, as a spider does its prey, with a fibrous net of narrow meshes, which is gradually converted into an impenetrable covering, while, however, the spider sucks its prey, and leaves it lying dead the fungus incites the algæ taken in its web to more rapid activity, nay, to more vigorous growth.'

The gonidia then are unicellular or filamentose algæ, and the thallus is a parasitic fungus. Following out this idea Schwendener divided the various algal types, which he regarded as constituting the gonidia, into two groups, viz:—the Phycochromaceæ and the Chlorophyllaceæ according to the color of their respective cell-contents. To the former group, that with bluish-green cells, he assigned five algal types:—1. Sirosiphoneæ; 2. Rivularieæ; 3. Scytonemeæ; 4. Nostochaceæ; 5. Chroococcaceæ; and to the latter group three algal types: 6. Confervaceæ; 7. Chroolepideæ; 8. Palmellaceæ.

As might be expected, such a radical change as this from preconceived notions, gave immediate rise to extensive discussion and criticism, and Schwendener was called upon to defend his theory. This he did in dissertations published in 1872 and 1873, without, however, adducing any absolutely new arguments.

Among the many supporters which this hypothesis secured, perhaps the ablest was Dr. E. Bornet, of France. Adopting the two algal types of Schwendener, he passed in review an extensive series of lichens and traced out in them the resemblance between their gonidia and many well-known species of algæ. Of these algæ he concluded that a comparatively small number of species furnish the gonidia for a great many different species, and even genera of lichens. The union between the hyphæ and these algæ he admitted to be difficult of demonstration, yet he was able to detect it in several instances in some of the higher lichens.

As the result of this investigation he considered himself safe in laying down the following propositions:—'1. Every gonidium of a lichen may be referred to a species of algæ. 2. The connection of the hyphæ with the gonidia is of such a nature as to exclude all possibility of the one organ being produced by the other, and the theory of parasitism alone can explain it satisfactorily.'

Without dwelling further upon these theoretical views, we may turn to a phase of the question which would seemingly present itself to every one, that of experimental demonstration. If a lichen is a dual organism, then, by sowing certain lichen spores in the vicinity of certain algals, and imitating as nearly as possible the conditions of nature, we ought to be able to observe the process of union. We ought to see this ascomycetous fungus grasp in its relentless web some unfortunate algal

compelling it to pay tribute. Indeed Schwendener himself was frank enough to admit that we could not settle this question by isolated, one-sided observations, but only by carefully conducted experiments in the culture of lichen-spores, lichen-gonidia, and unicellular algæ. Accordingly many experiments in lichen culture have been conducted since the promulgation of the Schwendenerian hypothesis, but in no instance have they been satisfactory. In the first place it was found exceedingly difficult to imitate the conditions of nature closely enough to allow more than the first stages of growth to progress. While the spores germinated freely, they could not be carried beyond a certain loosely cellular stage which never exhibited the slightest traces of gonidia nor produced perfect lichens.

Another method of culture called Synthesis has been attempted; that is, the manufacture of lichens by sowing their spores upon certain algæ. Thus, Rees sowed spores of *Collema glaucescens* upon *Nostoc licenoides*. Bornet sowed the spores of *Physcia parietina* upon *Protococcus viridis*, and Treub sowed spores of *Ramalina* and *Lanacora* upon *Cystococcus humicola*. These experiments, however, met with a very limited amount of success, even where the spores germinated and produced hyphæ enveloping the algæ. The process of union was easily accomplished, but instead of stimulating the algæ to greater activity, or producing new lichen plants, the contact resulted in the death of the algæ, so that instead of there being any bond of sympathy between them there exists a mortal antagonism.

'But,' says Mr. Crombie, 'apart altogether from such considerations relating to lichen-culture, there are two fatal objections to the hypothesis, either of which is quite sufficient for its subversion. The first of these has reference to the very peculiar nature of the parasitism involved in the theory that the fungal hyphæ are nourished by the captive algals.' Parasitism of itself is of very common occurrence in the vegetable kingdom, but instead of stimulating the host to greater activity, the contact is always detrimental, and, if the parasite be in sufficient force, is ultimately fatal. But in the present case we have a parasite exceeding by many hundred times the size of the host, and yet, instead of exhausting, it only stimulates it to greater activity, a phenomenon which certainly occurs nowhere else in nature.

But, granting that this hypothesis be true, 'Upon what,' Dr. Bentham pertinently asks, 'do the gonidia themselves feed?' This is a very important point in the physiology of lichens, which Schwendenerism does not satisfactorily explain. Shut up in a dark and narrow prison, and deprived of the free life they formerly led by the tyrant who has enclosed them in his meshes, they are cut off from all communication with the outer world, from which they could receive such nourishment as they themselves require and the much larger quantity their master extracts from them. 'Whence, then, and how is this nourishment obtained?' Now, it is a well-established fact, and one that no person attempts to deny, that lichens obtain their whole nourishment from water. It was formerly supposed that they obtained a portion of their nourishment through the rhizoides, from the substratum upon which they grow, but this idea is now not accepted, the rootlets merely serving to retain them in position.

Water, then, is the chief source of their nourishment. This is poured upon their surface and penetrates the cortical layer to the vicinity of the gonidia, which are the seat of special vegetative activity. But the gonidia are principally stimulating in their effect, the real organs of nutrition being the cortical layers. From this it seems that neither the captive algæ

nor the tyrant masters play anything like the part assigned them by the adherents of this theory.

The second objection pointed out by Mr. Crombie is to the effect that there 'are neither fungal-mycelia nor algal-colonies in the structure of lichens,' for if there were, as he very clearly shows, we should expect to find them in similar localities; but, as every one very well knows, quite the reverse is true.

No one, for instance, would think of searching for algæ upon the bare and exposed surface of a mountain-top, where lichens are in abundance; nor, *vice versa*, would we expect to find lichens where algæ are in profusion.

But, notwithstanding a certain superficial resemblance between the hyphæ of lichens and of fungi, their structure and character are entirely different.

'The hyphæ of lichens are perennial, firm, with thick walls, penetrated by lichenin, imputrible, and not dissolved by hydrate of potash. On the other hand, the hyphoid-mycelia of fungi are caducous, very soft, with thin walls, not at all amylaceous, readily putrifying on maceration, and, on the application of hydrate of potash, immediately becoming dissolved.' It is shown by this that there are irreconcilable physiological differences which should seem to preclude the dual nature of these organisms. But, beyond these, there is another very important point made by the opponents of the Schwendenerian hypothesis, viz., that if the gonidia are algæ, we should expect to find them all in the free state; but this is by no means true, the gonidia, for instance, of *Nætrocymbe*, *Phylliscum*, *Malanornis*, and others, have not yet been found elsewhere than in the lichen-thallus. But all this array of facts, important as it is in its bearing on the case, leaves us still in doubt as to the real nature of these organisms. The question is merely shifted from one horn of the dilemma to the other, for, as was stated in the beginning of this paper, unless we can demonstrate that the gonidia have their origin in the lichen-thallus, we might as well accept one theory as another. The proof, however, of their thalline origin, Mr. Crombie seems to have adduced.

As was before stated, the artificial cultivation of lichen-spores can rarely be carried beyond a certain loosely cellular state, when, the exact conditions of nature failing to be represented, the cultures are destroyed. But, fortunately, by carefully examining the plants in a state of nature, we are able to find them in all conditions from the freshly germinating spore to the mature plant. This is particularly the case with those species growing upon dry rocks, where there is no substratum to mingle with and obscure them.

Mr. Crombie uses the following language in description of the evolution of the gonidia: 'On germination, as may easily be seen in spore culture, the spore sends forth from the endosperm a germinating filament or filaments called the prothallus. This speedily passes into the hypothallus. The hyphæ thus produced contain lichenin from the very first, and in other respects present the distinctive characters already mentioned.' Now is the time, according to Schwendenerism, when we might expect to find the hyphæ going out in quest of algæ, which they might lay hold of and imprison in their meshes. As a matter of fact, however, we never do, for the hyphæ grow straight forward, never turning to the right or left in quest of the algæ, nor would they find them if they did, for not a vestage of an alga can be discovered in such a habitat. Yet in a slightly more advanced stage the gonidia are found in the thallus in abundance. Whence and how came they? Says Mr. Crombie: 'On a further inspection of the specimens you will readily perceive upon

the surface of the hypothalline stratum the presence of a number of small, variously colored glomerules, with which it is more or less sprinkled. These are formed at an early stage of the evolution of the hypothallus, at or towards its centre, and in immediate proximity to where the spore first germinated. On anatomical dissection, it is found that these glomerules consist of minute cellulose granules, in the cellules of which are to be seen the gonidia in various stages of evolution. From the fact of their thus occurring in the growing condition, and the impossibility of their entering from without through the closed walls of the cellules, it is evident that the gonidia originate in the glomerules themselves, and are thus, consequently, self-developed organs of the lichen.

'The glomerules gradually become more numerous and contiguous as the process of development goes on, until at length a continuous cortical stratum is formed upon the hypothallus.' This element is the third added to the structure of the thallus, yet it has been either ignored or misinterpreted by the adherents of the algo-fungal hypothesis. The intercellular origin of the gonidia is thus made plain, but it will be inquired how does it happen that in the mature plant the gonidia occupy the centre of the thallus in a seemingly free state? It, however, admits of a ready explanation. 'The cortical stratum,' as observed by Nylander, 'gradually increasing and expanding, is at the same time, in like proportion, dissolved (or resorbed, as it is termed in physiology), beneath, and the gonidia consequently become free.' The gonidia are thus seen to occupy a position between the two cortical strata, and to have been formed after or contemporaneously with them.

Another and important point claimed by Schwendener and his adherents must be explained, viz:—The contact said to have been observed between the gonidia and the hyphæ. This contact, says Crombie, is in no way genetic or parasitic, nor does it argue any kind of 'copulation,' as has been claimed. The gonidia are neither adnate to nor penetrated by the hyphæ, but only adherent to them by the lichenin, with which all parts of the thallus are penetrated. In all such cases the apparent union is simply an amylaceous adherence, and the fancied penetration the result of erroneous observation.

From these considerations, and others of minor importance might readily be added, it seems that we shall still have our lichens left, for in spite of the many and labored arguments which have been advanced to deprive them of their autonomy, they still remain a distinct class, recognized by botanists, between the algæ on one hand and the fungi on the other. The line of demarcation which separates them from these orders is no doubt indistinct, but it is not less so than that separating many other orders of plants or animals, and moreover nature's lines are never rigid. Many debatable organisms, for instance, on the border-line between the animal and vegetable kingdoms have been alternately captured and recaptured by botanists and zoölogists, but with increasing knowledge they have now been relegated to one or the other to the satisfaction of all. So with increase of understanding we may hope sometime to be able to explain, in the vegetable kingdom, phenomena which now require an element of mystery for their interpretation.

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On the Collection and Method of Studying Foraminifera.*

BY J. M. FLINT, SURG. U. S. N.

I have taken occasion to bring before the society for the inspection of those who may be interested either biologically, geologically, or æstheti-

*Read before the Biological Society of Washington Dec. 12, 1885.

cally, some specimens of the foraminifera collected by the Fish Commission steamer 'Albatross' during the last 18 months, and selected, prepared, and mounted on board during the cruise.

The specimens before you are the beginning of what is intended to be a type series of this interesting group of animals. It already includes representatives of all the orders except Gromidæ, which are principally fresh-water forms, and about half the genera mentioned by Brady in his Challenger Report, and numbers 125 species. The collections were all made on our Atlantic coast, and with the exception of a very few—not more than half-a-dozen species—were taken off the coast between Cape Hatteras and Martha's Vineyard.

Great quantities of this material are obtained by the Albatross, and its separation and preservation have been greatly facilitated by the devices of Mr. Benedict, the resident naturalist of the ship. The material is brought up from the bottom by means of what is known in the vernacular as the 'mud-bag,' a canvas bag about 2½ feet long by 18 inches wide, the mouth held open by an iron frame. This bag is attached to the free end of the net of the beam-trawl, and it rarely fails to scoop its full of mud as it is dragged over the bottom. Being brought to the surface the mud is dumped into the table-sieve, the hose turned upon it, breaking up the lumps and carrying all but the coarsest particles through the sieve, where it falls into a tub below. This tub has several holes at different heights at the side; these holes are stopped with spouts and over the spouts are fastened strainers made of fine linen 'scrim.' The heavier foraminifera fall at once to the bottom of the tub, the impalpable mud and the lighter foraminifera flow out through the openings of the tub, where the latter are stopped by the strainers. The material thus obtained is a comparatively clean mixture of sand and foraminifera, the proportions of each depending upon the nature of the bottom. Before being ready for examination this material requires a further thorough washing by decantation. It must then be washed with fresh water to prevent the formation of crystals of salt, and thoroughly dried.

The individual shells are picked out under a dissecting microscope by means of a fine camel's-hair pencil, moistened between the lips.

I may be excused for calling your attention to the method of mounting, since it is the only thing connected with the subject for which I can claim any originality. It was soon found that for the purpose of thorough study for identification of specimens the usual method of permanent mounting was extremely unsatisfactory. For the examination of objects of this character under the microscope nothing can equal what is known as Beck's disks and holder. By means of this accessory an object may readily be rotated in the field of view of the microscope so that all sides of it may be examined except that actually adherent to the disk. These disks are made of brass, with a short stem for insertion in the arm of the holder. By means of a fine chain concealed within the arm and passing around the axle of the milled head, rotation around a perpendicular axis is obtained; and the whole arm being permitted to revolve in its support, rotation around a horizontal axis is also secured. By a combination of these movements the object may be placed in any desired position without losing it from the field of view. The great advantages attending the use of this appliance led to the mounting of the whole series upon disks, any one of which may be placed in the holder and thoroughly examined. The specimen being secured to the disk, the latter is inserted into a wooden slide of the usual dimensions, and may be arranged in a cabinet in the ordinary way. For the

protection of these frail shells from dust and accident a cover is necessary, and it must be removable in order to get access to the specimen when it is desired to transfer it. This cover is supplied by curtain-rings, cemented one upon the other and capped with thin glass, and it is secured by small tacks driven just far enough apart and just deep enough so that the heads will catch in the groove between the rings. The cover is thus easily removed and replaced. For exhibition purposes, and for permanent preservation and reference as well, cardboard disks have been prepared. The specimens are planted in succession, as near the circumference as possible, and the covers fitted as on the single slides.* This cardboard disk is designed to rotate on a pivot supported by the upper stage plate of the microscope, and by means of this rotation each object in the series may be brought, in succession, into the field. The dropping of a light spring into a notch on the edge of the disk indicates to the observer when the object is in proper position. The mechanical stage movements give control of the object as if it were on an ordinary slide. In the collection before you, one disk has been devoted to each family. From each of these have been selected the specimens on the disk under the microscope, to which your attention is specially directed. Whenever necessary to identification or to elucidation of structure, sections of the shells have been made, and the sections mounted on the same slide with the entire specimens. Some few very thin or delicate specimens have been mounted in balsam, as it brings out more distinctly the peculiarities of structure. These are placed on the disks for examination by reflected light; they may be removed and placed on a glass slip and viewed by transmitted light, if desired.

It may not be altogether amiss, even in a society of biologists, to recall a few facts regarding this group of animals, apologizing to those who have made the subject a study for the trite remarks.

The foraminifera comprise a group of animals belonging to the sub-kingdom Protozoa, Class Rhizopoda. They stand nearly at the foot of the list in the classification of animal organisms by reason of the extreme simplicity of their structure, which consists of a minute bit of protoplasmic substance without differentiation of endosarc and ectosarc, without contractile vesicles, and until recently believed to be without even a nucleus. Like the other rhizopods they possess the power of thrusting out portions of the body substance or pseudopodia, which, when retracted, lose themselves again in the body mass. The character of these pseudopodia has led Prof. Carpenter to divide the rhizopoda into three classes: 1. Lobosa, of which *Amœba* is the type, the pseudopodia of which are blunt or irregularly club-shaped, and show no disposition to unite with one another when they come into contact; 2. Reticulosa, to which class belong the foraminifera, whose pseudopodia, projected in fine threads, unite whenever they come into contact, forming a network; and, 3. Radiolaria, of which *Actinophrys* is the type. The pseudopodia in this instance are projected radially and do not unite.

But little is known of the life history of these minute and simple animals. Their ordinary mode of multiplication is undoubtedly by subdivision or fission. But there seems to be some definite limit to the possibilities of that process, and it is probable that some form of conjugation and encysting process will ultimately be discovered. Their mode of nourishment is supposed to be by the absorption of the organic matter in solution in the sea-water, since the pores of the shell are, in most instances, too small (the largest being about $\frac{1}{5000}$ of an inch in diameter) to allow the introduction of any solid

*Rotary Object Carrier, vol. vi, p. 204.

particles of food likely to be within their reach. All species of this group surround themselves with some form of shell or test, and the fact to which they owe their chief importance is their ability to separate carbonate of lime from its solution in the sea-water.

Of their distribution it may be said that with the exception of polar seas it is as wide as that of the waters of the ocean. The sounding-cup never fails to bring them from the bottom, and in some parts of the Atlantic the mud dredged consists of as much as 85 per cent. of foraminifera. Wherever the ocean has rolled in past geological ages since any living thing has existed, they have been. The chalk beds all over the world are composed almost exclusively of their remains. These chalk beds, in this country, cover thousands of square miles, and in some places are 9,000 feet in thickness. They are probably not less extensive in other parts of the globe.

The nummulitic limestones extending in a vast bed on both sides of the Mediterranean, through Northern India and Central Asia, are principally shells of foraminifera and get their name from a genus of large size, very numerous and conspicuous throughout the stratum. The Pyramids of Egypt are built of this stone and rest upon rock of the same structure, in which the fossil foraminifera are easily visible to the naked eye. It is probable that the subcarboniferous limestones have the same origin. In short, the weight of evidence is that the foraminifera have had more to do in forming geological strata than all other animals taken collectively. Moreover, if the conclusions of Profs. Carpenter and Dawson in regard to the *Eozoon Canadense* are accepted, the foraminifera are the oldest in geological time of known fossils. So these minute shells, the product of the simplest of animal organisms, are not so insignificant in the economy of nature as they might at first appear.

Aside from their geological importance and biological interest, they attract attention by the beauty and infinite variety of their forms, and they illustrate better than any other series of animals the endless varieties that may be produced by the slight but persistent modifications of the mode of growth.

In all attempts at classification of such objects as these, external form must necessarily be the governing principle. There are, however, a few prominent distinctions based on physiological differences which should be considered. For instance, a large group of these animals form their tests of grains of sand, spicules of sponge, or the shells of other foraminifera. They repeat in a rude way nearly all the forms taken by the more delicate calcareous shells, but the physiological distinction is of more importance than the external resemblance and properly causes the testaceous foraminifera to be classified apart from the calcareous foraminifera. Another broad distinction is based upon the arrangements for the protrusion of the pseudopodia. In a portion of the group the shell is 'imperforate,' by which is meant that there is only one mouth-opening through which the pseudopodia can be thrust out. In the others the shell is porous, or 'perforate,' studded all over with minute openings, the largest not more than $\frac{1}{500}$ of an inch in diameter, through which portions of the body substance are extended for the absorption of nutriment. These latter generally have a conspicuous mouth-opening also, but this opening is believed to serve simply as an exit for the sarcodic substance in the process of growth. These then constitute the principal divisions based upon physiological differences which can be sustained, viz: into arenaceous and calcareous, and into perforate and imperforate. Other distinctions are based upon external form alone, and it is interesting to consider by what simple modifications the most astonishing results are brought about.

Key to the Desmidieæ.

BY DR. A. C. STOKES.

The following artificial key refers almost exclusively to the forms described in the Rev. Francis Wolle's 'Desmids of the United States.' In the table of genera the figures appended to each name direct to that genus in this list; those after the specific names to the pages of Mr. Wolle's work, where the descriptions and references to the illustrations will be found.

GENERA.

§ Cells united into filaments (*a*).
§ Cells not united into filaments (*g*).
a. In a transparent, jelly-like sheath (*b*).
a. Not in a jelly-like sheath (*d*).
b. Cells with 2 teeth on each narrow end . . . . . *Desmidium*. 6.
b. Cells deeply constricted, almost into two parts (*c*).
b. Cells not deeply constricted, and without teeth . . . *Hyalotheca*, 3.
c. With 'claspers' across the sutures . . . . . *Onychonema*, 9.
c. Without 'claspers;' cells united by a narrow isthmus *Sphærozosma*, 8.
d. Band not twisted; cells with 'claspers' across the sutures, *Onychonema*, 9.
d. " " cells without 'claspers' (*e*).
d. Band twisted; cells triangular or quadrangular . . . *Desmidium*, 6.
e. Cells barrel or hub-shaped, with 1 or 2 median bands *Bambusina*, 4.
e. " " " without bands, the sutures projecting, *Leptozosma*, 5.
e. Cells cylindrical, sometimes swollen at base (*f*).
e. Cells quadrangular, deeply constricted, often slightly twisted, *Phymatodocis*, 7.
f. Ten to 30 times longer than broad . . . . . *Gonatozygon*, 1.
f. Three to 6 times longer than broad . . . . . *Genicularia*, 2.
g. Cell more or less crescentic . . . . . *Closterium*, 13.
g. Cell cylindrical, fusiform, dumb-bell or hour-glass shaped (*i*).
g. Cell flattened; orbicular, oblong, or elliptical (*h*).
h. Mostly orbicular or broadly elliptical; centre deeply constricted, the semi-cells 3–5 lobed, the lobes entire or variously incised, *Micrasterias*, 22.
h. Mostly oblong or elliptical; margins wavy, the depressions rounded; ends usually notched or incised . . . . . *Euastrum*, 21.
i. Cell constricted in the middle; no arms nor spines (*j*).
i. " " " with arms or spines (*l*).
i. Cell not constricted; no arms nor spines (*m*).
j. Cell cylindrical, ends simply notched . . . . . *Tetmemorus*, 18.
j. " " ends rounded, truncate or divided (*k*).
j. Cell more or less dumb-bell—or hour-glass shaped (*p*).
k. Cell 6 to 30 times longer than broad . . . . . *Docidium*, 14.
k. Cell 2–5 times longer than broad; ends rounded . *Calocylindrus*, 16.
l. Arms 2, 3 or more, radiating . . . . . *Staurastrum*, 23
l. Arms none; semi-cells with a central, rounded, truncate or denticulate tubercle; spines usually numerous and marginal, *Xanthidium*, 19.
l. Arms none; no central tubercle; spines 4 or 8, two on each end, }
l. " " " spines 16, four on each end, } *Arthrodesmus*, 20.
m. Chlorophyll in one or more spiral bands . . . . *Spirotænia*, 11.
m. " not in spiral bands (*n*).
n. Surface rough with tooth-like or rounded elevations . *Triploceras*, 15.

n. Surface without tooth-like elevations; ends rounded (*o*).
o. Cells in mucus, short, cylindrical or oval . . . . *Mesotænium*, 10.
o. Cells not or rarely in mucus . . . . . *Penium*, 12.
p. End view 3–6 or more angular (*r*).
p. End view not angular (*s*).
r. Angles obtuse, acute, or with horn-like prolongations, *Staurastrum*, 23.
s. Margins smooth, dentate or crenate; no spines . . . *Cosmarium*, 17.

SPECIES.

1. GONATOZYGON.

1. Cells swollen at base, with 6 longitudinal lines of short setæ, *sex-spiniferum*.*
2. Cells not swollen at base (*a*).
a. With hair-like spines clothing the surface . . . . . *pilosum*, 22.
a. Without hair-like spines; surface minutely roughened . *asperum*, 22.

2. GENICULARIA.*

1. Cells $3\frac{1}{2}$ to 6 times longer than broad; granules in spirals. *Americana*.*
1. Cells 10–12 times longer than broad; granules scattered. *spirotænia*.*

3. HYALOTHECA.

1. Cells slightly constricted, length $\frac{1}{2}$ the width . . . . *dissiliens*, 22.
2. Cells slightly concave, length twice the width . . . . *undulata*, 23.
3. Cells not constricted, margins straight; sheath wide . . . *mucosa*, 23.
3. " " " " sheath absent . . *dubia*, 24.

4. BAMBUSINA.

1. Cells hub-shaped, somewhat longer than broad . . *Brebissonii*, 24.
2. Cells subcylindrical, 4 times longer than broad . . *delicatissima*, 25.

5. LEPTOZOSMA.

An immature form of *Desmidium*. 6.

6. DESMIDIUM.

1. Mucous sheath present . . . . . *cylindricum*, 25.
1. Mucous sheath absent (*a*).
a. Cells united by their entire end margins (*b*).
a. Cells united by the outer portions of the ends (*d*).
b. Cells nearly twice as long as broad . . . . . *longatum*, 26.
b. Cells less than twice as long as broad (*c*).
c. Cells in side view quadrate . *quadratum*, 26; *quadrangulatum*, 27.
c. Cells in side view triangular . . . . . *Swartzii*, 26.
d. Borders crenate or undulate . . . *aptogonium*, 27; *diagonum*, 159.
d. Borders straight, filament twisted . . . . . *Baileyi*, 27.

7. PHYMATODOCIS.

But one species . . . . . *Nordstedtianum*, 28.

8. SPHÆROZOSMA.

1. Cells twice *broader* than long, lobes not constricted (*a*).
1. " " " " lobes constricted near the end, *constrictum*.*
2. Cells twice *longer* than broad, in sheath or not . . . *excavatum*, 29.
2. Cells less than twice longer than broad (*b*).
a. Cells closely approximate, ends rounded . . . . . *pulchrum*, 29.
a. " " " ends truncate, concave . *rectangulare*, 31.
a. Cells more or less remote, ends rounded . . . . *vertebratum*, 30.
b. Ends pointed; semi-cells remote; sinus deep, wide . *moniliforme*.†
b. Ends rounded, spinous; cells slightly constricted . *spinulosum*, 31.

* *Journ. R. Micr. Soc.*, Dec., 1885. † *Bulletin Torrey Botanical Club*, Dec., 1885.

b. Ends rounded, not spinous; cells deeply constricted . *filiforme*, 29.
b. Ends truncate, concave . . . . . *Wallachii*, 31.

9. Onychonema *

1. Cells with spine-like projecting ends . . . . . *serratum*, 30.
2. Cells without spine-like ends. . . . . *Nordstedtianum*.†

10. Mesotænium.

1. Cells cylindrical (*a*).
1. Cells oval or elliptical, about twice longer than wide, in mucus on wet wood . . . . . *micrococcum*, 32.
a. Mucous masses floating; cells 2–2½ times longer than wide, *Braunii*, 31.
a. Mucous masses mingled with filamentous algæ; cells 3–4 times longer than wide . . . . . *Endlicherianum*, 32.
a. Mucous masses on wet rocks and mosses; cells 2–3 times longer than wide . . . . . *clepsydra*, 32.

11. Spirotænia.

1. Spiral band single (*a*).
1. Spiral bands more than one . . . . . *obscura*, 33.
a. Cell 8 to 10 times longer than broad . . . . . *condensata*, 33.
a. Cell 4 times longer than broad. . . . . *bryophila*, 33.

12. Penium.

1. Chlorophyll interrupted by 1 central transverse band (*a*).
1. " " by 3 transverse bands . . *interruptum*, 35.
1. Chlorophyll concentrated into 2 or more nuclei; in mucus, *crassa*, 37.
1. " diffused (*b*).
a. Ends truncate, square . . . . . *truncatum*, 35.
a. Ends not truncate; cells slightly constricted . . . . *minutum*, 35.
a. " " cell not constricted, 3–5 times longer than wide, *digitus*, 34.
a. " " cell not constricted, 5–6 times longer than wide, *closterioides*, 35.
b. Cytiaderm smooth (*c*).
b. " with pearly granules in longitudinal rows, *margaritaceum*, 34.
c. Cells in mucus, diameter $\frac{1}{300}$ to $\frac{1}{400}$ in. (63–83μ) . . *oblongum*, 34.
c. " " diameter $\frac{1}{1250}$ to $\frac{1}{1000}$ in. (20–25μ) . *rupestre*, 37.
c. " " diameter $\frac{1}{1400}$ to $\frac{1}{1560}$ in. (16–17μ) . *Brebissonii*, 36.
d. Cells oblong, often slightly constricted . . . . . *lamellosum*, 34.
d. Cells subcylindrical, in families of various sizes intermingled, *polymorphum*, 36.
d. Cells subcylindrical, not in families . . . . . *Jenneri*, 36.
d. Cells broadly fusiform, 4–5 times longer than wide . . *navicula*, 36.

13. Closterium.

§ Ends not or but slightly produced (1).
§ Ends produced into long, often setiform, beaks (2).
1. Cells straight or slightly curved; ends slightly tapering (*a*).
1. " " " dorsum convex, ventrum nearly straight (*g*).
1. Cells conspicuously curved; ventrum concave, with a central inflation (*i*).
1. Cells conspicuously curved; ventrum without an inflation (*j*).
2. Body margins equally convex; beaks longer than the body, *cetaceum*, 47.
2. Body margins not equally convex (*m*).

* Mr. Wolle joins this to *Sphærozosma*.

† *Journ. R. Micr. Soc.*, Dec., 1885.

a. Length 5–12 times the width (*b*).
a. Length more than 12, less than 20 times the width (*e*).
a. Length 20 times or more than the width (*f*).
b. Ends suddenly contracted; cell fusiform, 5 times longer than wide, smooth, *nasutum*, 41.
b. Ends not contracted, but tapering, acute; chlorophyl bands several, granules in 1 row . . . . . *lanceolatum*, 39.
b. Ends not contracted, rounded (*c*).
b. " " truncate (*d*).
c. Cell slightly curved, small, 6–12 times longer than wide, smooth, *acutum*, 44.
c. " " " 5–10 times longer than wide, smooth *obtusum*, 38.
c. Cell nearly straight, 7–12 times longer than wide, decussately striate, *decussatum*, 39.
d. Cell slightly curved, 6–12 times longer than wide, striate; vacuole distinct . . . . . *didymotocum*, 39.
e. Cytioderm with 4–5 longitudinal striæ, often with 2 or three transverse bands and decussating striæ . . . . . *angustatum*, 40.
e. Cytioderm striate; ends slightly incurved; globules about 20 in each semi-cell, axilary . . . . . *lineatum*, 43.
f. Long (19–24 times longer than wide) ends thin, finely rounded, *strigosum*, 42.
f. Long (20–40 times longer than wide) slightly curved, smooth, or with 1–4 transverse striæ; diameter $\frac{1}{2000}$ to $\frac{1}{3000}$ in. (5–13 μ) *juncidum*, 38; *macilentum*, 38; *gracile*, 39.
f. Long (20–40 times longer than wide) slightly curved, smooth, or with 1–4 transverse striæ; diameter $\frac{1}{6000}$ to $\frac{1}{8000}$ in. (3–4 μ) cell acicular, *subtile*, 158.
g. Ends inclined upward at a dorsal depression; ventrum slightly concave; striæ fine, numerous . . . . . *turgidum*, 41.
g. Ends suddenly contracted to a narrow point; cell slightly curved, *attenuatum*, 41.
g. Ends not suddenly contracted (*h*).
h. Cytioderm deeply striate, distinctly granulate or areolate *areolatum*, 43.
h. " indistinctly striate; cell linear fusiform, 15–24 times longer than wide . . . . . *accrosum*, 41.
h. Cytioderm indistinctly striate; cell semi-lunar, 5–6 times longer than wide . . . . . *Lunula*, 40.
i. Diameter $\frac{1}{2000}$ to $\frac{1}{3000}$ in. (75 to 110 μ); cytioderm smooth, *Ehrenbergii*, 45.
i. Diameter $\frac{1}{4000}$ to $\frac{1}{6250}$ in. (40–60 μ); globules a single row, *moniliferum*, 45; *Leibleinii*, 46.
i. " " " cell curved, rapidly tapering into narrow, somewhat upwardly-curved ends; cell 6–8 times longer than wide . . . . . *Ralfsii*, 46.
j. Cytioderm with many distinct striæ; length 6–16 times the width; vacuole large . . . . . *striolatum*, 42.
j. Cytioderm with fine striæ; length 12–16 times the width; vacuole small, *decorum*, 43.
j. Cytioderm with 5–8 distinct striæ; length 6–8 times the width; vacuole large . . . . . *costatum*, 42.
j. Cytioderm smooth; cell crescent-shaped, often subsemicircular (*k*).
j. " " cell not conspicuously crescent-shaped (*l*).
k. Ends separated 7–10 times the diameter; width $\frac{1}{12000}$ to $\frac{1}{16000}$ in. (16–20 μ), *Dianæ*. 44.

k. Ends separated 7–10 times the diameter; width $\frac{1}{800}$ to $\frac{1}{1000}$ in. (25–28 μ), *acuminatum*, 44.
k. Cell 6 to 8 times longer than wide, ends obtuse; width $\frac{1}{1785}$ in. (14 μ), *Jenneri*, 44.
k. " " " " width $\frac{1}{2000}$ in. (12 μ), *parvulum*, 45.
k. Cell 8 to 12 times longer than wide, nearly semicircular, ends sharp; width $\frac{1}{2500}$ to $\frac{1}{3100}$ in. (8–10 μ) . . . . . *Venus*, 44.
l. Cell stout, ends broadly rounded; width $\frac{1}{800}$ to $\frac{1}{1000}$ in (25–30 μ) *cucumis*, 40.
m. Beaks slender, nearly as long as the body, ends obtuse, curved, *Kuetzingii*, 47.
m. Beaks thin, $\frac{1}{2}$ as long as the fusiform body . . . . . *rostratum*, 46.

14. Docidium.

§ Suture a projecting or conspicuous rim (*a*).
§ Suture not projecting (*d*).
a. Cytioderm hirsute; semi-cell with 3 or 4 undulations . *spinosum*, 51.
a. Cytioderm not hirsute (*b*).
b. End dentate or crenate; semi-cell with 1 basal inflation (*c*).
b. " " " semi-cell with 4 regular inflations, *constrictum*, 50.
b. End truncate or rounded; semi-cell with 1 or 2 basal inflations, *Trabecula*, 48; *truncatum*, 48.
b. " " " semi-cell undulate to the contracted end, *crenulatum*, 47.
c. End with 1 tooth on each angle . . . . . *Flowtowii*, 49.
c. End crenulate with tubercles . . . . . *coronatum*, 49.
d. Cytioderm hirsute; base of semi-cell slightly inflated . *hirsutum*, 51.
d. Cytioderm not hirsute (*e*).
e. End dentate or crenate (*f*).
e. End not dentate nor crenate (*j*).
f. Semi-cell with 4 or more inflations (*h*).
f. " with whorls of quadrangular prominences . *verrucosum*, 52.
f. " with 20 or more constrictions . . . . . *costatum*, 53.
f. " with 1 inflation (*g*).
g. End with numerous pearly teeth or beads . . . *coronulatum*, 49.
g. End with prominent teeth, about 3 in view . . . . *tridentulum*, 52.
h. End with 3–5 minute tubercles; semi-cell with 4 or more undulations, *Floridense*, 159.
h. End with toothed angles (*i*).
i. Semi-cell with 4 prominent nodes; 8 to 10 times longer than wide, *nodosum*, 50.
i. " " 4 constrictions; 10–12 times longer than wide, *breve*, 51.
i. " " 8 constrictions; 20–24 times longer than wide, *sinuosum*, 51.
j. Semi-cell with 1 basal inflation (*k*).
j. " undulate to near the end (*l*).
j. " not or slightly undulate; densely granulate . . *breve*, 158.
k. Cytioderm densely, irregularly punctate . . . . . *clavatum*, 48.
k. " smooth; ends truncately rounded . . . . *Baculum*, 49.
k. " " ends round; cell minute . . . . *minutum*, 52.
l. Diameter $\frac{1}{1000}$ in. (25 μ); about 20 times longer than wide, *repandum*, 50.

l. Diameter $\frac{1}{1500}$ to $\frac{1}{1900}$ in. (13–16 μ) : 15–20 times longer than wide, *dilatatum*, 50.

l. Diameter $\frac{1}{2500}$ to $\frac{1}{2000}$ in. (10–12 μ) : 18–20 times longer than wide. *undulatum*, 51.

15. Triploceras.

(Mr. Wolle unites this with *Docidium*, 14.)

1. Tooth-like prominences oblong . . . . . *verticillatum*, 53.
2. " acute . . . . . *gracile*, 53.

16. Calocylindrus.

§ Chlorophyll homogeneous (1).
§ " divided or scattered in each semi-cell (2).
1. Length twice the width or less : cytioderm punctate or granulate (*a*).
1. " " " " cytioderm smooth (*b*).
1. " " " " cytioderm with 5–7 costæ. *costatus*, 56.
1. Length 2½ or 3 times the width : cytioderm punctate (*c*).
1. " 4 to 6 times the width : cytioderm smooth . . *minutus*, 54.
2. Cell twice or more longer than wide ; cytioderm punctate. *pseudoconnatus*, 55.
2. " " " " cytioderm smooth, *Thwaitsii*, 56.
a. Semi-cell subquadrate . . . . . *Ralfsii*, 54.
a. " cylindrical, rounded : constriction slight . . *cucurbita*, 54.
a. " " constriction wide, shallow . . . *connatus*, 55.
b. Cell somewhat fusiform, ends subconically rounded . . . *curtus*, 54.
b. Cell subcylindrical, ends broadly rounded . . . . *diplospora*, 56.
c. Cell subcylindrical, ends rounded : nuclei large, single or double, *Clevei*, 56.

[*To be continued.*]

EDITORIAL.

Publisher's Notices.—All communications, remittances, exchanges, etc., should be addressed to the Editor, P. O. Box 630, Washington, D. C.

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A pink wrapper indicates that the subscription has expired.

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The regular receipt of the Journal, which is issued on the 15th of each month, will be an acknowledgment of payment.

The first volume, 1880, is entirely out of print. The succeeding volumes will be sent by the publisher for the prices given below, which are net.

Vol. II (1881) complete, $1 50.
Vol. III out of print.
Vol. IV (1883) complete, $1.50.
Vol. V (1884) complete, $1.50.
Vol. V (1884), Nos. 2–12, $1.00.
Vol. VI (1885), $1 00.

American Society of Microscopists.—The ninth annual meeting, to be held at Chautauqua, N. Y., begins August 10th, one week before the meeting of the American Association at Buffalo, and will continue four days. The President, Prof. Burrill, has issued a circular calling for a good attendance and for communications of interest, and expressing sanguine expectations of a large meeting. All necessary information concerning the meeting can be obtained from the Secretary, Prof. D. S. Kellicott, 119 Fourteenth street, Buffalo.

Mr. E. H. Griffith, who has managed the 'working session' so successfully in the past, is again in charge of it, and has also issued a circular of information. Great preparations are under way to make this an important meeting; the Hon. J. D. Cox will have charge of the photomicrographic work: Prof. D. S. Kellicott and Prof. T. B. Stowell, of Cortland, N. Y., will conduct a dredging expedition on the lake, and other able co-laborers are named. Circulars pertaining to the working session can be obtained from Mr. Griffith, whose address is Fairport, N. Y.

Richmond Diatom Deposits.—In a review of W. B. Rogers's Geology of the Virginias published in the *Amer. Journ. Science*, we find the following paragraph relating to the discovery of the infusorial deposit:—

'A second point relates to the history of the first discovery of the famous *infusorial bed*, which crops out conspicuously along the slopes of the hills on which the city of Richmond stands, and at several other places in Virginia, as well as on the Maryland side of the Potomac. Although this interesting feature of our geology has for years commanded the attention and admiration of the scientific world, and the beautiful picture of its diatoms developed by Ehrenberg's microscope, become familiar to the eye of every geologist, we doubt whether many of our younger co-workers know much about the history of its first discovery. We deem it proper, therefore, to say that, after giving a general account of his first discovery and microscopic examination of the contents of this wonderful deposit of what was then regarded as "infusorial animals," Rogers says, "In view of these interesting facts, the discovery of the *infusory Stratum*, as one of the members of our series of Tertiary deposits, cannot fail to be regarded as an important edition to our knowledge of the Tertiary of this country, and has the greater interest at present, as being the first example yet observed in the *United States* of the occurrence of infusorial remains in any but the most recent geological formations." His latest view of the geological position of this formation is, that it is near the base but still within the Miocene group. We are ready, from personal observations, to accept this conclusion.'

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Microscopic Writing.—At a recent meeting of the Microscopic Section of the Literary and Philosophic Society of Manchester, Mr. Alfred Brothers, F. R. A. S., read a note on microscopic writing, in which he said:—'The Lord's Prayer has always been a favorite subject for testing the powers of minute caligraphy. To write the 227 letters within the space covered by the smallest coin is a feat of some difficulty, but that the same number of letters can be engraved on glass within a space so minute as to be almost invisible with the lowest power of the microscope, and the individual letters not defined clearly with an eighth object-glass, may seem incredible. There is, however, in the possession of this Section a slide which contains the Lord's Prayer, written by W. Webb in 1863, within the space of the 405,000th part of an inch. To find this minute speck requires the exercise of much patience, as it is not only necessary to have just the right kind of illumination, but the focus of the lens must be on the true surface of the glass on which the object is written. When once seen with a low power it is not difficult to find with the same power; but with the half-inch and higher powers it is always a trial of patience even when the position of the object has been carefully registered with a lower power, and you are sure that the object is central in the field. Perhaps with the achromatic condenser some of the difficulty may be removed. It will be remembered that about twenty years ago the late Mr. Rideout presented to the Section a machine for producing minute writing. The instrument was lent by Mr. Rideout to Mr. Dancer, by whom it was recently sent to the Society. It seemed to me that as this instrument was purchased by Mr. Rideout at the Great Exhibition in 1862, it might be the same with which the wonderful piece of writing, or perhaps it should be called engraving, referred to, was executed. I therefore wrote to Mr. Dancer for information on this point. In reply he says: "The microscopic writing

on glass of the Lord's Prayer referred to in your letter was at one time in my possession, and was, I believe, presented by me to the Microscopical Section. It was obtained from Mr. Webb, and he was the same person who exhibited the microscopic writing machine at the Great Exhibition of 1862. Mr. Webb died about ten or fifteen years ago, but I cannot give the exact date. I have a very strong impression that Mr. Rideout obtained the machine from him, which was sent by me to the Society. If able to find Mr. Rideout's letter it may confirm this." I have not received the letter, but as what Mr. Dancer says confirms the impression I have of what passed at the time, there can be little doubt that the instrument is the one used to produce the writing referred to. Under the microscope I have arranged two other slides of minute writing which have been lent to me by Mr. Armstrong. These are not very minute when compared with the one first referred to, and which I have placed under the third microscope where you will see the object with an eighth object-glass. Even with this great amplification the words can scarcely be read, but it can be seen that only greater power is required to make the whole legible. It happens that the covering glass is very thick, so that powers higher than the eighth cannot be used. It will be noticed that the name, "W. Webb, 1863," is distinctly legible and very beautifully written. Mr. Armstrong has given me some particulars of Webb's minute writing, from which it appears that he was accustomed to write the Lord's Prayer in spaces of the 500th to the 10,000th of an inch, and, as we have seen, to the 405,000th, and the prices of these slides varied from 2s. 6d. to 70s.'

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Botanical Laboratories.—The 'Laboratory Number' of the *Botanical Gazette*, issued last December, contains many good and interesting articles. It is devoted to a description, with illustrations, of the botanical laboratories of this country and abroad. Prof. J. C. Arthur describes the laboratories in the United States, illustrating his article with artistic representations of laboratories of Harvard, Cornell, the University of Pennsylvania, and Michigan Agricultural College. In this interesting article the reader will find a good account of the equipment and arrangement of these and other laboratories, which certainly afford ample facilities for thorough work in vegetable histology. The author's allusion to some remarks in these columns does not quite touch the point at issue, for we did not refer to the facilities for work but to the work actually done, and surely in this cannot be considered the routine work of undergraduates in college. We trust the opportunities presented by our laboratories will not be neglected by botanists.

In the same journal Mr. J. M. Coulter describes some laboratory appliances, and in another article gives an account of courses of instruction. The laboratory of Strassburg is described. Under General Notes are given some useful suggestions, from which we have selected a few items of interest to microscopists.

Prof. Burrill says good sections of potato showing the starch grains in the cells can be made by cutting out a prism about a quarter or half an inch in diameter and an inch long and drying it slightly on the outside before cutting.

Prof. Trelease describes the usual method of cultivating the common *Mucor* on stale bread under an inverted tumbler.

Mr. Coulter alludes to the cultivation of pollen-spores, recommending those of *Tradescantia*, in which the pollen-tube begins to develop in a few minutes. The culture fluid advised is a saturated solution of cane sugar. Spores should be collected

from flowers that have been open for some time.

Prof. Burrill states that the streaming of protoplasm can be shown in the thin membrane (upper epidermis of leaf-scale) found between the scales of the bulb of the common onion. Cut off a piece of the fresh membrane with scissors, place in a drop of water and examine with a power of four hundred diameters. This observation can be conducted in winter.

——o——

Microscopical Exhibitions.—Some time ago a plan of systematizing the exhibits at the annual exhibitions of microscopical societies was advocated in these columns. The plan seemed to commend itself to some of the members of the Washington Society, who presented the subject at a general meeting, when it was briefly discussed. It was finally decided to give an exhibition of microscopic objects pertaining to marine life, and a committee was appointed to arrange the programme. The exhibition was held on the 13th of April, at the city high school building, and was well attended. The committee found, however, that while the great majority of the members of the Society gave their hearty co-operation to the efforts of the committee to make the display in every way satisfactory and instructive, there were some who failed, for various reasons, to exhibit the objects assigned to them; and while the display of objects was a good one, there were a few breaks in the series.

It is, undoubtedly, true that the efforts of any committee to please all the members of a society are fruitless, for there will always be some disaffected ones. It is impossible to know just what everybody wants, until somebody is assigned to a part that he does not want. Then, when too late to make any changes, the committee learns that such a person will not be present. This is one of the difficulties in arranging a systematic display of this kind. Some persons will not sacrifice personal interests to the wishes of a majority. They seem to think they should be permitted to show what will probably give them most notoriety, or attract most general attention to their work. Not being allowed to do that, they stay away entirely. One or two such instances came to the notice of the committee this year. Had one of the absent members been allowed to make a display of a certain kind, there is not the slightest doubt he would have been there with more than one microscope.

Such a display of objects as the committee arranged, involved much labor and care. Most of the preparations were supplied by the committee, and assigned to the exhibitors; for it would have required more time than any member could spare to apply to every individual in the Society for specimens, which might not even then be of the best quality for the purpose.

We point out these difficulties because whoever attempts to arrange such a display should be prepared to meet them.

Taken as a whole, we are sure the exhibition was a good one this year, and we believe the Society and the visitors were well satisfied with the result. The plan still commends itself to our mind, if hearty co-operation among the members of a society can be secured. The list of objects was printed with short descriptions of each one, according to the plan first adopted by the New York society.

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Postal Club Boxes.—Box P^2 came to hand March 3d.

1. Caterpillar of Brinella beauty moth. F. F. Stanley.
2. Double-stained section of Lappa. W. G. Corthell.
3. Transverse section of *Phallus*. G. H. Meskel.
4. Jute fibres. S. P. Sharples.
5. Eye-piece micrometer. W. A. Rogers. Mounted on a slide to show

the ruling and the method of mounting.

6. Developing tooth of embryo of a pig. R. R. Andrews.

Box Cu reached this circuit March 12th with two very interesting slides:—

1. A transverse section of a mushroom, *Agaricus campestris*.

2. Prothallus of a fern, belonging to the series of Mr. A. C. Cole.

Box B was received March 13th, containing:—

1. Orbitolites. F. M. Hamlin. A very neat mount showing various modifications of orbitolite structure from Bermuda. A good description accompanies the specimen.

2. Endothelium. S. H. Gage. A fine staining with picrocarmine and silver nitrate.

3. Developing tooth from human embryo at four months. A. M. Ross. A good specimen well described.

4. Proboscis of moth. J. D. White. One of Mr. D. Folsom's excellent preparations.

5. Section of frog's lung. C. M. Burgess.

6. Tentacles of jelly-fish. M. S. Wiard. Showing the stinging cells.

This box seems to have passed through this circuit before as we find a note of our own on it dated Oct. 17, 1884.

Box N, containing two of Cole's preparations, was received April 2d.

Box B came to hand April 22d with good preparations.

1. Section of squash seed. A. B. Hervey. The section shows very well the six layers of cells which Mr. Hervey has observed.

2. Spores of cinnamon fern, *Osmunda regalis*. F. A. Hubbard. 'L. B. H.' asks if the names given to the fern are not 'a little mixed,' evidently under the impression that there may be a mistake somewhere.

3. Scale of a salt-water worm, *Sigalion arenicola*. J. M. Crocker.

4. Diatoms. E. Pent. An unpretentious mount, but one of those preparations well known to students of diatoms that will repay going over with a high-power objective.

5. Transverse section of branch of *Populus Candicans*. O. Fernald. A fine specimen of double staining.

6. Diatoms on algæ. W. H. Curtis. Some of these are offered in exchange.

NOTES.

— The third and fourth parts of 'The Rotifera,' by Hudson and Gosse, published by Longmans, Green & Co., London, have been issued. As an indication of the rich field of work that is still open to observers, we note in the Preface that since Dr. Arlidge's edition of Pritchard's Infusoria was published, twenty-five years ago, more than 120 new species have been discovered and are described in this work, nearly all of which have been discovered by the authors. Of these 80 have been added within the last fifteen months. The large plates are beautifully drawn and colored.

— We learn from Messrs. Emmerich & Son that the new $\frac{1}{8}$-inch objectives of Mr. Zeiss, made of the new glass, will be in the market very soon—indeed they are expecting daily to receive a supply. Hereafter Mr. Zeiss will not make any more of the celebrated $\frac{1}{12}$-inch objectives, but will provide another lens to take its place.

— Mr. Wolle, in a communication to the *Bulletin* of the Torrey Club, has mentioned some recent publications relative to desmids, among others referring to the article by W. B. Turner in *Journ. Royal Micr. Soc.*, Dec., 1885, in which the author describes desmids of this country which he regards as new. Mr. Wolle shows that only two or three of Mr. Turner's species can be regarded as new, and at the same time indicates how very unsafe it is to venture upon describing new species of desmids until the variations due to different stages of growth are well known, and these can only be learned by long experience.

— Mr. W. N. Hastings writes that he has found *Floscularia ornata* abundant in small ponds (peat holes) early in the spring, while the ice is thawing. Their occurrence under these conditions he has observed for several seasons, but has not seen the fact mentioned in books.

— We learn that Miss M. A. Booth received a diploma for microscopic mounts at the New Orleans Exposition, and also a badge of first honorable mention in the woman's department.

— The method of distinguishing between true and artificial or adulterated butter described by Dr. Thomas Taylor still holds good, notwithstanding certain newspaper articles to the contrary. Recently Prof. Weaver, of Columbus, Ohio, stated that he had made an observation that 'destroys in a great measure the usefulness of Dr. Taylor's discovery.' On submitting the matter to careful examination, it appears that Dr. Taylor's method is perfectly reliable, but it should be carried out as Dr. Taylor describes, and not as Prof. Weaver does it.

— Mr. Douglas H. Campbell, is the author of an interesting article on the development of the antheridium in ferns, published in the April number of *Bulletin* of the Torrey Botanical Club. He advises to use diœcious species or the young prothallia of the monœcious species. The prothallia are obtained by sowing the spores in fine earth kept moist. They germinate in from three days to a week, and in six weeks are in a condition to study. They are examined in water. The processes of forming the antheridium and the escape of antherozoids are described and illustrated.

CORRESPONDENCE.

Cement for Mounting.

TO THE EDITOR:—Some six or seven years ago I began to use the white zinc cement for mounting slides. It is one of the neatest and prettiest finishers I know, in spite of one or two drawbacks, and has also the merit of cheapness—a great advantage in class work with ordinary students. I then mounted a great many slides and have a few of them now in very good condition. About two years ago, my stock of this cement being low, I bought some more benzole and made a fresh lot. My surprise and disappointment were, however, great when I found that the new cement was quite worthless. After mounting several specimens and putting them aside for a week or two, the cement invariably became full of bubbles so that I could wipe off the whole of it with my finger. I lost them all. Supposing that the fault was in the new benzole, I obtained some more but had no better success. I next applied to a good firm in Philadelphia and obtained three specimens of their best benzole, but the same failure attended the attempt. In one case, however, the bubbles only appeared around the edge of the coverglass. This was, nevertheless, enough to allow the escape of the liquid and to ruin the slides. I think the difficulty must be connected in some way with the addition of the white zinc, because it does not occur in the damar varnish if used without this ingredient.

The trouble and loss have been so great that I have almost dropped the use of this kind of cement, much to my regret. If you, or any of your readers, can give me some advice that will relieve the difficulty I shall be much indebted to you for communicating the same.

AKRON, O. E. W. CLAYPOLE.

—o—

American Society of Microscopists.

TO THE EDITOR:—I desire to announce that the place and time of the Ninth Annual Meeting of the American Society of Microscopists have been determined by the Executive Committee. The Society will convene at Chautauqua, N. Y., August 10th, at 10 o'clock A. M., and continue its sessions at least four days.

This famous resort is so readily accessible, the fact that railway fares to Chautauqua are always greatly reduced, and the privilege of spending the week of meeting away from the heat and confusion of a large city, will, it is expected, secure a large attendance, and make this annual gathering unusually interesting.

Letters of inquiry addressed to the Secretary will be promptly and cheerfully answered.

D. S. KELLICOT, *Secr.*

BUFFALO, N. Y.

—o—

On Fine Measurements.

TO THE EDITOR:—I have read with great interest Dr. Shanks' 'Contribution to Blood Measurement,' in the February issue, and am glad to see so full a statement of the methods used, which, in my opinion, adds much to the scientific value of the work done. I think, however, the Doctor does not measure a sufficiently large number of corpuscles at one sitting to be certain that he has arrived at the true average in any one instance.

I hope the Doctor will favor us with more definite information as to the screw in his micrometer. Does he mean that it is absolutely without error? And are we to understand that his standard stage micrometer is free from all errors? I have

spent nearly a year trying to find a micrometer without sensible error, and if the Doctor has one that is absolutely without error he is indeed fortunate. I have one screw stage-micrometer in which I have never been able to discover any error whatever. It was made by Geo. Clark, of Alvin, Clark & Co., and was formerly owned by Prof. Rogers, who states that he was unable to find any error in it. It is the only precision screw I have ever seen that is without error. The accumulated errors of a single revolution of the screw of my dividing engine amount to $\frac{1}{10000}$ of an inch, and I do not suppose that the screw of my film micrometer is perfect, though it is a very good one. Will the Doctor kindly give us his experience with his ¾-inch periscopic eye-piece. I use a Huygheinan 1-inch, and if I were to order another would have a 1½-inch. In ordinary comparisons, I use a Bausch & Lomb ¼-inch opaque illuminator with a prism above the front lens, which gives excellent results on metal surfaces. My experience is that there is no micrometer at all comparable with one solid on metal. I use principally one sold by Prof. Rogers on speculum metal, which I have for some months been comparing with the standard of the American Society, so that its errors, which are very small, are well known. Its correction for total length (1cm.) is only $+0.25\,\mu$.

The subject of micrometry is an interesting and important one, and is not entirely free from difficulty; and a free interchange of opinion and judicious criticism of methods and results cannot fail to result in good.

CHICAGO, Ill. M. D. EWELL.

MICROSCOPICAL SOCIETIES.

WASHINGTON, D. C.

Forty-fourth regular meeting, May 11th.

Mr. Frank H. Knowlton presented a communication entitled 'A Résumé of the Algo-Lichen Hypothesis,' printed in full on another page. In the discussion which followed Prof. Seaman said that Schwendener's theory had been the subject of many attacks. It seemed repugnant to the laws governing plants so highly organized as the lichens. Their growth is extremely slow and, to a certain extent, peripheral, therefore the centre might die and the surface grow, but this did not appear to be the case. One of the principal objections to the theory is the variation in habits of plants which it requires to make it tenable. This variation should come, if at all, from the fungal side, but this does not appear to be the fact. See paper by Metcalf Johnson,* accompanied by a plate showing spores. The theory offers a tempting field for investigation. He had never seen gonidia except fully developed.

Prof. Seaman showed specimens of an alga from a pond in the monument lot. The algæ formed a layer on the water 1 mm. in thickness. He had not quite made out their nature. Prof. Burgess thought they were *Microcystis*. Dr. Reyburn stated that he had been investigating Laverau's researches on the presence of an amœboid body in blood corpuscles in cases of acute intermittent fever and promised to give an account of his results. Mr. Knowlton suggested that all botanical observations be recorded in the form of a card-catalogue.

E. A. BALLOCH, *Rec. Secr.*

NOTICES OF BOOKS.

What is Medicine? Annual address delivered before the American Academy of Medicine, at New York, October 28, 1886, by Albert L. Gihon, A. M., M. D., Medical Director, U. S. Navy, President of the Academy. Philadelphia, 1886. (Pamphlet, pp. 28.)

We are always glad to see the outspoken and telling writings of Dr. Gihon, whose efforts to improve and elevate the standard of education in medicine are praiseworthy and, we hope, of great influence. The profession at large is responsible for the condition of the ordinary medical colleges—how long is this disgraceful condition to continue? Those who do not know the extent of the evil should read Dr. Gihon's writings.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

For Exchange: Very rich specimens of *Isthmia nervosa* in situ on seaweed, from Timber Gulch, Cal., for good slides of diatoms or diatomaceous material or Foraminifera.

L. M. KING,
Santa Rosa, Cal.

* *Monthly Micr. Journ.* vi., 217. 'The Monad s Place in Nature.'

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Actinic Contrast in Photo-Micrography.

BY GEORGE A. PIERSOL. M. D.

The lack of appreciation of the inherent and unsurmountable limitations of photo-micrography, as well as failure to secure those conditions most favorable for satisfactory results, so continually leads to disappointment and condemnation that a repetition of the essential conditions for such work may be pardoned. What is here suggested is the teaching of no inconsiderable experience, embracing almost every class of work with direct sunlight from the heliostat.

In this connection a brief word regarding the relative merits of lamp and sunlight may, perhaps, be not amiss. It will be admitted by every one having had extended opportunities for comparison that sunlight, properly handled, is the illumination, par excellence, for all powers and for all kinds of work. On the other hand, however, with suitably arranged lamplight, excellent work can undoubtedly be accomplished with low and medium powers. Where high amplifications are necessary (from 800 to 2000 diameters) sunlight is so immeasurably superior to lamplight that all having occasion to use the higher powers should give it a trial. This can be done with an ordinary mirror by simple and easily arranged adjustments, although a heliostat is desirable where much work is to be undertaken. While photographs under high powers are possible with lamplight, we have yet to see a negative under 1000 diameters by lamplight which was comparable to that producible by properly managed sunlight.

Successful photo-micrography depends especially upon these conditions :—*a*. having all parts of the object accurately in the same plane; *b*. having a well-marked differentiation between the elements of the tissues; *c*. having the object so stained and illuminated as to insure sufficient actinic contrast between it and the surrounding field or background. The first condition is so evident that it would seem entirely unnecessary to more than mention it, and yet the fact is continually forced upon us that there is an insufficient appreciation of the imperative necessity of having this condition fulfilled to the greatest possible degree. Only those having had experience in photographing delicate objects under high powers will realize the care requisite in the selection of fields to secure all parts in the same focal plane.

Our modern histological methods have given us the means, fortunately, of providing sections whose thickness embraces little more than a single layer of cells. Sliding microtomes and paraffin methods leave little to be desired on the score of sections.

The second condition—differentiation of elements—is also obtained with facility. For histological tissues good hæmatoxylin and carmine stainings answer admirably. For very thin sections deep carmine colorings, with marked differentiation between cells and intercellular elements, are probably to be preferred.

The successful acquisition of the condition of actinic contrast, however,

is not always so readily had. While the blue stainings (hæmatoxylin, methyl-blue) are, of course, more actinically powerful than the reds and browns, yet so much depends upon the individual specimen in regard to opacity and thickness that each case must be determined for itself. While a thick section stained in carmine will yield but a dark mass without detail, a similar section stained in hæmatoxylin may furnish a satisfactory picture. But the days of thick sections are passed; the question now is, how shall we stain and illuminate the thinnest possible sections so as to yield good photographs?

While a very delicate section well stained with hæmatoxylin is all that can be desired for examination, we will soon find that actinically it is far too transparent to produce a vigorous photograph, there being insufficient actinic contrast between the general blue color of the field illuminated by the blue monochromatic light from the ammonia-sulphate of copper cell and the bluish purple of the section.

When the preparation of the specimen is under control, we believe it will be found advantageous to prepare a few sections as already suggested in these columns,* by which the thinnest sections in the brown colors always markedly impress the plate.

In many cases, however, it is inexpedient to especially prepare objects for photography. For such cases a very valuable adjunct will be found in the use of different colored lights produced by tinted glasses, carefully adapted to the intensity and color of the staining. The use of glass, or of solutions of a color complementary to that of the object, has been long employed in the arts in reproducing paintings. Koch, in his 'Traumatic Infective Diseases,' relates his experiences with this method, but condemns it as impracticable. On account of the length of exposure and vibration 'the picture does not have sharpness of outline sufficient to enable it to be of use as a substitute for a drawing, or, indeed, even as evidence of what one sees.'*

Notwithstanding the unfavorable experience of this skillful investigator some subsequent results by this method have been most encouraging. Defrenne obtained excellent photographs of the *Bacillus tuberculosis* by means of fuchsin staining and green glass, and quite recently our own experience with this same bacterium and stain has been very gratifying. Since then a number of modifications have been tried. As a result of these experiments the practical deductions have been reached that when the staining and thickness of the specimen are insufficient to give the necessary actinic contrast with the color of the field, we can best succeed by employing a colored glass, whose tint will be such as to give the contrast as well as to afford light to sufficiently impress the plate where not occupied by the object. Such a color will not be the complementary one in many instances. With blue stainings the use of the complementary yellow would yield but a faint image, since the weak actinic power of the transmitted rays are insufficient to deeply affect the unoccupied parts of the field. The substitution, however, of a suitable shade of green affords sufficient contrast of the object as well as permits the passage of rays sufficiently actinically powerful to adequately impress the surrounding parts of the plate.

With all these colors the exposure is greatly lengthened; with a medium green it being five to seven times longer than with blue light; as, however, the normal exposure is seldom over one second, the increase has practically little disadvantage. Not only for very minute objects, as bacteria, stained with methyl-blue, under high power, but equally for very

* *Staining Tissues for Photography*, Amer. Monthly Micr. Journ., March, 1885.

* Magnin-Sternberg. *Bacteria*; 2d ed., page 195.

thin hæmatoxylin or carmine sections under low amplification has this green glass proved most useful. By its use it is always possible to obtain pictures, where all the merits of vigorous negatives with the beautifully sharp details alone obtainable from the thinnest sections are combined, and where the usual method yields but a weak image.

These suggestions apply especially to sunlight. To those engaged in such work, who have never employed these means, the shades of green offer themselves as valuable modifications of illumination well worthy of a trial. The exact tint required—a matter of importance—must be determined for existing conditions by each manipulator.

—o—

Wax as a Material for Microscopical Mountings.

BY C. M. VORCE.

Much has been said and written about the use of wax for various purposes, chiefly as a material for cells, in microscopical manipulations. When first introduced, its merits were extravagantly lauded, later its defects were equally exaggerated. My own experience leads me to consider it a material of great value when rightly applied to the right purposes.

For some years I have kept, in one of the portable Piper cabinets, an assortment of opaque mounts and deep-cell objects selected from my general cabinet for exhibition purposes, and it has, in consequence, been considerably carried about. This collection embraces the work of a number of different persons, and exhibits a great variety of styles of mounting, including brass cells, Pierce's cover cell, bone, glass, lead, gutta-percha and rubber rings, wax cells, Atwood's cells, wooden slips, and brass ring cells of various kinds, and has, from time to time, acquired attention in the way of repair of loose cells, broken covers, etc. After a late trip I found an unusual amount of disaster among these slides, such as displaced covers and cells, and this time the mortality was greatest among the slides bearing hard rubber rings or cells, many of the loose cells being Atwood's pattern. Inspection disclosed that most of the loose cells had been fixed to the slip by means of either shellac, white zinc, brunswick black, or balsam; not one of the wax cells or of the wax-bottomed curtain ring cells, described in this Journal, vol. i, p. 208, were found loose. The great majority of the loose cells and covers had been cemented with asphaltum cement or brunswick black, and several showed that they had already been once remounted.

Acting on the hint gathered from the durability of the wax cell mounts in the same collection, these damaged slides were repaired in the following manner:—The Atwood cells, and other loose cells having their covers still attached, were cleaned of the old cement and the slip cleaned anew, and, placing the cell on a sheet of colored wax, it was cut round with a penknife, and, with the disc of wax adhering, transferred to the slip and centred on the turntable, and slightly pressed to fix it in place. The slip was then placed on the warming table and gently heated till the wax slowly melted, when the excess exuded as a colored ring around the cell. The slide was then returned to the turntable, and a ring of transparent cement spun around it over the wax. Gold size, Bell's cement, liquid marine glue, Brown's rubber cement, or Folsom's finishing cement, are all good for this purpose, and when dry the slide is complete.

In the case of loose covers, the top of the cell was cleaned of cement by means of knife and turntable, a cover was selected or cut of a size slightly smaller than the outer diameter of the cell, and placed on the cell; warm (not melted) wax was then filled into the space between cover and outer edge of cell by means of a knife-blade, and finally smoothed by the same means

on the turntable. Finishing cement was then applied over the wax from inner edge of cell down to and upon the slide, and the mount was complete.

My own experience leads me to conclude that the condemnation of wax cells and the use of wax on account of the sweating so common when it is used was premature. A wax cell with a covering layer of cement, if used when freshly made, will frequently sweat, but if well seasoned will scarcely ever sweat, according to my experience. The wax appears to soften some cements, probably because they contain some solvent of the wax, and these will sweat no matter how old, unless years be allowed for seasoning; hence cements containing turpentine or oil should not be used for covering wax cells, but benzole being so volatile will wholly leave the wax in a few weeks, hence, as well as on account of its color, I generally employ brunswick black.

The cells made as advocated in the article referred to have this advantage, that the slide may be left (and freely used) with no other cement than the primary wax filling around the edge of cover for months or years until it is seen whether any sweating will occur. If it does occur, by placing the slide on a turntable the wax filling can be instantly turned out with a sharp-pointed knife-blade, the cover freed, object removed, and cell recoated, or the cover simply cleaned and replaced as before in a minute or two, and thus objects too hastily mounted may be remounted or recovered with the least loss of time, which cannot be done so well or so quickly where covers have been cemented down with any of the cements ordinarily used.

[There is one point in the above communication to which we wish to refer, as it is of considerable importance. In reference to the sweating of the wax cells, whereby a deposit forms on the under surface of the cover-glass, which interferes with the clearness of vision, the author seems to think such a deposit is not necessarily an evil when wax cells are used. For a long time, while many different persons were relating their experiences with wax cells a few years ago, we were of the same opinion, which we regarded as fully sustained by the excellent condition of a large number of mounts of foraminifera, mounted dry in wax cells, which were then several years old. Since we have been in Washington, however, a great change has taken place in those slides, and the covers are now quite generally coated with the deposit complained of. It should be remembered that in this case the mounts remained in a perfect condition certainly four or five years, and then the change took place. Perhaps the explanation may be found in the climatic influences, but it scarcely seems possible that the slight difference in the average temperature in New York and Washington could bring about such a result.—Ed.]

—o—

A Few Simple Methods of Obtaining Pure Cultures of Bacteria for Microscopical Examination.*

BY DR. THEOBALD SMITH.

The bacteria may be broadly divided into two classes, the parasitic and the saprophytic. Of course there are numerous gradations between these extremes. These remarks will be confined more especially to the methods of obtaining pure cultures of the saprophytic bacteria.

A convenient method of obtaining pure cultures of a typical bacillus—the so-called hay bacillus—is to take some finely cut hay and make an infusion of it. This is to be boiled for from one-half to one hour in a flask, plugged with cotton wool, and then put into the incubator, or in fact in any warm place. In the course of two or three days a membrane will appear upon the surface of the infusion. Upon examination this membrane will be found to consist entirely

*Abstract of a communication to the Washington Microscopical Society, May 25, 1886.

of the *Bacillus subtilis*. This resembles very much the *B. anthracis*, so much so in fact that Büchner announced at one time that he had succeeded in converting the deadly *B. anthracis* into the harmless *B. subtilis*. His experiments are not considered reliable, and his conclusions are contradicted by the spore germination of the two forms. The *Bacillus subtilis* produces spores which resist boiling, and this fact is the key to the discussion on spontaneous generation which raged so violently some twenty years ago. In sterilizing other infusions this bacillus is often found if the boiling has not been thorough.

A simple method of isolating various forms of bacteria is by the use of gelatin plates. The gelatin should be neutral or slightly alkaline, as an acid reaction is unfavorable to bacterial growth. If about $\frac{1}{10}$ c.c. of Potomac water be added to some liquid gelatin and thoroughly distributed in it and the gelatin poured upon a sterilized plate, colonies of bacteria will begin to appear in a few days. Plates were shown containing several colonies from water, saliva, etc. Insects gaining access to the plates by accident, have left behind them several curious forms of bacteria. Sterilized potato is a good medium for the culture of bacteria. To sterilize a potato wash it thoroughly and scrub it with a brush. Place it in a $\frac{1}{10}$ per cent. solution of corrosive sublimate for half an hour; then suspend it over a steam bath by means of wire gauze for another half hour, then transfer it to a glass stand under a bell-glass and cut it, under the bell-glass, with a sterilized knife. Another culture medium is agar-agar or Japanese isinglass which is not liquified by certain bacteria as is gelatin, and lasts much longer. Several cultures on this medium in tubes were shown. The best tubes and cotton plugs are sterilized by steaming them on four or five successive days at least five minutes.

To examine any of these cultures microscopically it is only necessary to transfer a minute quantity of the culture or colony with a flamed platinum wire to a cover-glass either with or without a drop of sterile water. Pass the cover-glass, with the dried film on it, two or three times through the flame of a Bunsen burner, invert it over a dish containing an aqueous solution of some aniline such as methyl violet or methylene blue and allow it to remain until stained. Wash off the excess of stain and mount. In using the Abbe condenser with stained preparations remove the diaphragm; in examining unstained or living specimens use the smallest possible diaphragm opening compatible with a sufficient amount of light.

Key to the Desmidieæ.

BY DR. A. C. STOKES.

[*Continued from page 114.*]

17. COSMARIUM.

§ End view without central inflations (1).
§ End view with central inflations (2).
1. Cytioderm smooth or punctate (*a*).
1. " more or less verrucose or granular (*f*).
1. " spinous (*g*).
2. Cytioderm smooth or punctate (*h*).
2. " more or less verrucose or granular (*i*).
a. Chlorophyll diffused (*b*).
a. Chlorophyll concentrated in 1 or more nuclei (*e*).

b. Margins crenate, undulate, dentate or granulate (*c*).
b. " not crenate, undulate, dentate nor granulate (*d*).
c. Margin crenate (*s*).
c. " undulate (*t*).
c. " granulate (*n*).
c. " dentate or notched; end truncate, smooth; sides toothed, convex. *Reinschii*, 68.
c. " " end 4-spined; sides smooth, convex . *aculeatum*, 66.
d. Cell twice or more longer than wide (*j*).
d. Cell 1½ or less than twice longer than wide (*k*).
d. Cell less than 1½ times longer than wide (*m*).
e. Margins crenate, undulate, dentate or granulate (*v*).
e. Margins smooth; basal angles not toothed (*w*).
e. " basal angles each with 1 tooth or papilla. *Smolandicum*, 69.
f. Verrucæ or granules in patterns, or more or less restricted (*x*).
f. " " not in patterns; more or less covering the surface (*cc*).
g. Spines on the whole surface; cell suborbicular: sinus elliptical, *aculeatum*, 66.
g. Spines marginal, conical; centre with 7 granules, and punctate, *trachypleurum*, 73.
h. Margins crenate, undulate, or dentate (*jj*).
h. Margins smooth (*ll*).
i. Verrucæ or granules in patterns, or more or less restricted (*nn*).
i. " " not in patterns, more or less covering the surface (*vv*).
j. End rounded; semi-cell oblong, sides almost parallel . *De Baryi*, 58.
j. " semi-cell spherical . . . . . *moniliforme*, 60.
j. " semi-cell elliptical or oval . . *cordanum*,* *oblongum*.†
j. End truncate; semi-cell quadrate, sides almost parallel . . *anceps*, 59.
j. " semi-cell pyramidal . . . . . *parvulum*, 59.
k. Cells joined by pellucid bands into families . . . . . *Quimbyii*, 61.
k. Cells not joined into families (*l*).
l. Ends rounded; semi-cells oblong . . . . . *cucumis*, 58.
l. " semi-cells oval; diameter $\frac{1}{1111}$ in. (23μ) . *Witrockii*.†
l. Ends truncate; semi-cells pyramidal, sides convex; diameter $\frac{1}{900}$ to $\frac{1}{1132}$ (22–28μ) . . . . . *notabile*, 66.
l. Ends truncate; semi-cells pyramidal, sides convex; diameter $\frac{1}{500}$ to $\frac{1}{300}$ (50–85μ) . . . . . *pyramidatum*, 69.
l. Ends truncate; semi-cells pyramidal, sides convex; diameter $\frac{1}{1000}$ to $\frac{1}{600}$ (25–43μ) . . . . . *pseudopyramidatum*, 69.
l. Ends truncate; semi-cells pyramidal; sides straight or slightly concave, *granatum*, 60.
m. Cell conspicuously *broader* than long; semi-cells subsemicircular; side view circular, end view elliptical . . . . . *scenedesmus*, 59.
m. Cell ½ to ⅕ *longer* than broad (*n*).
n. Ends rounded; semi-cell subcircular, sinus a mere notch, *globosum*, 60.
n. " semi-cell subsemicircular (*o*).
n. " semi-cell oval (*r*).
n. " semi-cell elliptical, or hexagonal-elliptical; cell ⅕ longer than wide . . . . . *sexangulare*, 63.
n. Ends truncate; semi-cell hexagonal; diameter $\frac{1}{1200}$ in. (21μ) or less, *polygonum*, 65.

* Journ. R. Micr. Soc., Dec., 1885. † Journ. R. Micr. Soc., Feb, 1886.

n. Ends truncate; semi-cell triangular; diameter $\frac{1}{500}$ in. (50μ) or less, *galeritum*, 70.
n. " semi-cell subsemicircular, smooth; sinus deep, narrow, *nitidulum*, 62; *pseudonitidulum*, 62.
o. Sinus deep, narrow (*p*).
o. Sinus deep, wide, almost linear; cytioderm smooth . . *sejunctum*, 62.
o. " rounded or oval; semi-cells lunately curved; cytioderm punctate . . . . . *lunatum*, 65.
p. Cell elliptical; basal angles acute . . . . . *Baileyi*, 64.
p. Cell suborbicular; basal angles obtuse; diameter $\frac{1}{250}$ to $\frac{1}{420}$ in. (60–100μ), *Ralfsii*, 69.
p. " " " diameter $\frac{1}{650}$ to $\frac{1}{830}$ in. (30–38μ), *constrictum*, 58.
r. Cytioderm centrally somewhat granular; nucleus 1 in each semi-cell, *tumidum*, 61.
r. " smooth or punctate; cells small, *bioculatum*, 60; *tinctum*. 61.
s. Ends rounded; semi-cells semi-orbicular; crenæ usually 9, *undulatum*, 67.
s. Ends truncate; semi-cells pyramidal; cells small . . *notabile*, 66.
s. " sides almost parallel; diameter $\frac{1}{650}$ to $\frac{1}{830}$ in. (30–38μ), *crenatum*, 67.
s. " sides converging; diameter $\frac{1}{1250}$ in. (20μ), *Nægelianum*, 67.
t. Semi-cell quadrate, smooth, angles rounded; end retuse or convex. *quadratum*, 59.
t. " pyramidal or subquadrate; end undulate . *Holmiense*, 68.
t. " " end truncate; diameter $\frac{1}{700}$ to $\frac{1}{800}$ in. (32–36μ), *integrum*, 68.
t. " " " diameter $\frac{1}{1000}$ to $\frac{1}{1250}$ in. (20–24μ). *Hammeri*, 79.
t. Semi-cell pyramidal, punctate, base flat, angles rounded, *ansatum*, 68; *Nymannianum*, 79.
u. Diameter $\frac{1}{830}$ to $\frac{1}{1250}$ in. (20–30μ) . . . . . *punctulatum*, 74.
u. Diameter $\frac{1}{1500}$ to $\frac{1}{1800}$ in. (14–16μ) . . . . . *lævе*. 62.
v. Cell twice as long as wide, rectangular; sinus linear, not widened, *sinuosum*, 65.
v. Cell less than twice as long as wide; semi-cell pyramidal, *venustum*, 68.
v. " " " " semi-cell subquadrate, small, *Meneghinii*, 65.
w. Sinus narrow, not widened outwardly; cell elliptical, end convex, *variolatum*, 63; *exiguum*, 66.
w. Sinus widened and rounded inwardly, narrowing outwardly, cell wider than long . . . . . *obsoletum*, 64.
w. Sinus widened outwardly; semi-cell oval, base and end convex, *contractum*, 63.
w. " " " " base and end flattened, *depressum*, 64.
w. Sinus widened outwardly; semi-cell quadrate . . . *Meneghinii*, 65.
w. " " semi-cell subsemicircular; diameter $\frac{1}{250}$ to $\frac{1}{333}$ in. (75–100μ) . . . . . *pachydermum*, 70.
x. Margins crenate or granulate (*y*).
x. Margins not crenate nor granulate (*bb*).
y. Central verrucæ none or scattered on each semi-cell (*z*).
y. " more or less clustered on each semi-cell (*aa*).

z. Verrucæ none central, marginal 1 or 2 rows; cell about twice longer than wide . . . . . *ovale*, 57.
z. Verrucæ none central, marginal 1 or 2 rows; cell less than twice longer than wide . . . . . *triplicatum*, 73.
z. Verrucæ centrally scattered, marginal in series of 3 each; semi-cell quadrate, angles rounded . . . . . *triplicatum*, 73.
aa. Central verrucæ 3, in a single row . . . . . *Donnellii*, 71.
aa. " 6, in a triangle, apex toward the isthmus, *polymazum*, 70.
aa. " 6 or 9, in 2 or 3 transverse rows; marginal rows 1 or 2; semi-cell semicircular . . . *Kitchellii*, 72; *suborbiculare*, 78.
aa. Central verrucæ 10; semi-cell semicircular, end truncate, *anisochondrum*, 72.
aa. " circularly clustered; semi-cell twice longer than wide, sides emarginate, end truncate . . . . . *Seelyanum*, 73.
bb. Centre granularly rough and punctate; margin smooth; semi-cells oval, *tumidum*, 61.
bb. Centre with 3 verrucæ in a row: semi-cells semicircular, *Donnellii*, 71.
bb. Central verrucæ 1 at the isthmus, 8 or 9 marginal in 1 or 2 curves, *taxichondrum*, 71.
bb. " 4 near the isthmus: semi-cells semicircular; end somewhat truncate; basal angles often pointed, *pseudotaxichondrum*, 71.
cc. Chlorophyll diffused (*dd*).
cc. " concentrated into 1 or 2 nuclei (*ee*).
dd. Marginal verrucæ or granules rounded (*hh*).
dd. " " conical or pointed (*ii*).
ee. Cells twice or more longer than wide (*ff*).
cc. Cells less than twice longer than wide (*gg*).
ff. Cells cylindrical, sides parallel (sometimes rounded); verrucæ obtuse, *amœnum*, 78.
ff. " " " verrucæ emarginate, in lines, *elegantissimum*, 78.
gg. Semi-cells oval or elliptical . . . *tumidum*, 61; *orthosticum*, 78.
gg. " semi-orbicular . *tetraophthalmum*, 75; *intermedium*, 75.
hh. Semi-cells pyramidal, end truncate; basal angles rounded, *octhodes*, 76; *Botrytis*, 74.
hh. " oval or elliptical, approximate, *margaritiferum*, 74; *punctulatum*, 74.
hh. " " " remote, granulate . . *portianum*, 77.
hh. Semi-cells quadrangular . . . *conspersum*, 75; *pseudobroomei*, 86.
hh. " subreniform, sinus widened and rounded inwardly, *latum*, 76; *reniforme*, 76.
hh. " subspherical, approximate . . . . . *orbiculatum*, 77.
hh. " hemispherical, remote; base flattened . . *excavatum*, 77.
ii. Ends and sides with teeth; sinus narrow, widened outwardly; basal angles rounded . . . . . *Brebissonii*, 75.
ii. Ends without teeth, sides with 10 to 20; sinus gaping, *dentatum*, 76.
jj. Margins crenate; semi-cell semicircular, nuclei 2, end truncate, *cruciatum*, 81.
jj. " undulate; sinus widening outwardly . *homalodermum*, 81.
jj. " " sinus not widening outwardly (*kk*).
kk. Cell longer than wide; diameter $\frac{1}{560}$ to $\frac{1}{650}$ in. (38–44μ), *sublobatum*, 80.

kk. Cell longer than wide, diameter $\frac{1}{1000}$ to $\frac{1}{1200}$ in. (22–25μ), *margaritum*, 80.
kk. Cell not longer than wide, end truncate . . . . . *retusum*, 80.
ll. Diameter $\frac{1}{2000}$ in. (12μ), end truncate; sides convex, often obtusely angled centrally . . . . . *Schliephanckeanum*, 82.
ll. Diameter greater than (12μ) $\frac{1}{2000}$ in. (*mm*).
mm. Sinus acute inwardly . . . . . *thithophorum*, 80.
mm. " rounded, but not widened, inwardly . . *pseudogranatum*, 158.
mm. " rounded and widened inwardly . . . . . *phaseolus*, 81.
nn. Margins crenate or dentate (*oo*).
nn. Margins smooth; centre with 1 verruca; semi-cell elliptical; diameter $\frac{1}{1900}$ in. (13μ) . . . . . *bireme*, 82.
oo. Ends truncate; diameter $\frac{1}{450}$ in. (33μ) or larger (*pp*).
oo. " diameter $\frac{1}{900}$ in. (28μ) or smaller (*rr*).
pp. About $1\frac{1}{2}$ times longer than wide; diameter $\frac{1}{450}$ to $\frac{1}{500}$ in. (33–50μ), *triplicatum* 73; *speciosum*, 87.
pp. About $\frac{1}{3}$ longer than wide; diameter $\frac{1}{400}$ to $\frac{1}{350}$ in. (65–70μ), *supraspeciosum*, 88.
pp. About $\frac{1}{5}$ longer than wide; diameter $\frac{1}{300}$ in. (50μ), *pychnochondrum*, 89.
rr. Diameter $\frac{1}{925}$ to $\frac{1}{1250}$ (20–26μ); ends 4 crenate, sides 4–6 crenate, *subcrenatum*, 84.
rr. " $\frac{1}{1000}$ to $\frac{1}{1250}$ (20–25μ); sides nearly straight, *Kjellmanii*, 87.
rr. " $\frac{1}{1600}$ to $\frac{1}{1800}$ (14–15μ); granules not radiate; end 4 crenate, *Blyttii*, 87.
ss. Marginal teeth numerous, long, pointed or aculeate. *Eloiseanum*, 85.
ss. " 17, emarginate-truncate . . . . *quadrifarium*, 87.
ss. Margins crenate (*tt*).
tt. Basal inflation granulate in vertical lines (*uu*).
tt. " with scattered granules . . . *pseudopectinoides*, 89.
tt. " without granules, the marginal in 8 radiating lines, *nasutum*, 89.
uu. Sinus widening outwardly; granules geminate in rows, *pectinoides*, 88.
uu. " not widening outwardly; cell oblong, diameter $\frac{1}{450}$ (33μ), *pulcherrimum*, 90.
uu. " " " cell orbicular, diameter $\frac{1}{300}$ (50μ), *radiosum*, 90.
vv. End truncate (*ww*).
vv. End not truncate (*zz*).
ww. Diameter $\frac{1}{300}$ in. (50μ) or larger (*xx*).
ww. Diameter smaller than (50μ), $\frac{1}{350}$ in. (*yy*).
xx. Sides granulate, concave near the ends; semi-cell twice longer than wide, *protractum*, 83.
xx. Sides crenate-undulate, converging; cytioderm verrucose, *Quasillus*, 84.
xx. " rounded, acutely toothed, ends usually nude; cell as long as wide, *Everettense*, 85.
xx. " straight, diverging, verrucose; angles rounded . . *biretum*, 86.
yy. Cytioderm granulate; cell widest at base, sides converging, *sportella*, 83.
yy. " " cell narrowed at base, sides straight, diverging, *protuberans*, 84.
yy. Cytioderm verrucose; end more or less protruding and scolloped (4-crenate) . . . . . *cælatum*, 86.

yy. Cytioderm verrucose; end more or less protruding, not scolloped, *ornatum*, 82; *protractum*, 82.
yy. " " end not protruding; semi-cell twice as long as wide, oblong-quadrangular, angles rounded . . . *Broomei*, 86.
zz. Cytioderm finely granulate or punctate; semi-cells triangular, angles rounded, margins smooth . . . . . *Turpinii*, 158.
zz. Cytioderm verrucose; semi-cell subreniform, 3 times as wide as long, *commisurale*, 83.
zz. " " semi-cell pyramidal, angles rounded, *tumidum*, 75.

18. Tetmemorus.

§ Cytioderm smooth or very indistinctly punctate (*c*).
§ Cytioderm punctate (*a*).
a. Cell 3 times as long as wide, irregularly granular: base slightly plicate, *giganteus*, 92.
a. Cell more than 3 times as long as wide (*b*).
b. Front and lateral views fusiform; end with colorless, lip-like projection, *granulatus*, 91.
b. Front view cylindrical, not tapering; side view fusiform, tapering; end rounded . . . . . *Brebissonii*, 91.
c. Three times longer than wide, smooth; diameter $\frac{1}{125}$ to $\frac{1}{140}$ (18–20μ), *minutus*, 91.
c. Four times longer than wide, smooth; diameter $\frac{1}{52}$ (48μ); linear elliptical, no lip . . . . . *penioides*.*
c. Four to six times longer than wide, smooth or indistinctly punctate; front view tapering, lateral fusiform, $\frac{1}{125}$ to $\frac{1}{113}$ (20–22μ), *lævis*, 91.

19. Xanthidium.

§ Spines divided at the ends . . . . . *armatum*, 92.
§ Spines subulate, ends not divided (*a*).
a. Spines more or less scattered . . . . . *aculeatum*, 92.
a. Spines marginal (*b*).
b. Basal angles with 2 spines (*d*).
b. " " 1 spine (*c*).
c. Other spines geminate in 4 pairs . . . . . *cristatum*, 93.
c. " " in 2 pairs on the end, single on the sides, *asteptum*, 93.
d. Other spines 6 to 10 pairs on semi-cell; protuberance beaded, *bisenarium*, 93.
d. Other spines 2 to 4 pairs (*e*).
d. " none . . . . . *tetracentrotum*, 95.
e. Other spines, 4 pairs, terminal . . . . . *fasciculatum*, 93.
e. " 2 pairs, basal, vertical . . . . *rectocornutum*, 94.
e. " 2 pairs, terminal; a row of granules above the central projection, a spine above the granules, ... *Minneapoliense*, 94.
e. Other spines, 2 pairs, terminal; a row of granules above the central projection, no spine above the granules . . . . . *polymazum*, 94.
e. Other spines, 2 pairs, terminal, no granules above the projection (*f*).
f. Diameter $\frac{1}{450}$ in. (55–65μ) or more . . . . . *fasciculatum*, 93.
f. " $\frac{1}{500}$ in. (50μ) or less; semi-cell truncate-triangular, *asteptum*, 93.
f. " " " semi-cell not truncate-triangular, *antilopæum*, 94.

* Journ. R. Micr. Soc., Feb., 1886.

20. ARTHRODESMUS:

§ Cytioderm smooth (*a*).
§ Cytioderm verrucose or spinous (*b*).
a. Semi-cell with two spines (*c*).
a. Semi-cell with more than 2 spines (*d*).
b. Cytioderm with deciduous spines . . . . . *Rauii*, 95.
b. " verrucose in rows, margins crenate . . . *quadridens*, 96.
c. Spines on the same side diverging (*e*).
c. " " parallel (*f*).
c. " " converging . . . . . *convergens*, 95.
d. Margin of semi-cell angular, each angle with 1 or 2 spines, *octocornis*, 97.
e. End truncate: spines widely divergent . . . . . *Incus*, 97.
e. End convex; spines moderately divergent . *subulatus*, 96; *ovalis*, 96.
f. Nuclei, 2 in each oblong-oval semi-cell . . . . . *fragilis*, 95.
f. Nuclei none; semi-cell oval, diameter $\frac{1}{1250}$ in. (20″) . . *ovalis*, 96.
f. " semi-cell orbicular, diameter $\frac{1}{1200}$ (12″), *orbicularis*, 96.
f. " semi-cell elliptical; spines often very short, *convergens* var., 95.

[*To be continued.*]

Photo-Micrography.—VII.

BY THE EDITOR.

[*Continued from page 95.*]

4. Developing (continued).

b. Pyro or Alkaline development.

Prepare the developer according to any of the formulas given last month, or follow the directions given by the maker of the plates that are used. Doubtless, however, many will prefer to buy a developer already mixed, such as that of the Eastman Dry Plate Co., of Rochester, or, one that we can most highly recommend, which was forgotten as we wrote last month, Walmsley's developer, which can be obtained from Messrs. Walmsley & Co. in Philadelphia. There are several others on the market, which from the way they are advertised might lead one to suppose they are everlasting—one, indeed, is said to work constantly without any addition. Well, *rien d'impossible*, but it is just as well for the beginner to use well-tried, even though less economical, preparations.

Having mixed the solutions, pour them over the plate, and constantly tip the tray to make the developer flow back and forth. In a few seconds the picture will appear, and development must be continued until details are out. Then wash thoroughly and put the plate in the alum solution (fomula 8), which should have the oxalic acid added to it for the purpose mentioned. In ten minutes wash the plate again, and place it in the fixing solution.

When fixed wash very thoroughly and dry.

Treatment of plates not properly exposed.

When a picture develops all over, without sufficient contrast between the lights and shadows, it appears flat, and the plate has been exposed in the camera too long. If, on the other hand, the lights and shadows are exaggerated, and details in the shadows cannot be brought out, the plate has not received sufficient exposure. The former error can be remedied to a considerable extent in development. For the latter, not much can be done.

In attempting to modify the course of development it should be considered that:—

1. A weak developer acting slowly gives a soft, even development with good density.

2. An alkaline developer, strong in ammonia or alkali, tends to bring out details in the shadows.

3. A developer, strong in pyro or iron, and containing sufficient restrainer (2) to prevent general fog, gives strong contrasts and density.

From this it may be readily understood that:—

1. For an under-exposed plate a slow development is required. In using oxalate do not add more than 1 part of iron to 16 of the oxalate (even 1 to 20 might be better to begin with), and allow development to proceed slowly until as much detail is out as can possibly be obtained. Then add more iron, making the proportion 1–8, if necessary, to obtain density. In using pyro, begin with less than the usual quantity of pyro, but use more alkali, and let the detail come out slowly. Then if density is required, more pyro should be added. Another plan is to dilute the usual developer with half its bulk of water, or more; but the addition of ammonia tends to bring out detail without giving density, and this is what is required in an under-exposed plate. For the tendency in such a plate is toward density in the well lighted parts and transparency in the shadows. By using a weak developer, however, and giving time enough—it may require an hour or several hours—the feeble effect of the light in the shadows may be made to show, while the better lighted parts do not become dense, as they would with a normal developer. The reduction of the silver, once started by the weak developer, may then be continued by the stronger one, while, had we begun with the strong developer, the well lighted parts would probably be fully developed and perhaps quite opaque before the details in the shadows began to show.

We have thus conscientiously described the proper method of treating under-exposed plates; but lest we should be numbered among the many amateurs who, by their great skill, have made wonderful works of art out of under-exposed plates, we may add that the method described is not the one we are accustomed to adopt in practice. Our plan is, wherever we have a plate evidently under exposed, to immediately throw it away. This plan saves much time and labor. It is true, sometimes a good picture can be made from a slightly under-timed plate; but it is impossible to make a good picture unless the light has acted long enough to impress the details on the plate so that the developer can bring them out.

2. For an over-exposed plate a strong and well restrained developer is required, for in this case the tendency is toward flatness and want of contrast. This is due to the fact that, when the light acts too long upon a plate, development gives a thin image. Up to a certain point of exposure the development gives increasing density, but beyond that point the reverse action takes place. For this reason the sky over a landscape, the brightest part, is frequently quite thin, owing to over exposure, while the remainder of the picture is strong. In fact, by giving an excessively long and correctly timed exposure a positive picture may be taken in the camera.

A good formula for developing an over-exposed plate is 1 part of iron to 6 or 8 of oxalate, with about 5 drops of bromide to each ounce of developer. The quantity of bromide must be regulated by the requirements of each case—it must be sufficient to control the development. When pyro is used, put in twice the usual quantity of pyro, rather less alkali than usual, and a good excess of bromide. Some operators advise that plates known to be over exposed be placed in a plain bromide solution for a few moments before development. We have not tried this plan because we have not yet discovered a means of knowing that a plate is over exposed; however, there may be an advantage in the proceeding, for the

development can thus be kept well under control, and if it be found that the exposure is about right, the bromide can be washed out and development begun anew.

The novice will be puzzled at times to know whether a finished negative is over or under timed, although it may be evident that something is the matter. Usually, the question can be definitely settled by examining the shadows. If the detail is all visible and the negative is thin, the margins of the plate where it was protected by the holder remaining clear, the exposure was too long. If the margins are not clear it is an indication of a foggy plate. The fog may be due to the emulsion, or to accidental exposure to light. Fog may also be readily produced by using too much alkali in the developer. A foggy or light struck plate will give a weak and flat negative, just as an over-exposed plate. An under-timed plate will not show the details in the shadows, while in a landscape the sky will probably develop dense, black, and perfectly opaque.

We have still to consider a few methods of reducing and intensifying negatives, but these must be deferred until next month.

[*To be continued.*]

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Provisional Key to Classification of Algæ of Fresh Water.—IX.

BY THE EDITOR.

[*Continued from page* 97.]

Family XIV. NOSTOCACEÆ.

Filamentous, simple or branched trichomes. Resting spores observed in many genera, also peculiar heterocysts—colorless cells apparently without contents—interspersed in the series of vegetative cells, the function of which is unknown.

GROUPS.

Filaments usually branched, rarely simple, provided with a sheath, tapering to a hair-like end; with heterocysts. (RIVULARIEÆ.)

Filaments not tapering to a hair-like end, sheathed, branched, cell division only at right angles to the length of the filament, branches formed by lateral outgrowths of the filaments breaking through the sheath. Usually with heterocysts. (SCYTONEMEÆ.)

Filaments not tapering to a point, sheathed, branched, cell division also parallel to the length of the filament, whereby branching results and the filament itself includes series of cells lying side by side. (STIGONEMEÆ.)

Simple, unbranched filaments, with or without sheaths, never tapering to a point; heterocysts always present, and resting cells (spores) usually observed.

Propagation in two ways: 1. by development of resting cells after a period of repose, giving rise to new filaments by repeated division; 2. by multicellular, germinating filaments (hormogonia), separated portions of the trichome, which grow into new plants. (NOSTOCEÆ.)

Simple, unbranched filaments, with or without sheaths, single or forming extended layers, without heterocysts and resting cells, never tapering to a hair point.

Propagation: 1. by the breaking up (disarticulation) of filaments (hormogonia) the single pieces growing into new filaments (*Oscillaria*, *Lyngbya*, *Symploca*); 2. by unicellular gonidia, which may be either the separated, terminal cells of filaments (*Chamæsiphon*, *Leptothrix?*) or special cells developed in the course of vegetative division (*Crenothrix*).

A number of the genera manifest, either always or under certain conditions, a turning around the longitudinal axis of the filaments, and a forward, creeping movement (*Oscillaria*, *Beggiatoa*, *Spirulina*, *Spirochæta*). (OSCILLARIEÆ.)

a. RIVULARIEÆ. Group 1.

Synopsis of Genera.

Growing in tufts. Heterocysts at base of branches. *Calothrix*, 105.

Filaments free, unbranched, heterocysts at base. *Mastigonema*, 106.

Filaments radial, in gelatin, with basal heterocysts, branched; with resting cells. *Glœotrichia*, 107.

Filaments radial, in gelatin, basal heterocysts, no resting cells. *Rivularia*, 108.

Frond flat, otherwise as above. *Isactis*, 109.

105. Genus *Calothrix* (Agardh) Thuret.

Filaments branched, straight, not in gelatinous masses, growing in tufts. Heterocysts at the base of branches.

106. Genus *Mastigonema* Fischer (enlarged).

Filaments free, unbranched, not in gelatin, growing single, or in bunches. Heterocysts at the base of filaments. Resting cells unknown.

107. Genus *Glœotrichia* Agardh.

Filaments radially disposed, embedded in solid gelatin in spherical masses: branching by lateral outgrowth from the old filament beneath the heterocyst. The latter basal; resting cells single, over the heterocysts.

[Wide, gelatinous, transversely plicate sheaths enclose the trichomes, especially about the lower part. The resting cells or spores are elongated cells, which otherwise usually resemble the other cells. The next genus only differs in the absence of spores, a feature that cannot be regarded as constant.]

108. Genus *Rivularia* Roth.

The same characters as *glœotrichia*, but resting cells (spores) not known.

109. Genus *Isactis* Thuret.

Filaments parallel and erect in gelatin, often encrusted with lime; frond flat, otherwise like *Rivularia*.

b. Scytonemeæ. Group 2.

Synopsis of Genera.

Filaments sheathed; branching double, at right-angles; branches parallel. *Scytonema*, 110.

Filaments united in bands by a common sheath. *Symphyosiphon*, 111.

Filaments sheathed, branching below one or more heterocysts. *Tolypothrix*, 112.

Branching irregular, no heterocysts. *Plectonema*, 113.

110. Genus *Scytonema* Agardh.

Each filament with its special sheath; branching usually double as the filament bends and ruptures outside the sheath, and two parallel branches are thus produced, which run off at right-angles to the original filament. Heterocysts distributed without relation to the branching.

111. Genus *Symphyosiphon* Kützing.

Filaments as in *Scytonema*, but united in bands by the lateral expansion of the sheaths.

112. Genus *Tolypothrix* Kützing.

Each filament with a sheath; branching usually single, by lateral outgrowth of the filament through the sheath below the one or more heterocysts. The latter, therefore, are always found at the place of branching.

113. *Plectonema* Thuret.

Filaments irregularly branched, with single or geminate branching, each in its special sheath. No heterocysts. Color blue-green.

c. Stigonemeæ. Group 3.

Synopsis of Genera.

Several series of cells in a single filament. *Stigonema*, 114.

Cells in single series, very wide sheath. *Haplosiphon*, 115.

114. Genus *Stigonema* Agardh.

Cells of the filaments often in series of two, three, or more, side by side, owing to division in various directions; walls thick, very distinct in old filaments; sheath very wide; heterocysts distributed without order.

115. Genus *Hapalosiphon* Nägeli (extended).

Cells in a single series, sheaths thick or delicate, with heterocysts. Plants resembling *Tolypothrix*.

[*To be continued.*]

EDITORIAL.

Publisher's Notices.—All communications exchanges, etc., should be addressed to the Editor, P. O Box 630, Washington, D. C.

Subscriptions, and all matters of business, should be addressed to the Business Manager, P. O. Box 630, Washington, D. C.

Subscription price $1.00 PER YEAR *strictly in advance. All subscriptions begin with the January number.*

A pink wrapper indicates that the subscription has expired.

Remittances should be made by postal notes, money orders, or by money sent in registered letters. Drafts should be made payable in Washington, New York, Boston, or Philadelphia.

The regular receipt of the JOURNAL, which is issued on the 15th of each month, will be an acknowledgment of payment.

The first volume, 1880, is entirely out of print. The succeeding volumes will be sent by the publisher for the prices given below, which are net.

Vol. II (1881) complete, $1.50.
Vol. III out of print.
Vol. IV (1883) complete, $1.50.
Vol. V (1884) complete, $1.50.
Vol. V (1884), Nos. 2–12, $1.00.
Vol. VI (1885), $1.00.

BUSINESS CHANGE IN THE JOURNAL.—Most of our readers will be surprised to learn that the Editor will soon leave the country for a residence of some time in Japan. This change has been in contemplation for several weeks, but it has been deemed best not to make it public until proper arrangements were made for the JOURNAL. For the present no change will be made in the editorial management, but it is not unlikely that a resident Editor will soon be appointed, and that we shall be temporarily relegated to the position of special foreign correspondent. At all events, our readers may be assured that no means will be spared to ensure the satisfactory conduct and continued prosperity of the JOURNAL.

As will be seen from the cover, Mr. Rufus W. Deering has assumed the business management, which has, in fact, already been in his charge for some time. Mr. Deering is an experienced business man, and in future will have entire control of the business of the JOURNAL. It is expected that this arrangement will result in great benefit to the JOURNAL in several ways, but particularly in the increase of its subscription list, through a systematic attention to details of the business, which it has been practically impossible for us to give, even had we been at any time so disposed.

It is the intention of Mr. Deering to establish, in connection with his work on the JOURNAL, an agency for the sale of periodicals, including those pertaining to microscopy. He will receive subscriptions to any periodical at publisher's prices, and will furnish books of all kinds. This will be a great convenience to many of our readers, and we commend the enterprise to their patronage.

The Editor's foreign address will be, after this month, Osaka, Japan, where private letters may be sent at all times; but communications on matters pertaining to the JOURNAL had best be sent to Washington, as hitherto. Up to August 10th letters may be sent to the Palace Hotel, San Francisco, Cal.

—o—

DETECTION OF FATS IN BUTTER.—The processes discovered by Dr. Thomas Taylor, and already published in these columns, for detecting adulterations in butter have attracted great attention throughout the country, and are deserving of thorough investigation. The subject was referred to a special committee of the American Society of Microscopists at its last meeting, and it is expected that the committee will report at its next meeting. We learn, from private sources, that the results of the observations of the committee have sustained Dr. Taylor's assertions, and, without wishing to forestall the report of the committee by extending these remarks into particulars, we may express the belief that the accuracy of Dr. Taylor's work will be acknowledged. In some apparently mysterious manner, however, the report of the committee seems to have disappeared, and at least some members of the committee are unable to understand the cause. It has been intimated to us that one gentleman in Chicago prepared a report which was

so much the report of an individual that no other member would sign it; hence, no committee report has yet appeared. We trust this is not so, but that the free testimony of all the members will be given next month, properly signed. A committee of the Society can scarcely permit one person to be a self-appointed spokesman, and any attempt in this direction deserves to be severely censured.

Some criticisms of Professor Taylor's method have been made from time to time, and these have cast some doubts upon the reliability of it among a large number of persons. We leave it to Dr. Taylor to answer his critics, as he seems abundantly able to do; but we cannot refrain from expressing the regret we have felt at the attempts that have been made, apparently from unworthy motives, to belittle the merit which certainly belongs to Dr. Taylor, as the discoverer of the process, until the accuracy of his statements have been disproved. And we may assert, without hesitation, that, so far as we have been able to understand the subject, and the published articles relating to it, the accuracy of it has not been disproved, and we fully sympathize with the tone of Dr. Taylor's response to the at least very uncalled-for communication of an eminent entomologist, who claimed no special knowledge of the subject, which recently appeared in the newspapers.

We claim no special acquaintance with the processes ourselves, but in the light of all that has been published Dr. Taylor surely has the best of the argument; and in behalf of pure justice we are led to make these remarks. We do not ask that his statements be blindly accepted, but we do say that those who deny them should give experimental proofs to sustain their position, and not allow personal animosities or jealousy to bias their judgment, or influence public opinion.

We cannot overlook the statements attributed to Professor Weber, of Columbus, Ohio, who, it appears, questions the reliability of the method of Dr. Taylor, since the results of his experiments do not fully accord with those of Dr. Taylor. It is but just to the latter gentleman, however, to state that he says the Professor does not follow his method, and therefore does not reach the same results. This, from the published accounts we have seen, appears to be strictly true. If it were not that the gentlemen engaged in this work are presumed to be scientific gentlemen, seeking for the truth alone, we would be inclined to say a deliberate effort has been made to disprove facts for an unworthy purpose. It is certainly not easy to understand how a competent scientific observer can be led to criticise a method without following the processes described, which are, presumably at least, an essential part of it. Such criticism is trivial, inexcusable, and very unjust.

The steps of Dr. Taylor's process are simple and rational. The principle upon which he works is essentially sound. It involves no new discoveries concerning crystalline forms, since the crystals of butter and other fats have long been known. He has studied some of them more critically than has been done before, and has probably incidentally acquired a better knowledge of their peculiarities than has any other person. But the merit of his discoveries lies in the application of well-known facts, and the perfection of a method whereby he asserts that the presence and identity of foreign fats in butter can be detected with certainty. The matter of butter crystals, which seems to be a stumbling-block to many, may be disregarded at present, and the St. Andrew's cross is nothing very wonderful or significant, although it has figured pretty largely in this matter. In practice it is not required to detect butter in the presence of other fats, but to detect other fats in butter, and since oleo and lard are crystalline fats (except under very unusual con-

ditions),* and fresh butter fat is not crystalline, the detection of the adulteration by the microscope seems not to be an impossibility. It is because of those well-known facts, as well as of the clear understanding of them manifested in Dr. Taylor's articles, that we are inclined to put faith in his statements. Going a step further, it appears that butter also can be recognized by its crystalline form when mixed with other fats. The admirable manner in which Dr. Taylor seems to have succeeded in detecting adulterations in butter, entitles him to the credit of a discoverer of a new process of analysis.

——o——

Cutting Sections of Minute Organisms.—Dr. G. W. M. Giles has recently contributed an interesting article on Marine Collecting with Surface Net to *Science Gossip*. The special part of the article to which we wish to direct attention is a method of preparing sections of minute animals, such as the smaller entomostraca for example, which at first sight seems rather impracticable, but which the writer assures us has been successful in practice. The hard shells and chitinous coats of these animals offer some difficulties in cutting when embedded in paraffin, but occasionally good sections can be cut in the manner described, when the animals are very minute. The method is as follows: Take the animal from absolute alcohol, pass it through oil of cloves, place it in a watch-glass with a few drops of balsam, and heat until the oil of cloves is entirely displaced by the balsam. A single drop of balsam is then heated on a slide until it is hard when cooled. 'Now take up the animal, together with a bead of balsam on the point of a needle, and place it on the balsam on the slide, previously warmed, and prop it up in such a position that the plane of the sections desired may be parallel to that of the slide, holding it thus until the balsam has cooled sufficiently to keep it so.'

Sections are then cut with a razor and dropped upon the slide and mounted under a large cover-glass. The difficulty is to get the balsam hardened just right. It must be just right to be cut with a razor, and not brittle. Sections of coralline algæ can also be made in this way.

* See Amer. Quar. Micr. Journ., i, 295.

NOTES.

— Several serious typographical errors occurred in the communication on 'Fine Measurements,' from M. D. Ewell, in the June number, which our readers will do well to note.

Page 120:—16th line, for film read filar; 20th line, for Huygheinan read Huyghenian; 27th line, for solid read ruled; 28th line, for sold read ruled.

— Mr. Zentmayer has issued the ninth edition of his Illustrated Price List of Microscopes, and other optical instruments. His present list now embodies the results of more than forty-one years of experience in the manufacture of optical instruments. No instruments made anywhere in the world more justly deserve their reputation for excellence of workmanship and durability than do those of Mr. Zentmayer. Among the microscopes recently introduced by him, the 'portable histological' stand is already well known and popular. We also notice a new illustration of a cobweb micrometer in this edition.

— Mr. J. Grunow has issued a new price list of objectives, dated Dec., 1885, in which he makes the announcement that he has ceased to make water-immersion lenses, and all his immersion lenses are made for a fluid, having the refractive index of crown glass, which he prepares of an oily nature so that it will not run like oil of cedar. It is less fluid than any of the oils. He makes $\frac{1}{12}$ an $\frac{1}{15}$-inch objectives of balsam angle 115° N. A. 1.24.

— The Palmer Slide Company has issued a new circular concerning the excellent and cheap slides they are making upon their improved grinding and polishing machines. They also furnish cover-glasses, mounting media, staining fluids, and other articles. They offer Prof. Smith's new mounting media, prepared under his personal supervision,

one with refractive index of 1.7, the other of 2.0. The popular Pillsbury cabinets can also be obtained from them.

— Messrs. H. R. Spencer & Co. have issued a new price list of objectives, which can be obtained by addressing them at Geneva, N. Y. They make now a variety of lenses, all of them good, but their highest quality lenses are to be especially commended. They offer a $\frac{1}{10}$-inch, B. A. 116°, N. A. 1.29, for $60.00, and speak in high praise of it, for its long working distance and resolving power. Another $\frac{1}{10}$ in the same series, having a B. A. of 125°, N. A. 1.35, costs $80.00. The higher angle objectives are 'guaranteed to equal in performance any that can be made.'

— The Gundlach Optical Company has been very busy of late filling orders and preparing an extensive exhibit of photographic goods for the Photographic Convention at St. Louis. We may say, in passing, that they are doing some good work in objectives for field photography, a line of business they have recently established, although Mr. Gundlach has long been identified with the manufacture of such lenses. We are pleased to see evidences of their prosperty.

— Dr. Piersol, of Philadelphia, has gone to Germany, where he intends to pursue his studies in histology. He will also continue his work in photography, in which he has been so successful. Our readers are already indebted to him for some valuable contributions to these columns, and may expect others during his sojourn in Leipzig, where we trust his experiences will be always pleasant and profitable.

— Dr. Henri Van Heurck has had remarkable success in photographing the *Amphipleura* and the 18th and 19th bands of Nobert. We are in daily expectation of receiving prints from some of his recent negatives, which he has promised to send us, but in anticipation of their arrival it is of interest to have the opinion of such an experienced microscopist as Dr. Royston Pigott, who has thus expressed his appreciation in a private letter. He writes :— You will not be astonished when I declare they have in my opinion no equals. The total disappearance of false lights along the margins, which people have almost doted in declaring to be quite unavoidable, because they were diffractions, utterly explodes that gratuitous presumption.

CORRESPONDENCE.

An Old Record of Spencer.

To the Editor :—I have somewhere heard it said that in one of the editions of Quekett's Treatise on the use of the Microscope there appeared an account of the performance of the objectives of the late Chas. A. Spencer, which were then just beginning to be known in Europe, and also an engraving of what was then the test object, *Haricula Hippocampus*, as shown by a Spencer objective. Also that the fact of such notice aroused such a feeling in England that the objectionable matter, together with the cut, was omitted in subsequent editions. I would like to know if such was the fact, and, if so, in what edition of Quekett the notice appeared.

W.

—o—

Measuring Blood Corpuscles.

To the Editor :—I desire to present the following reply to Dr. Ewell's communication, in the June number of the Journal, on fine measurement.

My stage micrometer has no appreciable error when compared with the U. S. Coast Survey standard. The micrometer screw was made especially for micrometer use. A leading firm of fine tool makers refused to fill an order for a screw which they would guarantee to be accurate, consequently Mr. Fasoldt assumed the task. After many trials and corrections, occupying several months of time, a screw of 100 threads per inch was produced, which accorded in every revolution with the standard stage plate. The error, if any, of this screw is extremely small.

The use of a micrometer requires care and frequent testing, since the ordinary wear, when in service, tends continually to change the rate of the screw, and this is especially the case if a certain $\frac{1}{10}$ inch or $\frac{1}{30}$ inch of its length is used when making a large number of blood measurements.

The measurement and comparison of lines and screws requires much technical experience, and this matter is quite independent of mathematical ability. In measuring with a screw the milled head sbould be invariably turned in one direction, to the limit of the division or to the end of the scale to be measured. If a division or line be inadvertently overrun, the screw should be reversed one or two revolutions and the line again approached carefully in the proper direction. The

screw may push or pull the web, but it cannot do both accurately. When measuring, the web should always be moved in the same direction; when set for the next measurement it should be returned past the starting point, and then brought carefully to that point again, so the traverse of the web shall be continuously in one direction from point to point. This applies to all screw measurements, and there are mechanical reasons for a strict observance of this rule:—A properly constructed micrometer head should be always divided and numbered, and the revolution, when measuring, should follow the run of the numbers.

To-day I again tested a newly ruled plate with the screw. When the milled head was revolved in the proper direction every space of 100th, and also of 1000th of an inch, registered exactly on the micrometer head. A reversal of the operation produced an error of $\frac{1}{40000}$ inch in the whole length of the scales. Several repetitions of this exercise with other parts of the screw produced the same result.

A well-cut line on glass shows a narrow black central line between two more or less irregular edges. This black line represents the extreme bottom of the cut. This alone determines the exact position of the line, and not the irregular or illy-defined edges at the surface of the glass.

The periscopic is the only style of eye-piece I have used for micrometry. The field is wide and flat, and the focus, being below the field lens, allows an easy change of eye-piece magnification without disturbing the micrometer adjustments. I have used the periscopic 1, ¾, and ½-inch. The 1-inch is probably the most perfect of these eye-pieces; the ½-inch, with the vertical illuminator, presented a rather dim field, and sharp definition of the edge of the corpuscle could not be obtained.

The number of corpuscles in my list was not large, but each one was very carefully and deliberately measured. I did not have the time to make a larger number of measurements.

S. G. SHANKS.

ALBANY, June 2d, 1886.

MICROSCOPICAL SOCIETIES.

WASHINGTON, D. C.

Forty-fifth regular meeting, May 25th, 1886.

Dr. Theobald Smith, of the Bureau of Animal Industry, Department of Agriculture, addressed the Society, by invitation, upon 'A Few Simple Methods of Obtaining Pure Cultures of Bacteria.' An abstract of his remarks is published on another page.

Dr. Schaeffer said that in his opinion the bacterial origin of disease was not yet proved. His position was one of healthy scepticism. He thought there was a fashion in science as well as in dress, and just now it was the fashion to go to Germany for our theories about bacteria. He did not advocate a slavish adherence to or belief in everything written by the authorities. He thought that just now we were at the crest of the wave of bacteriology, and that we should soon begin the decline. In his opinion the true cause of disease was of a chemical nature.

Mr. Skinner asked whether Dr. Freire's researches on the bacteria said to be the cause of yellow fever were generally accepted as sound, and also alluded to the theory that bacteria themselves do not cause disease but the ptomaines generated by their presence, or, in other words, that the active cause of disease is not vegetable but chemical.

Mr. Hitchcock said:—Nowhere is better work in this line being done than in the Bureau of Animal Industry of the Department of Agriculture. Laborious and patient investigations have been carried on quietly for years and the results are just now beginning to appear. Alluding to Dr. Schaeffer's remarks, he said:—If a germ is isolated, cultivated, and a pure culture obtained which will invariably produce a certain disease in the animal inoculated; then, if the germ is not the cause of the disease, what is the cause?

Dr. Taylor said:—If, after inoculation with the *B. tuberculosis*, we find tuberculosis in any large number of the animals inoculated, then it is reasonable to suppose that the bacillus is the cause of the disease.

Dr. Seaman stated that the discoveries leading to the development of the germ theory had their origin in researches upon much larger objects than bacteria, viz., mycoderms.

Dr. Smith closed the discussion by saying that no original work in this line is accepted unless full and detailed accounts of all experiments are given, so that the investigator's methods can be exactly followed. So far he had seen no such accounts from Dr. Freire. Much of the scepticism as to the bacterial origin of disease is due to the fact that most of the

latest work of the foremost investigators is as yet generally inaccessible, not having been published in English. Any one who will read Koch's latest publications must be convinced of the truth of his reasoning. If I can inoculate mice and predict death in a given time, and there is nothing in the inoculation fluid but germs, then it is logical to assume that the germs are the cause of the disease. The speaker said that when he began his work in this line he was in a state of doubt as to the truth of the theory, but his own work during the past few years, and his knowledge of the work of others, had convinced him of its truth, and he was confident that this would be the case with any one else who would take pains to carefully look into the matter.

Prof. Seaman said that the alga shown by him at the last meeting, had been pronounced, by the Rev. Mr. Wolle, to be *Palmella Brunii*.

Dr. Caldwell alluded to some specimens of urinary crystals shown by him at the thirty-fifth meeting in December last, and concerning which he was in doubt at the time. He said that he had recently had occasion to examine a specimen of urine containing phosphates in excess. He had acidulated the specimen by nitric acid, and added excess of ammonia, and produced crystals identical with those shown in December. The use of acetic acid and potassic hydrate produced the same result. He therefore concluded that the specimens exhibited in December were crystalline forms of phosphates.

E. A. Balloch, *Secr.*

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San Francisco, Cal.

The regular semi-monthly meeting was held Wednesday evening, May 26th, Dr. S. M. Mouser presiding.

Dr. Stallard exhibited some fine slides illustrative of *arteritis*, or inflammation of the arterial blood vessels. He also explained at some length his method of preparing the specimens.

A letter was received from J. C. Rinnbock, of Vienna, a well-known preparer of diatom mounts, inclosing two exquisite specimens of his work. The first slide was composed of selections from various American diatomaceous deposits, and the other contained over two hundred selected and systematically-arranged diatoms, each of a different species, from the fossil deposit at Brunn, Moravia. Included therein were specimens of one genus and of several species which are comparatively new to science, they having been described only very recently by Cleve, and almost without exception the forms on the slide were those of rare and little-known diatoms. The mount was, therefore, not only a fine specimen of manipulative skill, but was also of high scientific value.

Prof. Hanks offered the following preamble and resolution :—

Whereas, It is desirable to call the attention of scientific men to the new field of California and to make the resources of our State known to the world; and

Whereas, The American Association for the Advancement of Science and the American Institute of Mining Engineers will meet in Buffalo on the 3d of August next, at which meeting it will be decided where the following one shall be held; and

Whereas, It has been intimated that the members of the associations mentioned would be pleased to hold a meeting on the Pacific Coast; therefore be it

Resolved, That the San Francisco Microscopical Society appoint a committee of three, and extend an invitation to all scientific societies in the State to appoint similar committees to meet in conference and consider the propriety of extending an invitation to the above-mentioned associations to hold their annual meeting of 1887 in the city of San Francisco.

The resolutions were unanimously adopted, and a committee was appointed to take the matter in charge.

A long discussion ensued regarding the advisability of giving a soirée, to be devoted exclusively to the demonstration of pathological subjects. The matter was finally laid over for future consideration.

A. H. Breckenfeld, *Rec. Secr.*

NOTICES OF BOOKS.

Notes on Histological Methods, including a brief consideration of the methods of Pathological and Vegetable Histology, and the application of the microscope to Jurisprudence. By Simon H. Gage, Assistant Professor of Physiology and Lecturer on Microscopical Technology. Ithaca, N. Y.: Andrus & Church. 1885–6. (Pamphlet, 8vo, pp. 56.)

An instructive pamphlet, comprising in a small space information that every student requires. It was prepared for the use of students in the anatomical department of Cornell University. The title fully expresses its scope.

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Photo-Micrography.—VIII.

BY THE EDITOR.

[*Continued from page 133.*]

The treatment of negatives after development is sometimes necessary in order to give good printing strength to such as are thin, and to reduce the density of such as are too dense. The methods of operating are many, but it will generally be found that the simplest are the best.

Intensification.—Prepare a saturated solution of corrosive sublimate in water, pour it into a tray and immerse the developed and fixed plate in the solution. This may be done immediately after the hypo-sulphite is washed out of the film, or at any subsequent time after the plate is dry, in which case the film should first be thoroughly soaked in water to ensure uniformity of action. The operation is finished when the film is whitened through, so that it appears white when looked at through the glass. It must then be thoroughly washed in water, and blackened by flowing with weak ammonia, or with a not very strong solution of soda sulphite, the latter being preferable to the ammonia. Then wash and dry.

Sometimes it is possible to increase the brilliancy of a flat, over-exposed negative in this way, especially if it is first subjected to the action of the cyanide reducing solution mentioned further on, but there is then liability to destroy the details, and such preliminary treatment must be applied with great judgment, or it will do harm. As a rule, it is better not to intensify negatives, for they are sure to lose something in softness and beauty.

A different form of the mercury intensifier is prepared as follows:—

Corrosive sublimate . . .	2 parts.
Potassium bromide . . .	2 "
Water	100 "

Put the negative in the solution, as before described, and after thorough washing darken the deposit with the sulphite. Those who prefer to use definite weights in preparing the sulphite solution may dissolve one part of the sulphite in six parts of water.

Reducing density.—This is an operation sometimes necessitated by over-development. It is not to be applied to under-exposed plates to diminish contrasts, except in such cases as permit of the local application of the reducer, for to apply it over the whole plate would only make the contrasts greater by removing the detail in the shadows. The method we prefer is a very old one, but, if we may judge from the current photographic literature, it is not in great favor among operators generally. It is useless to give exact proportions, for they will necessarily be varied to suit each case. Take a piece of potassium cyanide about the size of two peas and dissolve it in about four ounces of water. Make a solution of potassium iodide in an ounce of water, and dissolve in that sufficient iodine to make a strong solution. Then moisten the plate in water, take it in the hand by one corner and flow over it the cyanide solution with a few drops of the iodine solution added to it. If no reduction in strength is ob-

served add more iodine solution, and continue to do this until reduction begins. Then the strength is right, and the operation may be continued until the desired effect is obtained, pouring the solution over the plate, held level so as to flow evenly, and catching it in the glass as it flows off, so as to use the same mixture repeatedly. The operation can be done in a tray also, but there the progress of the reduction cannot be so critically watched.

Occasionally local reduction can be applied to advantage. A method that has been highly recommended is to moisten a piece of soft cloth with alcohol and rub it gently over the dense parts of the negative. The deposit is thus rubbed down, and the cloth becomes blackened. We have not experimented with this process, but it is well spoken of by reputable authorities. A method we have used with some success is the careful local application of the cyanide and iodine solution mentioned above. The plate was thoroughly soaked in a tray of water and the reducing agent applied with a flat brush just where it was required to act, frequently plunging the plate into clean water to prevent the action from spreading. By working slowly very good results were obtained.

(*To be continued.*)

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Provisional Key to Classification of Algæ of Fresh Water.—X.

BY THE EDITOR.

[*Continued from page 134.*]

Family NOSTOCACEÆ—Continued.

d. NOSTOCEEÆ. Group. 4.

Synopsis of Genera.

Curved chains, in gelatin with a common external envelope. *Nostoc*, 116.

Like *Nostoc*, but in indefinite gelatinous layers. *Anabæna*, 117.

Cylindrical, sheathless cells in filaments, spores cylindrical. *Aphanizomenon*, 118.

Spores on both sides of a heterocyst. *Sphærozyga*, 119.

Heterocysts terminal, spores single. *Cylindrospermum*, 120.

Filaments curved, in distinct sheaths, spores separated from heterocysts. *Aulosira*, 121.

Filaments sheathed; spores fuscous, golden yellow. *Nodularia*, 122.

Cells orbicular, in sheaths, spores unknown. *Chrysostigma*, 123.

Cells cylindrical, sheathed, heterocysts terminal. *Coleospermum*, 124.

Filaments curved, several in a sheath. *Hilsia*, 125.

116. Genus *Nostoc* Vaucher.

Trichomes composed of spherical cells, more or less curved and interlaced, with or without special gelatinous sheaths in a gelatinous matrix of definite form, enclosed in a common more or less firm membrane or pirederm. Heterocysts terminal or intercalate between the vegetative cells. Resting spores with thick envelopes, about the same size as the heterocysts, with granular contents, green, bluish, or yellowish-brown, formed from vegetative cells.

[In the course of vegetative increase, portions of the common gelatinous matrix soften, and some of the vegetative series of cells are set free, which for some time possess an oscillaria-like movement. These come to rest, and are not then to be distinguished from filaments of *anabæna*. New plants arise by the division of these cells parallel to the axis of the filaments, finally separating, and then grow into new filaments.]

117. Genus *Anabæna* Bory.

Filaments resembling *Nostoc*, but in single or in indefinite slimy masses. Heterocysts terminal or intercalate. Spores not contiguous to the heterocysts.

118. Genus *Aphanizomenon* Morren.

Filaments composed of cylindrical, vegetative cells without sheaths, united in free floating floes, blue or olive color. Heterocysts intercalate. Resting cells cylindric, not contiguous to the heterocysts.

119. Genus *Sphærozyga* Agardh.

Filaments not (or rarely) vaginate, in an amorphous, very diffluent mucilage, of indefinite form. Heterocysts intercalate. Resting spores on both sides of the one or two heterocysts.

120. Genus *Cylindrospermum* Kützing.

Plant like *Sphærozyga*. Heterocysts terminal, single. Spores single, just below the heterocysts.

121. Genus *Aulosira* Kirchner.

Filaments single, curved, enclosed in evident sheaths. Heterocysts intercalate. Resting spores cylindric, not contiguous to the heterocysts.

122. Genus *Nodularia* Mesteus.

Filaments distinctly vaginate, in a gelatinous, irregular stratum. Heterocysts regularly intercalated. Spores fuscous, or golden yellow, globose, slightly compressed.

123. Genus *Chrysostigma* Nobis.

Filaments single, consisting of orbicular, vegetative cells, enclosed in distinct sheaths. Heterocysts intercalate. Spores unknown.

124. Genus *Coleospermum* Kirchner.

Filaments composed of cylindrical cells, enclosed in a distinct sheath. Heterocysts terminal. Spores irregularly placed in the filaments.

125. Genus *Hilsia* Nobis.

Filaments curved, several enclosed in a sheath (or in the largest sheaths). Heterocysts single, intercalate. Spores unknown.

c. Oscillarieæ. Group 5.

Synopsis of Genera.

Filaments distinctly articulated colorless; macro and micro-gonidia. *Crenothrix*, 126.

Filaments short, bright green, attached. *Chamæsiphon*, 127.

Filaments free, single or in indefinite layers. *Lyngbya*, 128.

Like *Lyngbya*, but erect, in fascicles. *Symploca*, 129.

Like *Lyngbya*, but united in bundles in a common sheath *Microcoleus*, 130.

Like *Microcoleus*, but erect, and united in fascicles. *Inactis*, 131.

1. *Filaments in distinct sheaths, mostly without movement.*

126. Genus *Crenothrix* Cohn.

Filaments distinctly articulated, colorless, in sheaths closed at the ends.

Propagation by two kinds of gonidia, of which the larger (macrogonidia) are produced by the breaking up of the ends of the filaments into the single cells, the smaller (microgonidia) by the division parallel and at right angles to the axis of the filaments. Both kinds of gonidia accumulate in the swollen end of the sheath and germinate after breaking through the latter.

127. Genus *Chamæsiphon* A. Braun and Grunow.

Filaments short, attached, light blue-green, with thin, but distinct colorless sheaths. Propagation by unicellular gonidia.

128. Genus *Lyngbya* Agardh em Thuret.

Filaments not attached, single or often forming a membranous, consistent shapeless layer, variously colored; sheaths distinct, each containing only one filament. Propagation by germinating filaments which creep out of the sheaths and develop new plants.

129. Genus *Symploca* Kützing.

Filaments in sheaths like *Lyngbya*, but several united in small, upright bundles, which generally form larger fascicles.

130. Genus *Microcoleus* Desmazières em Thuret.

Filaments as in *Lyngbya*, but several or many united in a bunch and enclosed in a common sheath, which is either open or closed at the end, and which usually separates in fine branches. Bunches single or united in formless membranous layers.

131. Genus *Inactis* Kützing em Thuret.

Filaments as in preceding genus, several in a common sheath (at least in the larger sheaths), but upright,

and united in bunches or small fascicles, like *Symploca* (129).

2. *Filaments naked, or without distinct sheaths, mostly with active, creeping movement.*

a. Filaments not curved like a corkscrew.

Synopsis of Genera.

Sheath very delicate or absent, cell contents blue-green, movement active. *Oscillaria*, 132.

Like *Oscillaria*, but colorless. *Beggiatoa*, 133.

Like *Oscillaria*, filaments usually very fine, motionless. *Leptothrix*, 134.

Flexible, blue-green, moving. *Spirulina*, 135.

Like *Spirulina*, but colorless. *Spirochæte*, 136.

132. Genus *Oscillaria* Bosc.

Filaments straight or curved, naked, or with a very thin, scarcely discernable sheath; cell contents (usually blue-green) colored. All manifest a more or less active creeping movement.

133. Genus *Beggiatoa* Trevis.

Filaments as in *Oscillaria*, with active movement; cell contents colorless, with single, refracting granules of reguline sulphur.

134. Genus *Leptothrix* Kützing.

Filaments as in *Oscillaria*, usually very fine, always motionless.

b. Filaments curved like a corkscrew.

135. Genus *Spirulina* Link.

Filaments flexible, with blue-green contents, and active *Oscillaria*-like movement.

136. Genus *Spirochæte* Ehrenberg.

Filaments like those of *Spirulina*, with active movement, very fine, with colorless contents.

[*To be continued.*]

Key to the Desmidieæ.

BY DR. A. C. STOKES.

[*Continued from page 131.*]

21. Euastrum.

§ End lobe evidently distinct (*a*).
§ End lobe not evidently distinct (*b*).
a. End lobe deeply notched (*c*).
a. End lobe more or less concave (*g*).
b. End deeply notched (*e*).
b. End more or less convex semi-cell; with 7 or 8 lateral, short, conical teeth . . . . . *Donnellii*, 103.
b. End more or less convex; sides without teeth . . . . *pingue*, 105.
c. Margins smooth (*d*).
c. Margins more or less spinous or beaded (*f*).
c. Margins dentate (*h*).
d. Basal lobe deeply notched; basal *lobule* broadly marginate; central *lobule* obtuse . . . . . *multilobatum*, 98.
d. Basal lobe undulate (*m*).
d. " rounded or angular (*t*).
e. Margins smooth (*k*).
e. " cuspidate, spinulose or beaded (*l*).
f. Basal lobe undulate (*w*).
f. " rounded or angular (*x*).
g. Margins smooth (*i*).
g. " cuspidate, spinulose or beaded (*j*).
h. End lobes horizontal . . . *Nordstedtianum*, 105; *spinosum*, 106.
h. " upright, diverging . . . . . *formosum*, 103.

i. Basal lobes deeply notched (*y*).
i. " undulate (*z*).
j. Cytioderm rough with conic granules; semi-cells with 1 large central inflation, a smaller one on each side, 2 on end lobe, *verrucosum*, 100.
k. Basal lobes undulate (*cc*).
k. " rounded or angular (*ee*).
l. A short spine on the angles of end and basal lobes . *divaricatum*, 104.
l. A small projection on each side near the apex . . *compactum*, 107.
m. Cytioderm more or less tuberculate (*n*).
m. " punctate (*o*).
m. " smooth (*r*).
n. Tubercles basal, mostly 5 . . . . . *circulare*, 101.
n. " 5 central, 4 marginal . . . . . *elegans*, 106.
n. " scattered; end lobe with a tooth on each side, *ornithocephalum*.*
o. Semi-cell 5-lobed, basal lobe emarginate, the lateral small, entire, *pinnatum*, 98.
o. " not 5-lobed (*p*).
p. Basal lobe with 1 lateral, subcentral tubercle, not emarginate, *ampullaceum*, 100.
p. Basal lobe without lateral tubercle, slightly emarginate, . *affine*, 100.
p. " " " " not emarginate, *ornatum*, 97; *didelta*, 99.
r. Semi-cell subrectangular, basal lobe very broad, end lobe partly included between the lateral. . . . . *crassum*, 97; *ventricosum*, 160.
r. Semi-cell more or less pyramidal (*s*).
s. Diameter $\frac{1}{500}$ in. or more (50–55μ) . . . . . *Everettense*, 102.
s. " less than $\frac{1}{500}$ in., *Porkornyanum*, 104; *erosum*, 104; *elegans*, 106.
t. End lobe on a long slender neck; basal lobe with 6 protuberances, *mammillosum*, 102.
t. " " " " basal lobe without protuberances, *insigne*, 102.
t. End lobe not on a long neck (*u*).
u. Basal lobe much wider than the end lobe (*v*).
u. " scarcely wider; diameter less than $\frac{1}{600}$ in. (42μ), *simplex*, 106.
v. Basal sinus narrow, basal lobes approximate . . . . *ansatum*, 99.
v. " wide, basal lobes widely separated . . *intermedium*, 102.
w. End lobe beaded; angles of basal lobes beaded . . *ventricosum*, 160.
w. " dentate; angles of basal lobes dentate . . . *simplex*, 106.
w. " smooth, its angles spinous or cuspidate . . *rostratum*, 106.
x. Angles of end lobe and margins of basal each with 3 diverging spines, *cuspidatum*, 105.
x. " " with short spines, margins of basal dentate or granulate . . . . . *abruptum*, 107.
x. Angles of end lobe with one cusp or spine . . . . *rostratum*, 106.
y. Basal and central lobules both slightly emarginate . . *oblongum*, 98.
y. Basal lobes slightly emarginate, central obtuse . . *multilobatum*, 98.
z. End lobe columnar, margins nearly parallel, end truncate *attenuatum*, 103.
z. End lobe not columnar, partly included between the lateral lobes, *oblongum*, 98.
z. " " not included (*aa*).

* Journ. R. Micr. Soc., Feb., 1886.

aa. Cell 2–3 times longer than broad; diameter $\frac{1}{333}$ in. (75μ), *humerosum*, 99.
aa. Cell twice longer than broad; diameter $\frac{1}{1800}$ in. (14μ), *Lundellii.*
aa. Cell $\frac{1}{2}$ or less longer than broad (*bb*).
bb. Semi-cells urn-shaped; diameter $\frac{1}{500}$ in. (50μ) . . *urnaforme*, 100.
bb. " more or less quadrate; basal lobes horizontal, emarginate; protuberances minutely granulate . . . . . *gemmatum*, 101.
bb. Semi-cells more or less pyramidal, basal lobes emarginate, *insulare*, 104.
cc. Angles of end lobe acute . . . . . *elegans*, 106.
cc. " " rounded or obtuse (*dd*).
dd. Diameter $\frac{1}{650}$ to $\frac{1}{450}$ in. (32–38μ) . . . . . *inerme*, 104.
dd. " $\frac{1}{1800}$ in. (14μ); length $\frac{1}{900}$ in. (28μ) . . *crassicolle*, 105.
dd. " $\frac{1}{1125}$ to $\frac{1}{1250}$ in. (20–22μ); length $\frac{1}{900}$ (28μ), *compactum*, 107.
cc. Angles of end lobe acute (*ff*).
cc. " " obtuse or rounded (*gg*).
ff. End notch broad, gaping, the apices upright . . . . *binale*, 107.
ff. " narrow, close, the apices horizontal . . . *simplex*, 106.
gg. End broadly rounded, continuous with the sides; diameter $\frac{1}{1800}$ (14μ), *obtusum*, 107.
gg. End elevated above the sides, a small projection near the apex on each side . . . . . *compactum*, 107.
gg. End elevated, no lateral projections . . . . . *pingue*, 105.

22. Micrasterias.

§ Cell more or less circular (1).
§ Cell oblong (2).
1. End lobe narrow, lengthened into divergent arms (*a*).
1. " " not lengthened into arms, semi-cells 5-lobed (*b*).
1. End lobe broad, not lengthened into arms (*c*).
2. Semi-cell 5-lobed, lobes horizontal; end lobe with 4 arms (*d*).
2. " " lobes not horizontal, approximate; no arms, *Jenneri*, 115.
2. Semi-cell 3-lobed, lobes horizontal; end lobe with 4 arms (*d*).
2. " " " " end lobe without arms (*f*).
a. Semi-cell 5-lobed (*k*).
a. " 3-lobed, lobes radiate (*l*).
b. End lobe not or slightly exserted (*t*).
b. " " conspicuously exserted (*r*).
c. Semi-cells 5-lobed (*m*).
c. Semi-cells 3 or obscurely 5-lobed; lateral sinus shallow, obtuse; lateral angles mucronate . . . . . *decemdentata*, 113.
d. Basal lobes with 3 linear processes on each side . . *muricata*, 118.
d. " without linear processes, but (*e*).
e. Forked once only, margins finely serrate . *Mahabuleshwarensis*, 112.
e. " " margins smooth . . . . . *Nordstedtiana*, 113.
e. Forked twice (lobules forked); cytioderm spinous . . . *spinosa.**
e. " cytioderm smooth; margins serrate . *Hermanniana*, 112.
e. " " " margins not serrate, *Americana*, 112.
f. End lobe nearly as wide as the basal, apices deeply notched (*g*).
f. " " " " apices not deeply notched (*h*).

* Journ. R. Micr. Soc., Dec., 1885.

f. End lobe much narrower than the basal, end convex . *oscitans*, 116.
f. " " " " end deeply emarginate, *foliacea*, 118.
g. Basal lobes furcate (with lobules), (*i*).
g. " not furcate (*j*).
h. End lobe convex, without prominences . . . . . *laticeps*, 115.
h. " truncate, with 2 small prominences . . . . . *recta*, 112.
h. " retuse, basal lobe furcate . . . . . *Baileyi*, 118.
i. " with 2 slender, transverse, bidentate projections, *quadrata*, 117.
i. " without projections, convex; sinuses broadly rounded, *Kitchellii*, 116.
i. End lobe without projections, concave; neck short; sinuses acutish, *Rabenhorstii*, 118.
i. " " " " neck long; basal lobes curved upward . . . . . *simplex.**
j. Basal lobes horizontal, not curved . . . . . *pinnatifida*, 116.
j. " curved upward, narrow, *expansa*, 117; *arcuata*, 117; *simplex.**
k. Basal and lateral lobes deeply furcate (with lobules) . *furcata*, 111.
k. " " " shallowly furcate, *Crux-Melitensis*, 111; *superflua.*†
k. " " " not furcate . . . . . *pseudofurcata*, 111.
l. Lobules deeply furcate: borders not serrate . . . . *dichotoma*, 111.
l. " not furcate, borders not serrate . . . . . *ringens*, 112.
l. " " borders serrate . . . . . *serrulata.**
m. End lobe remote from the lateral (*n*).
m. End lobe not remote from the lateral (*o*).
n. End lobe triangular . . . . . *triangularis*, 115.
n. " not triangular . . . . . *hamata*, 114.
o. Lobes closely approximate, radiating (*p*).
o. " " " not radiating, end lobe truncate, *truncata*, 114.
p. End lobe triangular . . . . . *triangularis*, 115.
p. " cuneate, end concave . . . . . *conferta*, 114.
p. " very broad, end truncate or convex . . . . *crenata*, 113.
r. Cytioderm papillose . . . . . *apiculata*, 110.
r. " not papillose (*s*).
s. Basal lobes with 4 subdivisions, lateral with 8; apices of end lobe furcate, *rotata*, *fimbriata*, 109.
s. " " " " " apices of end lobe not furcate . . . . . *cornuta.*
s. Basal lobes with 2 subdivisions, lateral with 4 (*u*).
s. Basal and lateral lobes with the same number of subdivisions (*v*).
t. End lobe with 1 row of pearly granules . . . . *Minnesotensis.*†
t. " without pearly granules (*y*).
u. End lobe exserted on a long neck . . . . . *brachyptera*, 110.
u. " without long neck, its apices furcate . . . *simplex*, 110.
v. Margins spinous . . . . . *brachyptera*, 110.
v. " not spinous . . . . . *bispinata.*†
y. Sinuses deep, inwardly widened and rounded; subdivisions of semi-cell 20–40 . . . . . *radiosa*, 109.

* Bulletin Torrey Botanical Club, Dec., 1885. † Journ. R. Micr. Soc., Dec., 1885.

y. Sinuses inwardly more or less acute (*z*).
z. Base of semi-cell with a row of circular inflations . . . *verrucosa*.*
z. " " without inflations (*aa*).
aa. Lobules long, the lobes being deeply incised . . . . *Torreyi*, 108.
aa. " short, the lobes not deeply incised (*bb*).
bb. Margins with spinous teeth . . . *fimbriata*, 109; *papillifera*, 109.
bb. " without spinous teeth (*cc*).
cc. End lobe somewhat remote from the lateral . . . . *fimbriata*, 109.
cc. " approximate (*dd*).
dd. Its apices not dentate nor divided, end convex . *Pseudotorreyi*, 108.
dd. " " " end concave or emarginate, *denticulata*, 109.
dd. Its apices with denticulate appendages . . . . . *Novæ Scotiæ*.*

* Bulletin Torrey Botanical Club, Dec., 1885. † Journ R. Micr. Soc., Dec., 1885.

[*To be continued.*]

On Mounting Certain Diatoms.

A collection of diatoms recently received from Mr. L. M. King, of California, specimens of which he offers for exchange, calls to mind some methods of mounting such diatoms. The collection was a remarkably pure gathering of *Isthmia nervosa* attached to seaweed. These beautiful diatoms are very attractive objects however they may be mounted, but by the exercise of some skill and patience their natural beauty may be brought out far better than it is often seen.

There is a fine art in mounting microscopic objects, that many of the more stolid investigators affect to despise; but so long as the specimens are not distorted, misshapen, or crushed out of their natural condition, they lose nothing for purposes of study, by being skilfully prepared for exhibition, and there is no doubt the more perfectly the minute perfections of microscopic shell carapaces, and other organic structures are revealed by our art, the more attractive does our science become. One may be very wise and familiar with details of microscopic structure through long studies from the strictly scientific side, and yet oblivious to the beauty and wonder which would inspire another not less learned. The difference is surely in favor of those who most keenly appreciate the esthetic in their work, for from that arises an inspiration which elevates and broadens our thought, and is an incentive to further study and search for the sources and relations, not only of the organisms themselves, but also of their microscopic carvings and elaborate ornamentation. Have we any reason to suppose that the markings on a shell of a diatom are merely for beauty—to please the eye and arouse the wonder of the microscopist? Be assured there is a deeper reason for them, perhaps purely utilitarian, if only to combine strength with lightness; perhaps they are manifestation of that tendency observed throughout organic nature which some one has characterized as 'a kind of organic crystallization'—an expression that implies symmetry and beauty of form, while it does not conceal the want of knowledge that underlies it.

The usual method of mounting *Isthmia* is by drying the frustules, either on the seaweed or, freed by shaking, on an opaque ground. In this way, exercising some care in selecting the most showy groups, very attractive specimens can be obtained. A dry mount of the free frustules can be greatly improved by previously clearing them, or rather removing the dried endochrome. The best way to

do this is to place them for a few minutes in a bleaching solution which may be chlorine water Labarraque solution, or any such active agent. No acid is required. In the course of fifteen minutes the frustules will probably be quite white and, owing to the air contained in them, they will form a perfectly pure layer floating at the top of the fluid. It is then only necessary to remove the solution below by means of a pipette or syphon, wash several times with water, drawing it off in the same way, and finally collecting the diatoms in a bottle with some alcohol for preservation. They are now perfectly clean, and white as snow.

To prepare a dry mount select a clean cover-glass and place a sufficient number of the cleaned diatoms with water upon it to form a perfectly even layer of the diatoms over the central part of the cover. As the water evaporates the frustules will gather close together and form a compact mass in a single, uniform layer, perfectly adapted for a display slide. An exceedingly thin and clear solution of gum may be used in this operation to attach the frustules more securely. When thoroughly dry cement the cover-glass over a ring just deep enough to protect the diatoms, preferably with a dead black bottom.

This particular diatom, however, is a far more brilliant object when mounted in balsam and viewed with a dark field. It is likewise one of the most difficult to mount in balsam, owing to the persistence with which the air is retained within the frustules. A mount in balsam of the diatoms attached to the seaweed as they grow can be made by the method devised by the late Charles Stodder. Selecting a perfectly dry specimen, place it in chloroform for a short time, and, if necessary in order to remove all the air, heat the latter gently. In this way the frustules become filled with the liquid. Then place some drops of chloroform on a slide, transfer the specimen selected for mounting to this, and keep it covered with the liquid. It is well to put on a cover-glass to prevent rapid evaporation of the liquid. Then add chloroform balsam and let it run under the cover and follow the chloroform as it evaporates from the frustules, aiding the operation with gentle heat. In this way the hollow frustules can be completely filled with balsam without difficulty, and the mounts thus obtained are very fine.

In mounting the free frustules in balsam we have adopted a plan somewhat different in detail, in order to obtain a perfectly flat and even layer of frustules against the cover-glass. The cleaned specimens in considerable abundance were first placed in chloroform in a small vial, and raw, hard balsam added until a not very thick solution was obtained, which thoroughly permeated the shells. The solution was poured upon a cover-glass resting on a mounting table with a spirit-lamp beneath. In a short time the frustules settled down upon the cover-glass and formed an even layer. The closer they are the more effective the result. Heating now, very gently indeed, the balsam becomes slowly hardened without disturbing the diatoms. If necessary, more balsam can be added, but if possible a sufficient quantity should be put on at first, as the addition of more is likely to disarrange the specimens. The balsam must be thoroughly hardened, without heating enough to discolor it. We now have the frustules nicely mounted in the balsam on the cover-glass, and the latter may now be turned over and attached to a ring on a slide, and the mount thus finished. It will be greatly improved, however, by the well-known process of backing with black varnish. First put on a layer of shellac over the balsam to protect it from the action of turpentine, and then apply an opaque layer of black varnish. When this is thoroughly dry, mount the cover-glass on a ring and it will make one of the finest objects in any cabinet.

Staining Tissues in Microscopy.—XI.

BY PROF. HANS GIERKE.

[*Continued from page 99.*]

239. Busch. Die Doppelfarbung des Ossificationsrandes mit Eosin and hæmatoxylin. Verhandl. d. Berl. Phys. Ges., 1877, No. 14.

Sections of decalcified bones are placed for some days in a ½% chromic acid or 1% potassium bichromate, carefully washed and put into eosin solution. When sufficiently stained they are put in hæmatoxylin. Fundamental cartilage appears light blue on the edges of ossification, the nuclei of the neighboring cartilage cells are red, the contents of the medullary cavity light red, while the formed bone is a mixed tint between blue and red.

240. Renaut. Sur l'éosine-hématoxylique et sur son emploi en histologie. Compt. rend., lxxxviii, 1039–1042.

Equal parts of neutral glycerin and a saturated solution of eosin in alcohol or water are mixed, to which is added by drops Böhmer's hæmatoxylin (see No. 37) till the green fluorescence can scarcely be perceived. These stainings are mounted in salted glycerin (1–100) or in balsam. If the latter, they should be treated with alcoholic eosin (absolute) or clove oil. Good results are obtained from material hardened in alcohol, chromic or osmic acid. Nuclei stain violet, connective tissue gray, elastic fibers and blood corpuscles dark red, cell protoplasm and nerve axes rose color. The secretory cells of the salivary glands stain blue, their nuclei violet, and the crescent of Gianuzzi deep red.

241. Brandt. Färbung lebender einzelliger Organismen Biol. Centralbl., 1881, p. 202.

In staining unicellular organisms hæmatoxylin and Bismarck brown may be combined with success.

242. Renaut. Sur le mode dé préparation et l'emploi de l'éosine et de la glycérine hématoxylique en histologie. Arch. le Phys., 1881, p. 640.

Another method similar to No. 240. Make a saturated solution of eosin in salted glycerin and mix with a glycerin saturated with potash alum. Filter and add alcoholic hæmatoxylin. Mount with treatment as in 240 or in the staining fluid itself.

243. Stirling. See 230. Hæmatoxylin and iodine green or eosin.

ANILIN COLORS WITH METALLIC SALTS.

244. Lawdowsky. See No. 88.

To ammoniacal eosin in open air add picric acid to neutralization, the resulting compound is an excellent stain.

245. Calberia. See No. 96.

Dissolve 60 pts. methyl green and 1 pt. eosin in 30% warm alcohol and stain. The cuticle becomes grass-green, lymph cells blue, striped muscle red, nuclei green, unstriped muscle green, and the intercellular substance red.

The efferent ducts of the salivary glands stain blue, the follicles red, cells of connective tissue green or greenish blue. In the sinews the perichondrium becomes light green, nuclei deep green, Ranvier's cells medium green, and the stroma rose red.

246. See No. 99.

The tails of young rats and mice are treated with silver as usual, then tinged with eosin.

247. Schiefferdecker. Kleinere histologische Mittheilungen Arch. Mikr. Anat., xv., 30–40.

Various anilins as dahlia, methyl-violet, and green—not the methyl-green of Calberla—were combined with a red like eosin since 1876. The smaragd green was found worthless. Sections are placed first in alcohol, then in a little alcoholic eosin so long as required for the depth of color de-

sired. Wash quickly in water which extracts some color, then drop in 1% aqueous solution of either of the other dyes. When stained almost black, wash in water and put in alcohol, which extracts both dyes, and the exact moment should be seized to remove the section when of the precise shade. No directions as to time can be given. Oil of cloves does not extract eosin but acts slightly on the other dyes, and should be carefully removed before mounting in balsam. Minute descriptions of the peculiar effects of this method on different organs are given.

248. Tafani. Nouveau procédé de coloration des préparations microscopiques avec une solution picro-anilique. Journ. de Microgr. 1878, p. 127–130.

A mixture of picric acid and anilin blue gives a fine stain for nuclei. Add 3–4 parts of aqueous blue to 100 parts of picric acid in water, both saturated solutions.

249. Ehrlich. See 102. Several anilins are combined for staining the granulations of leucocytes.

250. Barrett. Staining fluids for vegetable tissues. Journ. R. Soc., ii, 942.

Plant tissues are first put in a solution of 'Crawshaw's anilin blue,' then in strong acetic acid, then in a weak magenta (Judson's), again in acetic acid, and then mounted in glycerin-gelatin.

251. Gibbes. See No. 229. Gilds the preparations first, then stains in anilin.

252. Stirling. Recommends 251 with anilin blue, iodine green, and rosein.

253. Richardson. On a blue and scarlet double stain, etc. Jour. R. Micr. Soc., i, 573–574 and 868–872.

See No. 232. Sections of the spinal marrow are soaked in atlas scarlet, first dissolved in alcohol and glycerin, then diluted with water, and then in soluble anilin blue prepared with glycerin first, and diluted with water. When of the proper shade, lay a few minutes in water, and add some glacial acetic acid, then mount in balsam. No proportions are given, and the process is therefore uncertain.

254. Johne. Zur mikroskopischen Technik. Dtsch. Zeitschr. f. Thiermed. u. vergl. Path., ii, 401–403.

Double staining with Gentian violet and eosin or hæmatoxylin and picric acid. The last may be mixed with oil of cloves.

255. Moore. Double staining of nucleated blood corpuscles. Micr., 1882, ii, 73–76, and

256. Stowell. Coloration différentielles des globules nucléés du sang. The Microscope and its relations to Med. and Pharmacy, 1882.

The blood is dried on the object-glass, then eosin (1 to 50 water and 50 alcohol) and methylgreen 1–100 water are poured on it. The first must be allowed to dry before the second is applied. Mount in balsam.

257. Ranvier. See No. 151.

258. Hansen. Weiner med. Jahrb., 1871.

Both the above advise to combine the treatment with silver and gold.

259. Lawdowsky, see No. 184, independent of the two previous writers, appears to have thought of the same combination. The silver treatment comes first, and experiment is required to determine the strength of the reagents.

260. Hoggan. Journ. de l'Anat. et Phys., 1879, pp. 54, 588.

Same as 259.

261. Jullien. Sur une nouvelle méthode de coloration des éléments histologiques. Lyon méd, 1872, No. 17.

A mixture of indigo carmine and concentrated picric acid is recommended as a beautiful green stain, coloring connective tissues blue, epithelium yellow. Mount in glycerin.

262. Wedl. Ueber Orseille als Tinctious mittel für Gewebe. Archiv. f. pathol. Anat., lxxiv, 143.

Recommends the dyestuff of Rocella tinctoria and other lichens.

——o——

Making Cells.

I observe your notice of the Postal Club in the March Journal. I have had some experience in the use of wax circles, and brass rings for cells. I cut the wax rings from sheet wax with Beck's improved brass punch, moistening same with starch prepared as for laundry use. To secure them, clean the glass slip thoroughly, being careful not to touch the central face with the fingers. King's amber cement, as recommended by Hervey in 'Behren's Guide,' is an excellent cement. Lay on a ring of cement, centre the wax cell in it, and as soon as it will so remain, cover the wax cell entirely with a layer of cement. Now gently warm the whole, until the wax cell settles close to slide, when all air will escape. Then lay aside to harden. Some experience will soon make this an easy manipulation. The edges of the wax cell will be rounded, and the entire cell, sides, bottom and top, will be coated with the cement. I then lay them aside to cure. This results in two or three weeks. The longer the better. I keep mine three months. The wax should be dried between sheets of paper before the cells are cut.

In using brass cells, cleanliness of the slide is simply imperative. Lay on a ring of the amber cement, then centre the brass ring in it. Allow it to dry, or firmly set. Then run a heavy ring upon and against the outside of brass ring, and neatly round it, or pile it, with a knife blade. When thoroughly dry, the ring is secure. King's 'Lacquer cell and Finish' may be used in place of the amber, or as a finish. Nothing can be finer.

Eugene Pinckney.

Photo-Micrography Without a Camera.

I have read your articles on photo-micrography with a good deal of pleasure, but there is one point on which I wish to present a few words. You say, in speaking of the method without a camera, that 'it involves considerable expense.' It seems to me that we cannot increase the expense by dispensing with the camera bellows, which is always one of the most expensive parts of the outfit

Again, by working in a dark room we can also dispense with a light-tight plate-holder, the simplest form of holder being perfectly satisfactory. The only extra expenses possible are to provide some means for darkening the room in the day-time, which may be done with very cheap curtains, and to provide a cloth hood to extend from the body of the microscope to the stage, and a cap or diaphragm for the lamp or lantern. I have tried both methods, with and without a camera, and I think the latter has some advantages. The apparatus that I have been using was constructed almost entirely by myself, at an expense of but a few dollars less than the camera alone for the other method would cost. Although my apparatus is somewhat rough, it is quite satisfactory.

Some of the advantages of this method are, that I am not limited by the length of the bellows but I can place the plate-holder at any distance from the microscope up to five feet. The apparatus might be made much longer if it is thought desirable. I can use the coarse adjustment with greater ease by this method. I can stand by the microscope and focus on the ground glass, or on a card, quite accurately. Replacing the ground glass or the card by plain glass, I can make the more accurate adjustment by the method adopted by Mr. W. H. Walmsley and others.

As I have said, the plate-holder is very simple, and one can be fitted to use very large plates at a very small

expense. This can not be said of the camera method.

The method without the camera has other advantages; in short, in every respect it is equal or superior to the method with the camera, with the possible exception of photography of opaque objects, and I think that it might be adapted to this work by slight modifications.

I think it would be an advantage to dispense with the microscope stand, and I have a plan for a complete photo-micrographic apparatus to be used in a dark room.

C. E. Norton, M. D.

EDITORIAL.

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Report of the Bureau of Animal Industry.—The Second Annual Report of the Bureau of Animal Industry, Department of Agriculture, Washington, D. C., has recently been issued, giving a record of the work during the year 1885. While there is much in the volume that is more of practical than of strictly scientific interest, there is also a great deal that deserves full notice in this place. Naturally the interest of microscopists and physicians centres mainly upon the researches into the bacterial origin of disease, which have been so ably conducted in the laboratory during the past few years by the Chief of the Bureau, D. E. Salmon, D. V. M., and more recently by Dr. Theobald Smith, to whose knowledge and skill as an investigator some of the most important results in this field are due.

The importance of the work of the Bureau may be indicated by the single fact, stated by Dr. Salmon, that pleuro-pneumonia which broke out among the cattle in Ohio, in 1883, has already, during the twenty months required to control it, cost the country millions of dollars, while with proper laws, such as could be formulated by the officers of the Bureau, the plague could have been effectually extirpated for a sum not greater than $100,000. But we must turn to the laboratory work.

The report begins with an extended review of experiments made in different countries to prevent pleuro-pneumonia by inoculation. This is a very useful compilation of results, and tends to show that while in some instances inoculation seems to confer a degree of immunity, it is quite as likely to introduce the disease among healthy animals, and is therefore a dangerous, and in practice a very useless operation. The only course of prevention advised is the killing of infected animals, and thorough disinfection of the premises.

The results of investigations of the Swine-plague possess especial interest at this time, not only from the conclusions as to the cause of the disease, but also because of the general and comprehensive review presented, which shows the unusual difficulties of the work, and the explanation of previous results which have demanded reconsideration. It is well known to the readers of these columns that several distinct organisms have been described by different observers as the cause of this disease, but several circumstances have conspired to make the investigation one of extreme difficulty, and only those who have had experience in such work can fully ap-

preciate the various possible sources of error. Some confusion has arisen in the assumption that the disease known as *rouget* in France is the same as the swine-plague of this country. Some specimens of Pasteur's cultures of the *Bacillus* of *rouget*, which is the same disease as the *rothlauf* studied by Löffler in Germany, were tested in the laboratory, and it was found that the diseases are quite distinct, and that Pasteur's vaccine does not confer immunity against the swine-plague of the United States. Pasteur's vaccine contained a very minute *Bacillus*, which appears to be the same as that already described by the German investigators.

Having thus disposed of the *Bacillus* of *rouget*, by experiments in cultivation and inoculation, it remained still to discover the specific microbe of the disease in question. It will be remembered that some time ago Dr. Salmon announced the discovery of a *Micrococcus*, which he then regarded as the cause of swine-plague. Some successful inoculations were made with it, but further opportunity for thoroughly testing the matter did not present itself. Last year some well-defined cases of the malady offered the long-desired opportunity to renew the investigations, and the results have shown, in a most conclusive manner, that the active agent in this disease is not the previously described *Micrococcus*, but a species of *Bacterium*. It is motile, of an elongated oval form, usually seen in pairs 1.2μ.—1.5μ. in length by 0.6μ. in diameter. Its thermal death-point is 58° C.

The reason for the previous failures to discover this organism is principally the fact that it is very difficult to isolate the specific microbe from the many others that are found with it in the lesions of chronic cases, such as had previously been studied. In acute cases, which were afterwards studied, the cultures were readily obtained pure. The best source of the material for cultures is the spleen.

In the Annual Report of the Department of Agriculture, 1881–'82, Dr. Salmon set forth a theory of immunity against contagious diseases which has recently received considerable attention. Some experiments with the swine-plague bacterium have lent confirmation to these views. The theory is essentially as follows:

The microbes of a disease are only able to multiply within the animal organism by virtue of a poisonous principle produced by their growth, which acts upon the animal bioplasm and modifies its activity, thus rendering it incapable of resisting the attack of the germs. After a time, however, the tissues recover from continued action of the poison, and, being no longer affected by it, do not permit the microbes again to gain a foothold. Thus a single attack confers immunity against a second.

It is well known that the opinion prevails at the present time that all germ diseases are caused by peculiar poisonous compounds produced by the growth of the microbes, supposed to be chemically related to the alkaloids, and known by the rather inexpressive name of ptomaines. Experiments have clearly shown that the culture-fluid of the swine-plague *Bacterium*, after exposure to a temperature of 58° C. until completely sterilized, when injected into pigeons renders those animals proof against subsequent inoculation with the living bacteria. Herein is one of the strongest experimental confirmations of the theory of Dr. Salmon, and it may lead to results of the utmost importance in the prevention and treatment of disease.

Among the various other microbes found in swine-plague a peculiar chromogene species has been studied and is fully described in this report under the name of *Bacillus luteus* (*suis*). It is a species possessing a most remarkable tinctorial power, but for a

satisfactory description of it the reader must refer to the original, where its peculiar methods of growth are beautifully illustrated by colored plates.

It may not be generally known that in the determination of specific distinctions among bacteria the mode of growth is often quite as characteristic of the different forms as the appearance, size, and other features revealed by the microscope. The microscopic appearance of a colony growing upon a slice of potato, on a gelatin plate-culture, or in a tube of gelatin, is often quite characteristic, and enables the experimenter to isolate the particular species desired for pure cultures when there are colonies of different forms upon one gelatin surface. The bacterium of swine-plague, for example, does not liquify the gelatin as it grows, a fact which at once distinguishes it from *Bacterium termo*.

——o——

Life and Death.—The mystery of life is no greater than that of the necessity of death. Go back to the origin of life—as near to it as we can—and we find it manifested in minute particles of matter, which move and grow. They have no visible structure, they only differ from the inert matter around them in the arrangement of their ultimate atoms and molecules. This arrangement, through which vitality becomes possible—which perhaps constitutes life, or all we shall ever know concerning it—when once established under favorable conditions may continue indefinitely. This is true of the simplest organisms. A single individual may give rise to an innumerable progeny, by indefinitely repeated fission, and though the individual be lost, merged into its unnumbered offspring, yet its vitality continues. Strictly speaking, among these low forms of life there is no mother or daughter. There is only an original cell that we recognize as an individual, which, by its peculiar power, transforms inert matter into bioplasm, and the living bioplasm continues this transformation and grows, dividing as it reaches a certain limit of size, and the progeny continue the same operations.

There is an increase of vital action with growth and the birth of each new cell. An interesting problem for speculation is suggested by this fact. Whence does this increment of vital force come? Obviously there must be a transformation of the latent energy of the inert matter that is taken up and formed into the bioplasm. The tearing apart of the atoms of dead matter to form complex organic compounds involves the expenditure of enormous energy by the microscopic cell. If we could measure the amount of such work, we could determine the mechanical equivalent of the life force. It is not incredible that this may yet be done. So far as its physical manifestations are concerned, life is essentially a succession of chemical phenomena, in which the atomic forces of inert matter are transformed into their equivalents in the molecules of bioplasm. Here, as throughout the range of physical phenomena, the law of conservation of energy holds true. The amount of energy in the universe remains constant, but a large proportion of it is constantly undergoing change from dead to living, from life to death. As Dr. Minot has inquired, 'May not life be coeval with energy? May it not have always existed?'

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Dr. Piersol's Photo-micrography.—The article on photo-micrography by Dr. Piersol, which has already appeared in these columns, deserves to be carefully read. The use of colored screens in the manner described is not absolutely new, and it has been already mentioned and advised in this Journal, but to Dr. Piersol is due the credit of having made a careful study of the subject as applied to the work upon which he has been engaged, and of perfect-

ing the method. So far as we are aware, no person has carried experiments in this direction quite so far as he; and those who have seen his photographs of that very difficult subject, the *Bacillus tuberculosis*, cannot fail to recognize the advantages of the method.

The same principle is now applied quite extensively to the copying of paintings, in order to represent the colors in their proper relative strength in the photographs. The so-called ortho-chromatic or iso-chromatic sensitive plates, now to be obtained from dealers in photographic goods, are intended to accomplish the same purpose, but they also require the use of colored screens, to prevent the undue action of the more refrangible rays. Such plates may be found useful in photo-micrography, but it is well to consider that they differ from other plates mainly in their greater sensitiveness to the less refrangible rays, while they are scarcely less sensitive to the blue which still preponderates. For this reason, in order to obtain strictly uniform results for all colors, colored screens must be used, particularly when working with sunlight. The great advantage of such plates rests in the fact that they are sensitive to the red and less refrangible rays which do not or only slightly affect the ordinary plates.

In this connection we may add the results of an observation quite recently made which clearly shows the great difference in emulsions of different makers. In developing some negatives on Eastman's paper it was found that they rapidly fogged, and it was at first thought the plates were not good. But the fogging took place in such a way that it was soon suspected to be due to the light in the dark room. On shutting off a great part of the ruby light the negatives developed clear. The same light, without screening in any way, has been used for months with the most rapid glass plates in the market, such as Cramer, Stanley, Inglis, and Seed plates, and not a trace of fog could be seen on them. This may explain why some persons assert that they cannot use paper plates. The ruby light should be very carefully tested.

——o——

Detection of Fat in Butter.—A few more words on this subject extracted from a private letter of Mr. C. M. Vorce, which we take the liberty of printing, will not be amiss at this time, since they indicate very well just what the writer considers to be the character of Dr. Taylor's improvements upon other processes. Mr. Vorce writes:—

'In the butter matter I think Dr. Taylor's method of influencing the crystallization by removing part of the olein by draining the melted fat is a new modification of the old processes. Hassall summarizes all that had been done in Taylor's line before Hassall's last edition, viz., to melt the fat and allow it to cool—sometimes with repeated melting and cooling. But the process appears to have always been done in impervious vessels, at all events no mention is made of cooling the fat in a porous or pervious vessel, nor of any method of removing any part of the least readily crystallizable elements. The result was that, as all fats contained the elements olein and stearin, the crystallization was more or less similar, and the melting point being in each case different, time enough was always allowed to enable a thorough cooling. Hence the fat would come back to about the same state it was in at first, and it is no wonder they could tell little or nothing about it. I long ago discovered that by dissolving butter and other fats in ether or carbon disulphide, and allowing crystals to form by partial evaporation, different crystals would form from each fat. This I presume was not new. I do not know whether it was or not, but at all events it did not touch Taylor's

method, as I did not separate any part of the fat before solution.

'Then came Taylor and improved the old process by pouring the melted fat into a porous receptacle, whereby some of the free olein was taken up, and his next step of cooling it slowly *before* draining was another advance, inasmuch as it allowed the readily crystallizable stearic part to separate first and to hold the slower acting element in mixture, which in the porous receptacle was quickly deprived of its free uncrystalized olein.

'By this means every fat, if so treated, will yield a result corresponding to the proportion of its olein to its stearin and to the presence of other fatty acids which affect the combination of the olein and stearin.

'My last modification is to combine my old process of solution with Taylor's process of draining. I first boil, cool, and drain, then dissolve the drained fat (now strongly crystalline) in a given proportion by weight of the solvent, then allow crytallization to proceed for a given time at a specific temperature, and note the resulting crystals. This combination of methods I do not know to be new, but suppose it to be. It has been called Vorce's method. I think it is of value in connection with Taylor's methods.'

——o——

Jottings by the Way.—Perhaps it is for nothing else than the sentiment of it, that we pen a few words to our readers from off the bold eastern coast of the green island of Cuba. It is writing under difficulties, leaning on the quarter rail just after dinner on the steamer 'Colon,' about the time of sunset, within plain sight of the white spray thrown up here and there along the shore, indeed almost within sound of the breakers, and the ship rolling and tossing about in the heavy swell. The island is like a huge, broad, spreading mountain, with bold cliffs like terraces, trending away to the southwest, shrouded in a heavy blue mist that destroys the detail, only showing the contour where it joins the overhanging, torn and jagged, slaty clouds. The sun is setting behind the hills, but a thickly overcast sky shuts out the radiance and color so often seen from the deck of an ocean steamer over a quiet sea in southern latitudes.

Two evenings since there was a sunset scene that would inspire an artist with a desire for the strongest colors of Nature's laboratory, that he might put them on his canvas in all their brightness and transparency and gradation of tint, with all the truth and beauty of a Ruskin and Turner.

The sun went down behind a low, level bank of cloud, above which a perfect flood of glorious, golden light shone from the misty sky, and radiated from the invisible source in great broad bands to right and left, fading away into the purple and blue above. Sinking down lower and lower we then saw the great red ball dip beneath the cloud just raised above the horizon, and sink into the sea. Suddenly the last faint line of light disappeared. Every eye watched it as it passed away, and for many minutes more was turned to the brilliant colors in the sky above.

All this is not microscopical in the strictest sense, but the Editor is away from home and he may be allowed some liberties in writing. Moreover, our readers may find some interest in a few jottings by the way in the course of our travels to and in distant lands. We had almost completed arrangements for a journey across the country by rail, and anticipated much pleasure in meeting a number of microscopists on the way from New York to San Francisco, as we proposed to stop over at various points. A sudden change in plans, however, resulted in engaging passage by way of the Isthmus of Panama.

The change in our programme was made so suddenly, and final preparations were so hurried, that no time remained to write letters to those whom we had promised to visit, in-

deed, we engaged passage by telegraph and sailed without due preparation, but not without regret for the anticipated pleasures of the railroad journey, and the friends we should meet on the way.

These notes will be posted at Aspinwall. The incidents of the voyage have not been numerous or of particular interest. The broken, lumpy water of the Caribbean Sea made a slight change in the ordinary course of events, but as a whole the passage has been a good one.

The temperature in the tropics at sea is not so high as might be anticipated. There has been no great discomfort from the heat on the steamer, for a good breeze has been blowing almost constantly. One evening, as we were watching the progress of a rain storm to the eastward, a squall of remarkably cool air came on quite suddenly, and carried away a sail with a great deal of flapping, that made some excitement for the lady passengers. Such cool and refreshing currents we have noticed quite frequently within the tropics at sea, apparently coming from a local shower not far away.

As we write now, about 300 miles from Aspinwall, the sun is shining, casting its shadows southward—for its declination is well to the north of us. Within five minutes the rain may come down in torrents, and as quickly the sky clear again. It is the rainy season in this region, and if we succeed in crossing the Isthmus without floating off in a deluge, and escape the attack of Dr. Freire's germs, to say nothing of those as yet unknown microbes of Chagres fever, our readers will hear from us again next month.

——o——

Eyes of Insects.—In the *Transactions* of the Linnean Society Mr. B. Thompson Lowne, F. L. S., has an article entitled, 'On the Compound Vision and the Morphology of the Eye in Insects,' in which the structure of the eyes of insects is described as made out by the author. His results differ in important details from the conclusions of all previous observers, but there is strong evidence in support of them throughout the paper. One reason for these differences is unquestionably to be found in the improved methods of preparation. For example, it was found that in the ordinary process of preparing sections of eyes, a certain structure, which the author has found to be an inner lens situated behind each corneal facet, is entirely lost, and the shrivelled stroma of the lens constitutes what has long been known as the 'nuclei of Semper.' Further, the true structure of the cornea or basilar membrane has only been made out by the study of extremely thin sections, such as have not hitherto been made.

According to these observations the compound eye consists of two lenses, the first forming an inverted image which is magnified and erected by the second, the image being thrown upon a retinal surface composed of structures resembling the rods and cones of the vertebrate eye.

——o——

Postal Club Boxes.—Box S[2] came to this circuit June 10th with seven slides.

1. Palate of garden snail. Thomas Garth.

2. Spicules of sea-fan. *Gorgonia*. E. S. Coutant. A good sketch of the sea-fan or 'flexible coral' is given, with a description of the method of obtaining the spicules.

3. Section of cork oak. J. M. Barrow.

4. Medulla oblongata in myelitis. G. W. Hubbard.

5. Amphipleura pellucida. Chas. Mitchell. Picked specimen in balsam. The same preparer sends another slide showing sarcoma. The method of mounting is described in full.

6. Diatoms from Puget's Sound. Geo. W. Woraster (?).

Box A came to hand June 10th.

1. Anthers of willow changing to ovaries. R. H. Ward. The description is as follows:—

'In the absence of the lowest powers mentioned above, use a good pocket lens. The slide is covered with paper, in hope of preventing its shaking to pieces, an accident that seems nearly unavoidable in dry mounted specimens circulated by mail.

'The object is circulated as an interesting study in teratology. It was taken from a willow tree which, being the male plant of a diœcious species, bore only catkins of exclusively staminate flowers. Mixed with the normal stamens, however, were a few which, like those on the slide, were deformed into a resemblance to pistils.

'Pistillody of the stamens, of which this is a typical example, is a metamorphosis of the whole or a part of the stamen into the form and character of a pistil. It occurs occasionally in the willows, heaths, poppies, and some other families. This change to a form belonging nearer the centre of the flower is somewhat less familiar than the more common anomaly of reverting to the foliar type which is nearer in character as well as position to the foliage-leaves. Only a portion of the stamen may be modified, or the stamen as a whole may be changed into a pistil bearing ovules.

'In the present instance, the filaments are unaltered, and each anther is changed to an ovary, more or less bifid, the division being so complete in some cases that each anther-cell appears as a single stalked ovary looking like an entire carpel. The normal anther cells have mostly disappeared, or been reduced to ovule-like nodules inclosed within the carpels. The short specimen, at the bottom, is a doubly interesting transitional form, having become pistillate in shape, and having a well-characterized stigma, but still remaining open like the carpels of the coniferæ, and still retaining on its surface a pair of normal anther-lobes containing pollen-grains. In the absence of ovules, however, it cannot be considered a fully hermaphrodite organ.'

2. Section of swelling of spinal cord of cat. J. D. Lomax. Well explained in the letter-packet.

3. Section of human lung in consumption. C. E. Hanaman. Also well described.

4. Temporary tooth of puppy. A. M. Wright.

5. Antheridia of moss. Joseph McKay. A good specimen well described.

6. Louse of crow, *Menopon mesoleucum*.

NOTES.

—'The Popular Science Monthly' for August will open with a richly illustrated article of great economic value entitled 'Woods and their Destructive Fungi.' The author, Mr. P. H. Dudley, a civil engineer of rising reputation, has, for several years, been studying the structure of those woods most commonly employed in the arts, with reference to the agencies concerned in their deterioration. The results of his investigations put quite a different aspect from the generally accepted one on the process of decay, and promise to be of vast industrial importance in their practical application.

—Hon. David A. Wells closes his series of papers in 'The Popular Science Monthly,' on 'An Economic Study of Mexico,' with an article in the August number considering the attitude which the United States should take toward that country. Having given us what is accepted by the best informed as a generally accurate and approximately complete statement of the deplorable condition of affairs which now exists in Mexico, Mr. Wells maintains that, being partly responsible for this ourselves, we should assume the *rôle*, henceforth, of the generous big brother, and actively assist them in their strivings after better things.

CORRESPONDENCE.

To the Editor: Although unable to fully answer the query of W. in your July number, I may be able to assist your

correspondent somewhat by saying that in the first edition of Tuckett's 'Treatise,' (1848,) p. 438, he refers to *Navicula Hippocampus* as resolved by Robert Harrison in 1841, but making no mention of Spencer in connection with that form. He, however, devotes some space (p. 440) to *N. Spencerii*, which had that year, 1848, been brought to the attention of English microscopists by Prof. Bailey, of West Point, who stated that a young backwoods artist named Spencer had, with an object-glass of his own construction, shown three sets of lines on this diatom, while objectives of equal power by the first English opticians had failed in defining them.

Two English observers had later, however, made out the markings clearly and resolved them into 'dots,' and one of them, Mr. De La Rue, furnished Quekett with a plate delineating this diatom under 800 and 1900 diameters. This plate is numbered ix in the first edition of the Treatise. But in the third edition (1855) both the plate and the article on *N. Spencerii* are wholly omitted, and no allusion whatever made to them. This omission is significant, as the paragraph on *N. Hippocampus* and other test diatoms are repeated verbatim.

As I have not the second edition (1852) of Tuckett's Treatise, I am unable to state whether it contained the article referring to Mr. Spencer, nor the cause of its omission.

Yours truly,

J. P. Thompson.

Portland, Me., July 20, 1886.

[The book referred to in the above letter, we are sorry to say, could not be found in Washington.—Ed.]

NOTICES OF BOOKS.

Disinfection and Individual Prophylaxis against Infectious Diseases. By George M. Sternberg, M. D., Major and Surgeon, U. S. A. Concord, N. H.: Republican Press Association, 1886. (Pamphlet, 8vo, pp. 40.)

This is the Lomb prize essay of the American Public Health Association. More than one-half of the essay relates to the important subject of disinfection, which is treated in a masterly manner. An excellent solution is recommended, composed of mercuric chloride, 4 ounces; copper sulphate, 1 pound; water, one gallon, to be used in the proportion of 1 to 100 parts for the destruction of spores.

The second part treats of individual prophylaxis, and contains much sound and reasonable advice to those brought in contact with infectious diseases, or who reside in unhealthful localities.

The Public Health Association has done well to publish such a useful pamphlet, and to Mr. Henry Lomb, of Rochester, the public is deeply indebted for giving such liberal encouragement to the preparation of it. The prize awarded was $500.00, and we think it justly won.

Fur Fibres as shown by the Microscope. By Henry L. Brevoort. 1886. (Quarto. pp. 3, plates 16.

The author of this work, which is almost entirely made up of plates drawn accurately to scale, has been engaged for a long time in studying fur fibres. The explanatory text is very brief, but the plates are undoubtedly accurate. From his studies of fur the author has drawn some conclusions of importance in the business of manufacturing, which have not been made public; but one point he brings prominently forward, the prevalence of the air cells and the almost entire absence of pigment from the fur of animals that have to resist dry cold, the air-cells being such excellent insulators, and no space can be spared for pigment. On the other hand, in the case of animals living in a moist climate, the pigment cells are present, since they make the fibre more repellent to water.

Medical and Surgical Directory of the United States. R. L. Polk & Co., Publishers, Tribune Building, Detroit, Mich.

The urgent necessity of such a work had long been apparent to the medical profession. In the present laborious undertaking, we are glad to see, the publishers have spared no pains to make the book what it ought to be, a reliable and official list of all legally-recognized practitioners within the limits of the United States and Territories. Their names, 80,000 in number, are accompanied by all the attainable information regarding place and time of graduation, and the arrangement adopted by the publishers could scarcely be improved upon. The work cannot fail to be appreciated by the profession.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

For Exchange: Seeds of *Orthocarpus purpurascens* and *Orthocarpus attenuatus*, and slides of same, in exchange for good objects, foraminifera preferred.

EDWARD GRAY, M. D.,
Benicia, Cal.

THE AMERICAN
MONTHLY
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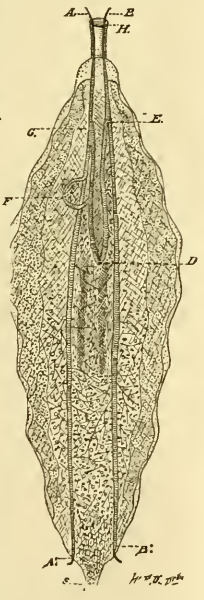
VOL. VII. WASHINGTON, D. C., SEPTEMBER, 1886. No. 9.

A Parasite of Porcellio.

BY W. F. DURAND, ASST. ENG., U. S. N.

The parasite figured in the accompanying sketch was found in a specimen of *Porcellio spinicornis* taken from a decaying pine stump in the spring of the present year. The length of the *Porcellio* was about .4 of an inch, the length of the parasite about .2 of an inch. It occupied the whole of the abdominal cavity, which was much distended beyond its normal size.

Its body seemed to consist of a sac elongated and tapering at each end, without external appendages. Its mode of progression was by a series of rythmic contractions and extensions of the outer integument, accompanied by corresponding changes of form and pulsations of the body contents.



At *H* was a kind of cylindrical, transparent head, furnished at *A* and *B* with two little horn-shaped processes, with a suggestion of a knob on the end. Following these back they were found to be the ends of two tracts extending the entire length of the body, and terminating with very similar extremities at *A'* and *B'*. At *C* and *E* these tracts gave off each a branch, which became united at *D*. At *F* was an arch connecting *BB'* with *ED'*. The structure of these tracts seemed to resemble somewhat that of tracheæ in insects.

In addition to the larger tracts or vessels spoken of above, there seemed to be an extensively ramified system of smaller vessels, extending in all directions through the outer integument or just beneath it.

At *S* was a kind of cylindrical opening with two reddish spots just inside, at the ends of two dark processes, continuing into the body cavity. Both this and the so-called head at *H* were retractile at will.

[We regret that we are unable to furnish any information as to the creature above described. Mr. Durand found but a single specimen, a sketch of which he referred to Prof. Leidy, the original, killed and much distorted under examination, being unfit for preservation, but it was entirely unknown to him, and in his letter he says he does not even feel sure to what group it belongs.—H. L. O.]

—o—

American Society of Microscopists.

The ninth annual meeting of the American Society of Microscopists was held at Chautauqua on the 10th, 11th, 12th, and 13th of August, a very full attendance of members being present, the interest in the proceedings well sustained, and a large accession of new members received. The Society appears to be flourishing and to be gaining the support and encouragement of microscopists gen-

erally, and we hope will continue to do so. The usual number of the older members arrived on Monday, and on Tuesday forenoon, so that the opening of the first session of the meeting at 2 o'clock P. M. on Tuesday found about sixty members and a considerable number of their friends present. Members continued to arrive by every boat, and on Thursday about two hundred persons wearing the badge of the Society could be counted, about two-thirds of whom were members. About sixty new members were elected at this meeting.

The first session, after the transaction of ordinary routine business, was devoted wholly to the subject of butter and fats, and their detection and discrimination, etc. It was fully understood that Dr. Thomas Taylor, of the Department of Agriculture, and Prof. H. A. Weber, of the Ohio Agricultural Experiment Station, would be pitted against each other as the chief contestants, as it is well known to microscopists and chemists that these two gentlemen entertain exactly opposite views on the subject, and especially as to the reliability of Dr. Taylor's published tests for the detection of oleomargarine and foreign fats in butter. Prof. Weber first took the floor, and read a well-prepared paper, reiterating substantially the position taken in the bulletins issued over his name by the Ohio Experiment Station, and known as bulletins No. 13 and 15, with which most of our readers are familiar. Dr. Taylor followed in support of his well-known position, maintaining in substance the same views set forth in his published papers in the Reports of the Department of Agriculture and the proceedings of the American Society of Microscopists for 1885. President Burrill, Mr. Vorce, and Dr. Detmers also spoke on the subject, and the latter gentleman exhibited photographic prints made by him from preparations by Prof. Weber; but the chief burden of the debate was borne by Prof. Weber and Dr. Taylor, each of whom maintained his position with ability, and at the same time with perfect courtesy and good feeling, the discussion, although consuming the entire afternoon, at no time becoming in the least degree acrimonious. Later on the committee appointed at Cleveland to examine and report upon Dr. Taylor's claims, of which Dr. Detmers was chairman, rendered a very brief non-committal report, which was, however, in effect favorable to Dr. Taylor's claims for the value of his processes.

The address of President Burrill was delivered on Tuesday evening to a large and apparently appreciative audience, to whom he was introduced in an eloquent address of welcome to the Society by Chancellor Rev. J. H. Vincent, in behalf of the Chautauqua Association. President Burrill's subject was 'Bacteria and Disease,' which he treated at length and in accord with the most advanced ideas.

Papers were read on Wednesday by Dr. G. W. Lewis, Jr., of Buffalo, on the Comma Bacillus; by Dr. Geo. E. Fell, on *Demodex folliculorum;* by Dr. R. H. Ward, of Troy, on Micrometer wires, and on Microscopical Societies; by Dr. F. S. Newcomer, of Indianapolis, on Preparation and Selection of Diatoms. On Thursday, papers by Dr. M. D. Ewell, of Chicago, on A Study of Centimeter bar A. and by Prof. W. A. Rogers, of Cambridge, on the Effect of Temperature in Comparing Standards of Length, were read by the latter. On Friday, papers by E. Gundlach, on Optical Errors and Human Mistakes; by Edward Bausch, on the Inverted Microscope; by D. W. P. Manton, on Microscopical Anatomy of the Ovary, and by Prof. H. L. Smith, on Further Experiments on Media of High Refractive Index, were read. Several other papers were read during the meeting, and much interesting discusssion on the papers read took place. We shall endeavor to lay before our read-

ers abstracts of the more important papers at an early date.

At the close of the afternoon session on Wednesday, about thirty of the members embarked upon a small steamer, and, under the direction of Prof. T. B. Stowell, Ph. D., of Cortland, N. Y., dredged the lake at different points, obtaining a rich gathering of aquatic forms, mollusca, crustacea, etc., etc., among which Mr. C. S. Fellows, of Chicago, reported the finding of the rare *Leptodora hyalina*, specimens of which were exhibited at the Soiree on Thursday evening.

Wednesday evening was devoted to photography in its application to microscopy. The subject was well handled and practically illustrated by Hon. J. D. Cox and Mr. W. H. Walmsley, both of whom are acknowledged experts in the art of photo-micrography.

The working session, held in the gymnasium Thursday afternoon from 2 to 6 o'clock, was fully equal to any previous session of the kind, and was the source of deep interest to the numerous spectators who thronged the building and surrounded the various tables.

The Soiree in the same room, Thursday evening, was of the usual character of such displays, about 140 microscopes being in position, and a well-selected list of objects shown to a constantly shifting audience, who gazed with delight upon the beauties and wonders revealed to them, often being loath to leave the scene of so much attraction even to make room for the constantly increasing throng of new-comers. The noted Chautauqua spectacle of the Illuminated Fleet given in the latter part of the evening served to somewhat deplete the audience, and many of the members availed themselves of the opportunity to close their exhibits and join the crowds of spectators on the banks of the lake watching the evolutions of the fleet of some half-dozen steamers and innumerable small boats brilliantly lighted with colored lights and a profuse display of fireworks.

The nominating committee of seven members was elected on Thursday, and on Friday reported the following board of officers for the next year: President, Prof. H. A. Rogers, of Cambridge; First Vice-President, C. M. Vorce, of Cleveland; Second Vice-President, Dr. James E. Reeves, of Wheeling; Executive Committee, J. J. B. Hatfield, of Indianapolis, Dr. W. R. Mandeville, of New Orleans, Dr. W. R. Clapp, of New-Albany—all of whom were unanimously elected, and Mr. E. H. Griffith was recommended as the director of the working session.

Invitations were extended to the Society from Washington, Indianapolis, and San Francisco to meet in those cities respectively next year. The whole matter was referred to the Executive Committee, who will decide at an early date. We think no better locality than Washington could be chosen, in view of the meetings of medical and other scientific societies to be held there next year.

Key to the Desmidieæ.

BY DR. A. C. STOKES.

[*Concluded from page 148.*]

23. STAURASTRUM.

¶ With numerous processes, their ends more or less divided (§§).
¶ Without processes, the angles in front view produced or not (§).
§ Cytioderm smooth or finely punctate (1).
§ Cytioderm verrucose or granulate (2).
§ Cytioderm hirsute, spinulose or thorny (3).
§§ End view 3 or 4-angled (B).

§§ End view 5 or 6-angled, apices of (6) rays rounded and spinulose, *Kissimmense*.†

§§ " " " apices of (5–6) rays trifid, distended, *distentum*, 149.

§§ End view 8-angled; rays a whorl of 8 below, 4 above, *tetroctocerum*, 151.

§§ End view circular, rays a whorl of 9 below, 6 above, . *artiscon*, 148.

§§ " " rays marginal, very short, usually 9, ends notched, *Eloiseanum*, 149.

1. Angles of semi-cell in front view not produced; rounded and smooth (*a*).

1. " " " " " " mucronate, spinous or notched (*c*).

1. Angles of semi-cell in front view produced more or less (*h*).

2. Angles of semi-cell in front view more or less produced (*i*).

2. " " " " " " not produced (*gg*).

3. Angles of semi-cell in front view more or less produced (*oo*).

3. " " " " " " not produced (*yy*).

a. Semi-cell oval or elliptical; diameter $\frac{1}{150}$ to $\frac{1}{100}$ in. (13–16μ) *muticum*, 119; *minor*, 119; *Bieneanum*, 124.

a. Semi-cell oval or elliptical; diameter $\frac{1}{400}$ to $\frac{1}{225}$ in. (60–112μ) (*b*).

a. Semi-cell semicircular; sinus narrow, linear, . . *orbiculare*, 120.

a. " triangulare, sides concave . . . . . *trihedrale*, 123.

a. " subcuneate: cell slightly longer than wide, *pseudopachyrhynchum*, 125.

b. Sides slightly constricted near the angles, especially in end-view, *tumidum*, 120.

b. Sides not constricted; diameter $\frac{1}{300}$ to $\frac{1}{333}$ in. (75–83μ) *grande*, 120.

b. " " " diameter $\frac{1}{416}$ in. (60μ) . . . . *inerme*, 122.

c. Angles mucronate (*d*).

c. Angles aculeate, spinous, awned or notched (*e*).

d. Mucros double on basal angles, none on the end in front view; semi-cells truncated triangles, ... *paniculosum*, 124.

d. Mucros single on all angles, horizontal; diameter less than $\frac{1}{300}$ in. (50μ); semi-cells not quadrangular, ... *brevispina*, 121.

d. Mucros single on all angles, horizontal; semi-cells quadrangular, *quadrangulare*, 145.

d. Mucros single on all angles, diameter larger than $\frac{1}{500}$ (50μ), *magnum*, 120.

d. Mucros single, oblique downward and inward; diameter $\frac{1}{250}$ (100μ) or more . . . . . *majusculum*, 121.

d. Mucros single, oblique downward and outward; diameter $\frac{1}{550}$ (45μ) or less . . . . . *Dickiei*, 122.

e. Aculei or awns 1 on each angle (*f*).

e. " 2 on each angle (*g*).

e. " 3 on each angle (*vv*).

e. " 4 or more on each angle (*www*).

f. Semi-cells elliptical, often angular, approximate; ends straight, concave or convex: awns horizontal, diverging, converging or upwardly oblique; diameter $\frac{1}{656}$ to $\frac{1}{1000}$ in. (25–38μ) . . . . *dejectum*, 121.

f. Semi-cells elliptical, separated by a long, narrow isthmus, *cuspidatum*, 123.

f. " triangular-fusiform; awns long; diameter $\frac{1}{500}$ to $\frac{1}{438}$ (50–57μ) *megacanthum*, 121.

† Bulletin Torrey Botanical Club, Dec., 1885.

f. Semi-cells triangular; sinus with a small spine on each side, *Lewisii*, 122.
f. " " sinus without a spine . . *aristiferum*, 122.
f. Semi-cell quadrangular, margins toothed or spinous, *quadrangulare*, 145.
g. Angles in end view trifid . . . . . *trifidum*, 123.
g. " " simple or bifid (*ss*)
h. Arms trifid or bifid; end view 3–4 radiate; arms smooth, *brachiatum*, 124.
h. " " " end view 3-radiate; arms aculeate, rough, *aspinosum*, 143.
h. " " " end view 5–6 radiate . . . . *distentum*, 149.
h. " " " end view 7–9 radiate . . . . . *Rotula*, 135.
h. Arms truncate, oblique, geniculate, short; end view 4-radiate, *inconspicuum*, 125.
h. Arms acute or aculeate, curved; end view 3-radiate . . *sudeticum*.*
i. Ends separated by a more or less elongated isthmus (*j*).
i. Ends approximate (*z*).
j. End view fusiform, with a central obtuse inflation . *leptocladum*, 136.
j. " oval, a long arm on each side, *grallatorium*, 136; *ungulatum*, 136.
j. End view triangular or 3-radiate (*k*).
j. " quadrangular or 4-radiate (*p*).
j. " 5-radiate (*v*).
j. " 6-radiate (*w*).
j. " 7–8 radiate . . . . . *Ophiura*, 134.
k. Isthmus basally inflated, cuspidate or spinous (*l*).
k. " not basally inflated, cuspidate not spinous (*m*).
l. Isthmus basally inflated . . . . . *elongatum*, 130.
l. " with a 1–4 cuspidate protuberance on each side; arms short, *fasciculoides*, 130.
l. " with 1 notched spine on each side . . . . *spinosum*, 139.
m. Diameter $\frac{1}{500}$ in. (50μ) or less (*n*).
m. " $\frac{1}{400}$ in. (60μ) or wider (*o*).
n. End straightish, sides tapering into short, mostly obtuse processes, *tricorne*, 126.
n. End broadly convex; processes curved . . . . . *cyrtocerum*, 128.
n. " " processes straight, slender . . . *gracile*, 133.
o. In end view the angles produced in long arms, *vestitum*, 138; *pseudosebaldi*, 139.
o. In end view the angles not produced in long arms . . *Sebaldi*, 138.
p. Isthmus basally inflated or cuspidate (*r*).
p. Isthmus not basally inflated nor cuspidate (*s*).
r. Isthmus basally inflated, corrugated and denticulate . *tetragonum*, 130.
r. " with a short spine on each side . . . . . *odontatum*, 134.
s. Diameter $\frac{1}{800}$ in. (31μ) or smaller (*t*).
s. " $\frac{1}{400}$ in. (60μ) or larger (*u*).
t. End straight, sides tapering into short, mostly obtuse processes, *tricorne*, 126.
t. End convex; processes short, stout . . . . . *crenulatum*, 126.
t. End concave; processes short, upwardly diverging, *pusillum*, 130; *Donnellii*, 132.
u. Processes short, robust, incurved; end of semi-cell truncate, *cerastes*, 133.
u. " long, narrow, incurved; end of semi-cell convex, *ankyroides*, 137.

* Journ. R. Micr. Soc., Dec., '85.

u. Processes long, horizontal . . . . . *tetracerum*, 134.
v. Processes curved, apices bifid . . . . . *pentacladum*, 129.
v. " " apices entire . . . . . *incisum*, 132.
v. Processes horizontally radiating; ends of cell with bifid papillæ, *pentacerum*, 134.
v. Processes horizontally radiating; ends without bifid papillæ, *crenulatum*, 126.
v. Processes upwardly diverging, the apices bifid . . *franconium*, 131.
w. Diameter $\frac{1}{625}$ in. (40μ) or smaller (*x*).
w. " $\frac{1}{350}$ in. (70μ) or larger (*y*).
x. Isthmus centrally ribbed; rays curved downward . . *comptum*, 129.
x. " not ribbed; in end view rays basally separated by an acute incision . . . . . *incisum*, 132.
x. Isthmus not ribbed; in end view rays separated by a rounded sinus, *crenulatum*, 126.
y. End with prominent papillæ; diameter $\frac{1}{166}$ to $\frac{1}{180}$ in. (140–150μ) . *Ophiura*, 134.
y. End with prominent papillæ; diameter $\frac{1}{294}$ to $\frac{1}{333}$ in. (75–85μ). *coronulatum*, 135.
y. End without prominent papillæ; ray margins serrate, *macrocerum*, 134.
y. " " " ray margins granulate-crenate, *hexacerum*, 137.
z. End view oval, ends produced in a long, thin arm, . *ungulatum*, 136.
z. " fusiform, ... *fusiforme*, 137.
z. End view triangular or 3-radiate (*aa*).
z. " 4-radiate or angular (*ee*).
z. " 5-radiate (*ff*).
aa. Apices of rays obtuse; diameter $\frac{1}{500}$ to $\frac{1}{625}$ in. (40–50μ), *arachne*, 129.
aa. " " " diameter $\frac{1}{1250}$ to $\frac{1}{1562}$ in. (15–20μ), *iotanum*, 137.
aa. Apices of rays not obtuse (*bb*).
bb. End of cell in front view papillose or verrucose (*cc*).
bb. " " " " not papillose nor verrucose (*dd*).
cc. Diameter $\frac{1}{700}$ in. (36μ) or smaller, *arcuatum*, 139; *subarcuatum*, 140.
cc. " $\frac{1}{300}$ to $\frac{1}{400}$ in. (60–80μ); arms diverging, . *anatinum*, 139.
dd. End view, sides straight, angles 3–4 spinous, . *polymorphum*, 126.
dd. " sides concave: arms long, straight, in front view diverging, *paradoxum*, 129.
dd. End view, sides concave; arms short, *Haabœliense*, 131; *uanum*, 138.
dd. " sides convex; arms short, tumid at base. *Heleanum*, 133.
ee. Apices of arms inconspicuously bifid or trifid, *Haabœliense*, 131; *paradoxum*, 129.
ee. Apices of arms prominently and deeply trifid, ... *Osceolense*.*
ff. Apices of arms obtuse; the arms mere lobes, very short, *silatatum*, 128.
ff. " " " arms long, narrow, . . . *arachne*, 129.
ff. Apices of arms bifid: front view end with a crown of papillæ, *Floridense*, 135.
ff. Apices of arms bifid: front view end without papillæ, *pentacladum*, 136.
gg. End view 4, 5, 6, or 7-angular or radiate (*hh*).
gg. End view triangular (*ii*).

* Bulletin Torrey Botanical Club, Dec., 1885.

hh. Cytioderm rough with pearly granules; rays 4–7, short, obtuse, *margaritaceum*, 125.
hh. " granulate; end view 4–6 angled, sides straight, *Meriani*, 132.
hh. " " end view 4– angled, angles with 2 spines, *Novæ Cæsareæ*, 145.
hh. " " end view 4–5 angled, sides concave, angles without spines . . . . . *dilatatum*, 128.
ii. Angles in front view notched or otherwise divided (*jj*).
ii. Angles entire (*kk*).
jj. Surface granules emarginate or divided; semi-cells broadly elliptic, *asperum*, 127.
jj. " not emarginate; semi-cells elliptic . *truncata*. 128.
jj. " not emarginate; semi-cells subsemiorbicular, angles truncate . . . . . *muricatum*, 127.
jj. Surface scabrous, semi-cells elliptic . . . . . *scabrum*, 130.
jj. Surface tuberculate; sides at base convex, spinous; a central, spherical, spinous projection conspicuous . . . . . *bullosum.**
jj. Surface tuberculate: sides at base concave; no central protuberance, *tuberculatum.**
kk. End view sides concave (*ll*).
kk. " sides nearly straight, very slightly convex (*nn*).
kk. " sides convex; semi-cells subsemiorbicular, *muricatum*, 127.
ll. Semi-cells twisted; 2–3 times longer than wide, elliptic or oblong, *alternans*, 128.
ll. Semi-cells not twisted (*mm*).
mm. Front view ends concave; end view angles rounded . *striolatum*, 126.
mm. " " end view angles acute . . *Pringlei*, 132.
mm. Front view ends convex; end view angles crenate, sides smooth, *crenatum*, 126.
mm. " " end view angles not crenate, somewhat truncate . . . . . *dilatatum*, 128.
nn. Diameter $\frac{1}{1000}$ in. (25μ) or less . . . . . *pygmæum*, 128.
nn. " greater than $\frac{1}{1000}$ in. (25μ); end broadly truncate, sides slightly convex or nearly straight, converging . *botrophilum*, 131.
nn. Diameter greater than $\frac{1}{1000}$ in. (25μ); end rounded, sides convex; semi-cells elliptic . . . . *rugulosum*, 127; *punctulatum*, 127.
oo. End view 3-radiate or angular, sides nearly straight (*pp*).
oo. " " " sides concave (*rr*).
oo. End view 4-radiate or angular (*xx*).
pp. Cells spinulose on the whole surface . . . . . *aculeatum*, 140.
pp. " " on the margins only . . . . . *setigerum*, 141.
rr. Cells spinulose, a short, irregular process on each side, *controversum*, 143.
rr. Cells spinulose on the margins of the long, colorless, diverging arms, *aspinosum*, 143.
ss. End view triangular or 3-radiate (*tt*).
ss. " 4 or 5-angular or radiate (*uu*).
ss. End view circular, with usually 9 short, marginal, notched processes, *Eloiseanum*, 149.
tt. End view margins smooth; spines short; semi-cells in front view twice as wide as long . . . . . *avicula*, 123.

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tt. End view margins smooth; spines short; semi-cells in front view 3 or 4 times as wide as long . . . . . *commutatum*, 124.
tt. End view margins smooth; spines very long . . *longispinum*, 145.
tt. End view margins verrucose, the verrucæ emarginate or not, *forficulatum*, 144.
tt. " " dentate, angles usually 3 . . *monticulosum*, 144.
uu. End view margins smooth, concave; angles notched *quadrangulare*, 145.
uu. " " crenate; spines long, divergent, *Novæ Cæsareæ*, 145.
uu. " " spinous; angles produced, furcate, *forficulatum*, 144.
vv. End view triangular; aculei short, *Hystrix*, 142; *tridentiferum*, 142.
vv. " " spines long, colorless . . *tricornutum*, 145.
vv. End view 4-angled, angles broadly rounded, spines scattered; sides concave . . . . . *Hystrix*, 142.
vv. End view 5-angled, sides concave . . . . . *Brasiliense*, 146.
ww. Angles with numerous setæ as long as the lobes; cells in front view cruciform . . . . . *cruciatum*, 142.
ww. Angles with 4 teeth, 2 projecting upward, 2 downward, *cerberus*, 142.
ww. " 2 spines; margins concave, spinous . *quaternium*, 144.
xx. Sides unequally produced, spinulose or spinous . *controversum*, 143.
xx. Sides equally produced, spineless; angles spinous . *aculeatum*, 140.
yy. Diameter $\frac{1}{650}$ in. (38μ) or less (*zz*).
yy. Diameter greater than (38μ) $\frac{1}{650}$ inch (*A*).
zz. Cytioderm aculeated, aculei larger and denser at the angles, *teliferum*, 140.
zz. Cytioderm aculeated except at the centre, *echinatum*, 141; *pecten*, 141.
zz. " spinous; margins dentate, ... *convexum*.*
zz. " " margins crenate, ... *Ravenellii*, 143.
A. Cytioderm aculeated, aculei geminate, ... *sociatum*, 142.
A. " " aculei not geminate, densest at the angles, *Brebissonnii*, 141.
A. " " aculei evenly covering the surface, *Saxonicum*, 141; *hirsutum*, 141.
A. Cytioderm spinous, spines not notched, ... *echinatum*, 141.
A. " " spines or short processes notched, *spongiosum*, 148.
B. End view 3-angled; processes within the margin, 6 in number (*C*).
B. " " " " " " 3 in number (*D*).
B. " " " processes both on and within the margins (*F*).
B. " " " processes at the angles only (*E*).
B. End view 3 or 4-lobed, emarginate or bifid; cell very irregular or quadrate, ... *enorme*, 151.
C. Front view lateral margins crenate; basal margins crenate, *eustephanum*, 147.
C. " lateral margins smooth. . . . *pseudofurcigerum*, 147.
C. " lateral margins with 3–6 sharp teeth: basal margin smooth, *cuneatum*, 148.
D. Cytioderm granular, ... *furcigerum*, 146.
D. Cytioderm smooth; end view angles produced into 2 processes, a third above and between them, ... *Pottsii*, 151.
D. Cytioderm smooth or finely punctate; end view angles notched, *Kitchellii*, 150.
E. Processes 9, nearly as long as semi-cell diameter, ends furcate, *Tohopekaligense*.†

* Journ. R. Micr. Soc., Feb., 1886.

† Bulletin Torrey Botanical Club, Dec., 1885.

E. Processes shorter than semi-cell diameter, ends furcate, *furcatum*, 150.
E. Processes 6, short, notched; semi-cell rectangular, twice wider than long, *duplex*, 149.
F. End view central radiating processes 6; marginal, including angles, 9, *senarium*, 147.
F. " central and marginal spines short, numerous, notched, *spongiosum*, 148.

Butter and Fats and Oleomargarine.

DR. THOMAS TAYLOR'S REPLY TO PROF. WEBER.

Dr. Thomas Taylor, microscopist of the U. S. Department of Agriculture at Washington, was appointed the first speaker at the meeting of the American Society of Microscopists held at Chautauqua, August 10th to 14th, to make answer to the paper of Prof. Weber on 'Butter and Fats.' Dr. Taylor commenced by alluding to the first three experiments made by Prof. Weber in relation to the crystals of butter, lard, and oleo fat. Here Dr. Taylor called attention to the fact that Prof. Weber acknowledged that thus far Dr. Taylor's statements in relation to the forms of the three respective fats named were verified. The next following three experiments of Prof. Weber were reviewed by Dr. Taylor. They related to three different compounds of butter and lard. The first composition consisted of ninety parts butter and ten parts lard; 2d composition, seventy-five parts butter, twenty-five parts lard; 3d composition, fifty parts butter, fifty of lard. Each of these compositions was boiled, cooled, and examined by Prof. Weber. He says all exhibited the butter crystal. To these three experiments Dr. Taylor objected because they did not represent his method of testing for oleomargarine. Dr. Taylor in his annual report to the Commissioner of Agriculture sets forth that it is absolutely necessary to examine all butter substitutes as purchased. By this means the crystals of lard, if present, are at once detected by means of the microscope. The object being to distinguish foreign fats, such as lard and beef, which are never found in pure butter. Dr. Taylor explained that it was a great error on the part of Prof. Weber to boil a suspected butter substitute on receiving it, because were butter present in quantity in combination with lard and beef fat the foreign crystals would be absorbed by the large butter crystals formed by the process of boiling. It should be observed that lard and beef fats have passed through the process of boiling, while the butter combined with it has simply been melted at a low temperature. In normal oleomargarine their crystals are already formed while the butter shows none unless boiled. To a superficial observer boiled oleomargarine, if it contain much butter, would appear true butter instead of oleomargarine. Whereas, by first making microscopical examination, the lard crystal may be at once detected and save further labor.

Dr. Taylor further stated that it should be borne in mind that the object sought was not the presence of butter, but the presence of foreign fats, and that the moment they were detected by the microscope, the parties may be prosecuted under the butter laws of the District of Columbia.

Dr. Taylor here stated that already seven convictions had been made under his testimony, and in no case had he sanctioned a prosecution, unless he found an abundance of lard or beef fat crystals, or other foreign fats in the substance. Dr. Taylor further said that the parties

subjected to the prosecution, rich and poor, men and women, publicly acknowledged, on conviction, that they knew that the substance they were prosecuted for selling was oleomargarine. Following this Dr. Taylor discussed the experiments of Prof. Weber in relation to the production of the so-called butter crystal by artificial means. Dr. Taylor said that Prof. Weber believes he has, by the use of salt and water, in the manner described by him, formed or caused to be formed, butter-like crystals by using either oleo oil or lard. In relation to these experiments Dr. Taylor stated that he had lately found that while the kidney and cellular tissue fats gave purely stellar crystals without a cross, that a sample of leaf lard, lately tested by himself, yielded stellar crystals with a cross; but these crystals could not be mistaken for butter crystals by an experienced observer, since they show distinctly the spinous character of lard crystals. That the same result is obtained without the use of salt and water is shown also in this connection. Dr. Taylor stated that in point of fact the introduction of salt and water was not necessary to produce the cross. Dr. Taylor cited the number of fats that he had examined showing in their first stages of crystallization a globose crystal with a cross, all without the addition of salt and water. Dr. Taylor stated that in his annual report he had clearly stated that any microscopic body which was globose, comparatively smooth, translucent and polarizing would show a cross. Dr. Taylor gave four illustrations upon the blackboard of four different fats whose forms could be seen with plain transmitted light. Following this Dr. Taylor threw the form of a cross on each of the illustrations, pointing out the fact that notwithstanding that each was invested with the shadow or illusive marking of the cross, each form could still be distinguished one from the other by reason of their peculiarities, thus showing that the presence of the cross would not alter the identification of lard, beef fat, or other crystals. Dr. Taylor further stated that when Prof. Weber melted a fat and cooled it quickly and found that no crystals had formed under these conditions, he but verified what he, Dr. Taylor, had published some ten years ago in the New York quarterly *Journal of Microscopy*, to wit, that butter substitutes composed of solid fats when newly made and suddenly chilled, did not show any crystals of fat when examined in the fresh condition, but that when laid aside a short time in a moderate temperature the crystals began to form and are readily detected. Dr. Taylor further observed that in no case had he found in the oleomargarines, or butterines sold in the Washington markets, butter crystals on boiling; he invariably found foliated crystals of beef fat.

Dr. Taylor strongly objected to Prof. Weber's constant use of the term 'Characteristic of the Butter Crystal' within quotation marks, stating that nowhere in his writings or in public speech has he stated that the cross was characteristic of the butter crystal, meaning thereby that the St. Andrew cross, so called, was to be found nowhere except in the globose butter crystal. Dr. Taylor has shown that the cross is only a factor, and does not contend that it is exclusively characteristic of the butter crystal. The butter crystal, he stated, had several peculiar characteristics which he has not yet found in connection with any other crystals of fat, animal or vegetable.

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Provisional Key to Classification of Algæ of Fresh Water.—XI.

BY THE EDITOR.

[*Concluded from page 144.*]

VI. ORDER FLORIDEÆ.

Sexual propagation by fruiting of a female cell (carpogonium) which bears on its end a more or less drawn

out neck or projection of varying form (trichogynium). Fructification by spherical spores or male elements (spermatozoides, antherozoides) produced in the ends of 1–2 celled branchlets, or in special parts of the surface of the thallus, single or in groups (antheridia), one in each mother cell These float in the water and adhere to the trichogyne and fertilize it. The neighboring cells beneath the trichogyne, the so-called trichophore apparatus, give rise to a bunch of short branches, the terminal cells of which produce the reproductive cells, the carpospores.

A sexual propagation by gonidia which, like the carpospores, are produced at the points of special branchlets, or between cells of the surface of the thallus, usually 4 in a mother cell (tetraspores), not motile.

The florideæ contain a red coloring matter, phycoerythrin, or a blue, phycocyanin, in addition to chlorophyll, and therefore usually are violet, purplish red, blueish green, brown or black.

XV. *Family* LEMANEACEÆ.

Simple or somewhat branched, setaceous, conferva-like, hollow filaments. Spores produced on the surface in special zones. Carpospores formed within the tubular filaments. No tetraspores.

137. Genus *Lemanea* Bory.

Rather large, robust, bristle-like filaments, of a dark, bluish green, brownish or black color. The single filaments simple or branched, usually nodular. They are attached to a filamentous mass, scarcely visible to the naked eye (thallus), which is attached by hair roots, and from which arise the thick, hollow, fruiting threads.

XVI. *Family* BATRACHOSPERMACEÆ.

Branching filaments, consisting of a principal axis and a more or less developed system of branching. Spermatozoids and carpogonia formed at the ends of branchlets. Tetraspores at the ends of branchlets.

138. Genus *Batrachospermum* Roth.

Branched filaments, slippery, soft, consisting of a branched principal axis, made up of a simple series of colorless, cylindrical cells. At the upper end of each of these cells originates a series of cortical cells, and clustered fascicles of moniliform branches of cells.

139. Genus *Chantransia* Fries.

Small, steel-blue, brownish or red tufts. Filaments consisting of a single series of cells, straight, branching, naked, fasciculately branched above, joints cylindrical.

Carpospores formed in small tufts at the ends of small branchlets, as in *Batrachospermum*.

Asexual propagation by tetraspores, formed at the ends of cells like the carpospores, not often observed.

XVII. *Family* HILDENBRANDTIACEÆ.

Thallus membranaceous. Tetraspores sunk in receptacles in the thallus. Propagation unknown.

140. Genus *Hildenbrandtia* Nardo.

Membranous, spread out flat, on the matrix upon which it grows, consisting of several layers of small, spherical cells, with red contents.

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— King's amber cement, prepared by the Rev. J. D. King, and, we believe, sold by dealers generally, is prepared as follows: Dissolve 453 grammes of best bleached shellac in half a litre of 95 per cent. alcohol. Dissolve 1 part of gum mastic in 2 parts of alcohol, and let stand until clear. To the shellac solution add 38 grammes of the mastic solution, color with dragon's blood dissolved in alcohol, and filter. Place it on a water bath and stir frequently until it comes to boil. Filter through flannel. Thin with alcohol if necessary.

— King's lacquer finish, which was also recommended in a recent article in these columns, is made as follows:—Dissolve 1 part of bleached shellac in 2 parts of 95 per cent. alcohol. To every 38 grammes of 1 add 5 grammes of 2 and 5 grammes of Brown's rubber cement. This is highly commended as a color finish for mounts.

EDITORIAL.

Publisher's Notices.—All communications, exchanges, etc., should be addressed to Henry Leslie Osborn, Lafayette, Indiana, Purdue University.

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EDITORIAL CHANGE.—In the July number it was suggested that on account of the protracted residence of the Editor in Japan a change would be made in the editorial management of the JOURNAL. Prof. Hitchcock was compelled to leave the country for his work in Japan before the publication of the August number, and before arrangements had been completed for the future conduct of the magazine. In this condition of affairs we have undertaken to act temporarily as editor until we can further communicate with the Editor. We promise the readers of the JOURNAL that so long as our connection with the magazine shall continue we shall spare no pains to keep up the interest of the pages of the JOURNAL. As heretofore, we trust there will always continue the greatest good-feeling between the friends of the paper and the acting editor, and shall always welcome letters of inquiry or information, and solicit the kind treatment of the readers. Fully understanding the difficulties of the situation, but with hopes of success, we attempt this temporary position until an arrangement shall be made for the entire term of Prof. Hitchcock's absence. Whatever that arrangement shall be Prof. H. will always continue to watch over the magazine as he ever has, and retain all his interest in it, and send it frequent letters from his residence in Japan. He will also retain the relation of publisher to the JOURNAL. Letters to him should be addressed to the Dai-gaku Bunko, Osaka, Japan.

HENRY LESLIE OSBORN,
Acting Editor.

—o—

THE BENEFITS OF IMPROVEMENTS IN OBJECTIVES.—The presidential address of Dr. Dallinger, delivered at the last annual meeting of the Royal Microscopical Society, shows very clearly that the recent improvements in the construction of lenses for the microscope have revealed many important facts which are utterly beyond the possibility of demonstration by even slightly inferior optical appliances. The work upon which Dr. Dallinger has been for many years engaged —the study of the life history of minute flagellate monads—has demanded the highest qualities of critical observation with the best objectives. Going back less than ten years, to 1878, definite and positive results of observation with the best lenses then produced were recorded. In the author's own words: 'The lenses were the best that the science and art of the time could produce; and the organisms on which the researches were made were thoroughly known, and were examined through consecutive years under every variety of condition, optical and other; while the limits of disclosure were clearly known, and can be readily shown with the same lenses on the same objects to-day.' But there was more to be done; details that were only suggested by the work of that time and faintly indicated in the drawings published, were relegated to future examination when further improvements should be made in objectives. The expected progress was rapidly accomplished. First came Powell & Lealand's fine water-immersion lenses, then the homogene immersions of

Zeiss, of gradually increasing numerical aperture, until, during the last year, Dr. Dallinger received a $\frac{1}{6}$, a $\frac{1}{12}$, and a $\frac{1}{20}$, each having a numerical aperture of 1.5, made by Mr. Powell. With these fine lenses much has been discovered that has hitherto been hidden.

The most important results are the elucidation of the process of development and growth of the nucleus in the organisms studied. These are so low in the scale of existence that they cannot be classed as either animal or vegetal, and may be assumed to represent the nucleus in a very elementary condition. Previous researches had already shown that after repeated fission of the monads, always characterized by division of the nucleus, two individuals coalesce, and become quite still until the investing sac bursts and sets free a cloud of innumerable germs, so minute as to be almost invisible. These were observed to grow up to a certain size, when the growth was temporarily arrested. By the use of the finest lenses the arrest of growth has been explained. It is the nucleus that grows from the minute germs, and the arrest of growth is due to internal changes which result in the development of the nuclear structure. Up to this point no internal structure is to be seen; but a granular structure can then be observed to develop, when the full aperture of the new lenses is employed, and after this condition is fully attained, the growth of the body substance around the nucleus begins. One other important observation was made at the same time, when the development of the flagella from the nucleus itself was distinctly followed.

It has also been discovered by the aid of the new lenses, that fission begins in the nucleus, and not in the body substance as hitherto observed. We will not attempt a description of the appearances presented by the nucleus previous to division, but they are remarkable, and show the importance of critical examination in this field.

In the case of coalescence of two nucleated monads the changes of the nuclei have been followed, and the results seem destined to throw much light upon the phenomena of conjugation among simple organisms. The nuclei fuse together, but finally the nuclear contents seem to become diffused throughout the sarcode body and lost. Then the organism gives rise to the germs of a new generation.

This brief and inadequate notice affords but a faint idea of the great and painstaking work of Dr. Dallinger, which is surely leading to a knowledge of the operations of life, deeper and clearer than would be possible without the optical means at his disposal. We cannot but think, in this connection, of the work upon the growth and functions of nuclei so long in progress in Germany, and it seems not improbable that Dr. Dallinger has advanced further in some respects than any other investigator, because he has been so anxious to avail himself of optical appliances superior to any hitherto used. It is also noticeable, and this may be a very significant fact, that although he speaks of a plexus-like structure, he does not figure or describe any network structure in nucleus or sarcode such as we are taught to believe characterizes living matter. The granules of the nucleus are not described as connected by threads, the sarcode is structureless. We have often thought the network structure might be due to imperfections in the optical apparatus, or to a delusion of imperfect vision. Surely Dr. Dallinger would not overlook, with his fine lenses, a structure easily seen with inferior ones.

No one can read Dr. Dallinger's contributions without a feeling of respect and admiration for those qualities of mind and industry that have enabled him to carry on such difficult observations so long and successfully. H.

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Jottings by the Way.—It is the 29th of July, and high time that our wandering thoughts should be direc-

ted upon the next issue of the JOURNAL. We are off the coast of Lower California, just above the Tropic of Cancer, which was crossed a few hours since. Our last contribution was written in the Caribbean Sea, and posted at Aspinwall, or Colon. The principal feature of that place, during the one night we remained there, was mosquitoes. Such an intolerable nuisance and pest never before came into our experience, although we have found it bad enough in passing through Jersey swamps. But it is remarkable that the Colon species is essentially and conspicuously a nocturnal insect. Just as the sun sets he comes, with all his sisters and cousins and aunts and generations of other relatives, in a perfect swarm, and torments people until broad daylight.

A trip across the Isthmus of Panama at any season is well worth all the discomfort it involves. We cannot enlarge upon it here. Colon, since the fire, has changed very much. It is more attractive from the outside than when we saw it first, about eight years ago, but just as muddy and unhealthful as ever. M. de Lesseps has a fine residence at the terminus of the projected canal, and an attempt has been made to protect the lives of laborers engaged upon the canal by providing good dwelling-houses for them. The first attempt to improve the sanitary condition of the Isthmus has been made by M. de Lesseps.

The railroad runs through a country teeming with the rank life of the Tropics. Panama is about 8° 30′ north latitude, near enough to the equator to give one a sufficient experience of purely tropical life and heat. Yet we were fortunate in having a cool day for our journey, and before sunset the steamer 'San Juan,' which had been waiting for us all day, steamed out of the beautiful harbor of Panama, and bore us still nearer the equator, down to about 7° 10′ N. lat., and then we began to follow the coast line towards the north *en route* for San Francisco.

Our steamer made four ports on the way, two of which we visited, but the most interesting of all was the old Mexican town, Acapulco. Leaving the ship early in the morning, armed with a large camera, we spent several hours of the greatest interest among the people, heading a motley company of natives, who were much attracted by our operations. Our own party consisted of four persons, the writer, his wife, a fellow-passenger, and a fat, good-natured native boy, who was engaged to carry the camera box.

The sun was intensely hot, but in the shade the heat was not oppressive. The town was full of interest and novelty. First, we came upon the market-place, where a motley gathering of picturesque if not overclothed natives — men, women, and children — squatted on the ground with ridiculously small stores of merchandise—perhaps two chickens or a dozen eggs, or a few bananas or oranges or cocoanuts — which they desired to sell, but seemed quite as contented if no purchaser came. Mounting camera and ourselves on the same coping near by, we carried away an impression of the scene on a paper plate. Then there was a ruin of an abbey, once dedicated to a saint to us unknown, but no doubt famous in his day. That also we photographed, with some lazy buzzards perched on its crumbling stone tower. On the hillside above were some stone wells, overshadowed with tall cocoanut palms, which carry one back through the centuries to an earlier age, and women bearing water-jugs on their heads.

But we must leave the scene so full of interest, for we cannot spare the space to tell more of what was there. Our next stop was Manzanillo. There is little there except alligators, scorpions, lizards, and creatures that squirm and bite. The most picturesque subjects there are the miners who come in with a curious kind of sac which they carry

on the back of the head, secured by a band passing around the forehead.

San Blas was the next stopping place, but no one was permitted to go ashore. At Mazatlan we lay for several hours, and thence sailed for San Francisco.

The sail along the coast is not devoid of interest, although there is not much to be seen. Here and there the land is near enough for clear view; then it sweeps away until lost in the mist that seems to enshroud it all the time. When the sea is quiet, as it is now, save for the heaving swell that makes our vessel pitch considerably, the beautiful pearly nautilus spreads its sail, as it is figuratively expressed by writers usually, and floats about in full enjoyment of life. How many there must be of them! All day we have been passing them by scores, half a dozen of their delicate, transparent sails in sight at one time, miniature ships of pearl dotting the surface of a boundless ocean. As we sit outside by the captain's cabin-door, penning these lines, the white foam from the bows engulphs many of them with every lurch of the ship.

The pleasure of this voyage has been greatly enhanced by the genial and social character of Captain Pitts, the commander of the ship, whose kind attentions we shall always remember.

At night the phosphorescence of the water has been a remarkable sight. The luminous foam spreads out over the dark water as the ship cleaves her way through it, and here and there bright points of light shine out with wonderful brilliance.

The cause of the brilliant phosphorescence we were unable to determine. It seems quite impracticable to secure specimens for close examination while the steamer is under way. We endeavored to collect some specimens, but were not successful, with the appliances at hand. The abundance of phosphorescent creatures is astonishing. Looking over the side of the vessel, a broad line of lambent light marks out the water-line from stem to stern, the foam from the bows is intensely white on a dark cloudy night, and every wavelet that breaks around is capped with light.

The last two days and nights were foggy, and we entered the Golden Gate on Tuesday morning, August 3d, with a heavy mist hanging over the harbor, hiding the distant prospect from view.

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A Convenient and Inexpensive Microtome for wood sections is described in the June number of the *Journal of the Royal Microscopical Society*. It is made of a block of wood two inches square in end section and four inches long. Across one side of this two cuts are made directed downward toward each other and meeting so as to remove from the block a triangular prism. The space thus left is the 'well' of the microtome; the piece to be cut is laid in the well with the end projecting, and the razor moves across it held in place by the side of the block. To protect the side of the block and support the razor a glass slide is cemented on each side of the well in the shape of a letter V.

For softening wood tissue before cutting, the wood may be immersed for several hours in a mixture of equal parts of alcohol and glycerin kept slightly warm (60° Centigrade) for several hours. This, without injuring the structure, will render it soft and easily cut, and should be especially resorted to when the tissue has be allowed to dry for some time.

NOTES.

— We have received some very fine collections of diatoms from Mr. L. M. King, who is offering similar specimens for exchange. This reminds us that we should say, in order to correct any erroneous impressions that may arise from the occasional absence of our exchange column, the omission is not purposely

made, but from necessity. We always endeavor to publish the list of exchanges, but occasionally it will happen that the Notes and Correspondence just fill the last page. The most attractive material under the microscope is that containing *Isthmia* on seaweed. This is the richest and cleanest collection of that diatom we have seen, although it may be very abundant on the Pacific coast. We will elsewhere give some hints on mounting such diatoms in the most effective manner.

— Mr. L. M. King announces the discovery of a new deposit of diatoms near Santa Rosa, Cal. In sending us a specimen he writes concerning it as follows:— The material that I send is in its natural state, and crops out in ledges in the hills in various parts of the surrounding country. It varies in richness according to the locality, but in some places it is almost pure diatoms and as white as snow, and can be mounted without any previous cleaning. The earth contains many genera which also vary with the locality, but in some places the following are particularly well represented, viz:—*Cocconema*, *Pinnularia*, *Navicula*, *Surirella*, and many others.

— We are indebted to Dr. James K. Stockwell for an excellently-prepared section across the tail of a mouse, passing through the bone, in which the different tissues are beautifully distinguished by staining.

— Dr. Van Heurck has prepared an extended report on the microscopical exhibits at the Antwerp exposition, which is published in pamphlet form. Only six makers were represented, Hartnack, Nächet, Prazmowski, Reichert, Ross, and Zeiss. The apparatus exhibited was freely offered for examination, and the tests of objectives were made by Dr. Van Heurck in his own work-room, under precisely identical conditions. We cannot undertake to notice in detail a report of this kind, which must be read entire to be of value. It can doubtless easily be obtained by addressing the author at Antwerp. It is printed in French.

— A new mounting medium having an index of refraction of 2–4 has been prepared by Mr. S. Meate. Ten grains of bromine and 30 grains of sulphur are heated in a test tube, and when the sulphur is dissolved 13 grains of metallic arsenic in powder are added, and the heating continued until this is dissolved. The medium is easily used, as it melts on the slide when gently heated, and runs like balsam.

— The *Moniteur du Praticien*, edited by M. Aug. Zune, at Brusselles, is a valued exchange, containing articles of a practical and instructive character. The last number contains an article on the medico-legal examination of blood, which is a brief review of progress in this kind of work since the year 1832. Another article, by the editor, treats of the examination of drinking-water, chemically, microscopically, and for hygienic purposes. The subject of the action of the more important chemical reagents in quantitative analysis is continued. The list of reactions given in these articles is valuable for reference.

— 'Ex-President Porter on Evolution' is the title of the opening article in the September number of *The Popular Science Monthly*. It is by Mr. W. D. Le Sueur, already well known as an able writer on the relations of theology and evolution, and is an outspoken review, as entertaining as it is effective, of Dr. Porter's recent address before the Nineteenth Century Club.

— A correspondent sends the following quotation from E. Häckel:—

'According to the same law of divergent adaptation, both eyes also frequently develop differently. If, for example a naturalist accustoms himself always to use one eye for the microscope (it is better to use the left) then that eye will acquire a power different from that of the other, and this division of labour is of great advantage. The one eye will become more short-sighted, and better suited for seeing things near at hand, the other eye becomes, on the contrary, more long-sighted, more acute for looking at an object in the distance. If, on the other hand, the naturalist alternately uses both eyes for the microscope, he will not acquire the short-sightedness of the one eye and the compensatory degree of long-sight in the other, which is attained by a wise distribution of these different functions of sight between the two eyes. Here, then, again the function, that is the activity, of originally equally-formed organs can become divergent by habit; the function reacts again upon the form of the organ, and thus we find, after a long duration of such an influence, a change in the more delicate parts and the relative growth of the different organs, which in the end becomes apparent even in the coarser outlines.'

— Dr. L. Heydenreich has recently discussed the subject of cements for mounting in the *Zeitschr. für Wiss. Mikr.*, and gives

a formula for what he regards as the best cement. Mr. E. A. Schultze has translated the article for the *Journ. N. Y. Micr. Soc.* After discussing the merits of various resins used in varnishes, he gives the following instructions for preparing his cement:—

'Taking equal parts of the best, clearest, and hardest amber-varnish and copal-varnish, mix them and heat until all the turpentine has disappeared. This will require a temperature of 100° to 150° R. As soon as all the turpentine has evaporated, remove the dish from the flame, allow it to cool somewhat, and then add oil of lavender to the liquid in proportion of ½ to 1; mix well, and allow the entire mass to cool thoroughly. The process is terminated by adding from 20 per cent. to 40 per cent. of artificial cinnabar (eosin with cinnabar), which should be very carefully and thoroughly rubbed in. The best method for rubbing in the cinnabar is that employed in the preparation of fine oil-paints. Should the cement when finished be too thick for use, as much oil of lavender as will give the required fluidity may be added. The component parts and their proportions would then be as follows:—

Amber	25	parts.
Copal	25	"
Linseed-oil varnish	50	"
Oil of lavender	50–60	"
Artificial cinnabar	40–60	"

We are quite at a loss to understand the parenthetical expression 'eosin with cinnabar' as applied above, but in the formula itself the expression is 'eosin or cinnabar,' which is probably what the author intended to write, the eosin being added to impart color, although in this case the proportion given would be excessive. The addition of oil of lavender is to be highly commended. For a cement that depends upon the drying of the resins and oil, rather than the evaporation of a volatile solvent, we have no doubt this one of Dr. Heydenreich is the best.

— This matter of cements recalls to mind an expression in the *Zeitschrift*, above mentioned, applied by Dr. Griesbach to ourselves. In describing the method given by us sometime since for preparing shellac cement, he referred to us as 'ein eifriger Anhänger des Schellackcementes.' We are quite satisfied with the appellation, for with nearly ten years experience with shellac, using it for the great variety of preparations that naturally come to a general observer in microscopy, we may say it is the only cement that has come into our hands (and we have tried many) that never fails. But apart from this, there is another reason why we have so persistently urged its use in these columns, until we doubt not many of our readers are tired of it, and are inclined to regard us as a crank on the subject. The reason is that so many of the best observers and students do not mount specimens for preservation because they have not the time to spare. There is just reason for this if the ordinary methods of mounting in fluids are followed, while Canada balsam is not the proper medium. But by using shellac, a permanent mount dry in water or in glycerin can be made on a perfectly plain slide in five minutes, and it will keep perfect for years.

— We are also reminded that in several of the photographic journals the method of clearing shellac solution with 'petroleum spirit' or 'gasoline' recommended by us* has been condemned, and the assertion made that for various excellent reasons the plan will not answer the purpose. In this case, however, the results of experience are not in strict accord with the theories of the critics. The plain fact is that the plan does work; otherwise we would not have published it. But to show to what extent the principle of it has been misunderstood, and also the coolness with which improvements upon well-tried methods are sometimes suggested by persons who do not understand the subject, we may refer to a leading article in one of our contemporaries. After explaining why our plan will not work, the writer suggests that it might be better to first treat the dry shellac with the petroleum derivative, for the purpose of dissolving out that portion not soluble in alcohol, after which a clear solution in alcohol might be obtained. We need only say that the naphtha in our experiments did not dissolve the matter insoluble in alcohol, but effected a mechanical separation of it.

CORRESPONDENCE.

To the Editor:—I notice, in June number of Microscopical Journal, a complaint concerning oxide of zinc cement. I think Mr. Claypole's annoyance has been caused by impurity of the zinc oxide used. Very little of the oxide, as purchased, is pure, as it contains a portion of the carbonate, due to exposure to air, from which it takes up carbon dioxide. If the oxide is exposed to a gentle heat

*Vol. v., p. 131.

before use, to drive off the carbon dioxide, and thus destroy the zinc carbonate, the trouble will be likely to disappear. I have noticed that oil of cedar (used as immersion fluid) is apt to soften or destroy the zinc cement rings, if they are at all recent, and mention it, because I have not seen it noticed.

T. F. C. VAN ALLEN.

ALBANY, N. Y., July 12th, 1886.

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TO THE EDITOR :—I note a letter in the Aug. number of your JOURNAL from Mr. Thompson, in reply to query from W. in July number.

He quotes 'Tuckett's Treatise.' From a pretty fair acquaintance with treatises on the microscope published in English, from 'Hook's Micrographia,' say, 1665, down, I think I can safely assert that there is no such treatise as *Tuckett's*. Could you have mistaken Mr. T's manuscript, and thus read it instead of Quekett? I have the 3d ed. of Quekett, 1855, and it is as Mr. T. states. Some years since, in N. Y., in conversation with Mr. John Phin, editor of the *Am. Jour. of Microscopy*, in regard to older works on microscopy, he stated that he had a copy of Quekett, *2d edition;* that it gave a plate of the diatom in question, and remarks on its resolution by Spencer's objectives, which had been impossible till then with the best glasses then made in Britain or on the Continent, and that it had so galled the English opticians, and raised such an outcry, that Quekett dropped the matter in his 3d edition. There should be no great difficulty in finding this 2d edition in some public library, or in the collection of some microscopist. Practical optics is a *very* old science dating back to the days of Babylon, quite old in Europe, quite young in the U. S. Through Spencer, the child gave the mother the *first* lesson on increased angular aperture. His glasses, in this respect, far exceeded any thing then known in Europe. Further advance in this direction had been proclaimed useless and impossible by the first English authorities. Still, there were the facts and the glasses, both stubborn things. The *second* lesson, and in the same direction, was given by the late Mr. Tolles, a pupil of Spencer, in the + 180° war which lasted some years, the truth of his deductions and productions being triumphantly established to the satisfaction of the world, and again, despite of the dictum of the highest British authorities. Still, this setting limits to the advance of science still goes on, and every ten or twenty years we have to set them further back. Within a few years a president of the Royal Micr. Soc., in his annual address, fixed the limits of resolution of fine lines at 100,000 to the inch. This did not fit existing facts then, and far less since, as there is the strongest possible evidence to attest that it reaches to 130 or 150,000 at least. This fixing of limits is an old business. In ancient times they fixed the limits of the world, the 'ultima thule,' at the pillars of Hercules, as the 'ne plus ultra' (nothing beyond.) My namesake did not accept the proposition, hence our being. Spain, after this, with very pardonable vanity, stamped on her coin the pillars (of Hercules) encircled with a streamer, and the motto, 'plus ultra' (further yet,) and this, by the way, is the origin and 'true inwardness' of our dollar mark, $, despite several other accounts of the same. The two straight lines represent the pillars of Hercules, and the curved one the streamer. The motto 'plus ultra,' so decidedly American, in its origin, I think a good one for our scientists while engaged from time to time in setting back the various 'limits' by which they are sought to be confined. In scientific matters it would not seem to be safe to accept the 'dictum' of any man or body of men. The 'limit' they place is usually that which includes *their own* knowledge, with very little room for expansion.

CHR. C. BROOKS, Ph.D.

393 E. Eager St., Baltimore, Md.

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A 1-25 Inch Objective.

TO THE EDITOR :—I received of H. R. Spencer & Co. last October a $\frac{1}{25}$ inch objective; it has a B.A. angle of 125°. I consider this $\frac{1}{25}$ to be one of the best high power objectives I have ever looked through; it resolves the most difficult slides of Amphipleura in balsam with plain mirror, illuminated mirror being placed central and no stops in the condenser.

All things being in good order and the light in the proper direction for the work in hand, it resolves the most difficult tests at once. I consider this $\frac{1}{25}$ of the Spencers to be the best, or one of the best, high powers that he has ever made for resolution and definition, and I cannot see how it can be excelled or ever equalled. Its definition with glycerin and central light is unrivalled. It has a good working distance and works easily through a thin No. 1 cover, and it works well with water, glycerin, and homogeneous fluid, and works well and gives good definition when

used dry. I have tested it on all kinds of work that could be done with such a high power, and, as far as my experience goes, I believe it to be superior in definition and resolution to any high power that I have ever examined. The picture given of bacteria and micro-organisms is all that could be desired.

PIERCE TYRRELL.

MICROSCOPICAL SOCIETIES.

CLEVELAND, OHIO.

At the annual meeting of the Cleveland Microscopical Society, all the officers were re-elected for another year, viz: President, C. M. Vorce, F. R. M. S.; Vice-President, Montague Rogers; Secretary, J. A. Wilson; Treasurer, John Hoehn, Ph. G.

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SAN FRANCISCO, CAL.

The regular semi-monthly meeting was held Wednesday evening, June 9th; Mr. E. J. Wickson, presiding.

A well-mounted slide of the beautiful brine shrimp, *Artemia Salina*, was shown under dark field illumination. This interesting little crustacean is now found in large numbers in the brine-pits of the salt-works near Alameda. It is about one-fourth of an inch in length, and each segment of the thorax is provided with a pair of branchial feet, the rhythmical motion of which impart a very graceful appearance to the animal when swimming in the brine.

The Secretary called attention to an unusually fine mount of the head of the male wasp obtained from Fred Enoch, the well-known English preparer of entomological objects. The slide was accompanied by a camera lucida sketch, showing the upper and under sides, and designating the various organs.

The remainder of the evening was devoted to the examination of several varieties of fruit pests, mainly insects belonging to the aphis and coccus families, and their natural insect foes. The collection had been brought by Dr. Bates, who narrated some interesting facts regarding the same, and then called upon Mr. Wickson for a further elucidation of the subject. The latter stated that some experiments were now being carried on at the State University orchard with reference to keeping the destructive insects on fruit trees in check, by fostering the propagation of other insects which are the natural foes of the former class. He cited an instance of a plum tree which was apparently hopelessly overrun with the plum aphis, but several varieties of the well-known lady-bug, *Coccinella*, soon appeared in such numbers that the tree became fairly red with them. As a consequence, the aphides were losing the ascendency, and the tree would no doubt ultimately be rid of them. The larval form of *Coccinella* is even more useful than the perfect insect, as a factor in the destruction of aphides. Specimens of the lace-winged fly (*Chrysopa perla*) and of a fly belonging to the genus *Syrphus*, together with their larval forms, were shown under the microscope, and their peculiarities of structure pointed out. The larva of *Syrphus* is footless and blind, but nevertheless creates great havoc among the multitudes of destructive insects infesting fruit trees.

A. H. BRECKENFELD, *Rec. Secr.*

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SAN FRANCISCO, CAL.

The regular semi-monthly meeting was held on Wednesday evening, July 28th, Dr. S. M. Mouser presiding.

Pursuant to announcement, Mr. A. H. Breckenfeld read a paper on 'Hydra, the Fresh-water Polype.' After referring to the original discovery of this remarkable little creature by that pioneer microscopist, Antony van Leeuwenhoek, in 1703, allusion was made to the investigations of Trembley—by whom the animal was practically re-discovered nearly forty years later—and the great interest excited thereby among the naturalists of Europe.

Hydra consists essentially of an elongated, nodular sac of protoplasmic substance, imbedded in which are found large numbers of colored granules. At the upper end of this sac is a simple opening, the mouth, and just below this is a circle of tentacles, usually from six to ten in number. At the lower extremity the body is furnished with a flattened, suctorial disk, by means of which the animal attaches itself to filaments of algæ, rootlets of duckweed, and similar objects, while its slender, tendril-like tentacles are slowly and gracefully waving about in search of prey. The body and tentacles, when fully extended, seldom measure over one-fourth or one-half of an inch in length, except in the case of the rare species *H. fusca*, which sometimes attains a length of several inches, owing to the extraordinary development of the tentacles, which in that species are many times the length of the body. The tentacles of *Hydra* are hollow, each being traversed by a canal communicating

directly with the body cavity. It subsists entirely upon animal food, consisting mainly of minute worms and the smaller entomostraca.

With regard to the histology of *Hydra*, many very diverse views have been held. It is now universally conceded that *Hydra* is composed exclusively of cells and cell derivatives. The most valuable researches on the subject were those of Kleinenberg, whose admirable monograph appeared in 1872. The body and tentacles of *Hydra*, Mr. Breckenfeld stated, were resolvable into two distinct layers, an inner—the endoderm—and an outer—the ectoderm.

After alluding to the structure of the curious nematocysts or stinging organs, and of the reproductive bodies of *Hydra*, the paper next described the gemmation of the animal, a process strikingly analogous to that of budding in plants. A little swelling on its body surface gradually elongates, at the free end a mouth is formed, below which is developed the crown of tentacles, and thus a young *Hydra* makes its appearance, the entire process being usually completed in a few days.

Some remarkable instances of abnormal development in *Hydra* were alluded to, and a description given of two curious parasitic infusoria by which it was often infested.

During the reading of the paper, enlarged images, illustrative of the subject, were thrown upon the screen by E. W. Runyon with his oxy-hydrogen lantern, thus adding greatly to the interest of the occasion. By means of the microscopical attachment devised by him, very successful images of the living animal were also thus shown.

A. H. Breckenfeld, *Rec. Secr.*

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New York.

Organized Dec. 11th, 1877; incorporated 1878. Regular meetings at No. 64 Madison avenue, on the first and third Friday evenings of each month, from October to June, inclusive of both. Active members, 62. Average attendance of members and guests at the regular meetings, 36. Attendance at the annual reception, Feb. 6th, 1885, 500; and number of microscopic objects exhibited, 48.

The addresses, lectures, papers, discussions, communications, and the names and descriptions of objects exhibited at all the meetings, have been published in course in the *Journal* of the Society.

The names of the officers for the year 1886, are the following:—

President, the Rev. J. L. Zabriskie; Vice-President, P. H. Dudley; Recording Secretary, M. M. Le Brun; Corresponding Secretary, Benj. Braman; Treasurer, Charles S. Shultz; Librarian, William G. De Witt.

NOTICES OF BOOKS.

The Kindergarten and the School, by Four Active Workers. Milton Bradley Co., Springfield, Mass. (pp. 136).

This little work is made up of five essays by four ladies, apparently teachers, who speak from personal experience. The essays cover the following subjects:—1. Froebel and his work. 2. The theory. 3. The methods of kindergarten teaching. 4. Kindergarten in the public schools. 5. Kindergarten and the school.

The work is an admirable exposition of the kindergarten method, well illustrated with figures of the blocks, and with colored plates to show models for the mats, etc., the children learn to make. The work does not claim to be a defence of the system or comparison of its benefits with those of any other system of education. Possibly it assumes this as too certain. We can, however, not hesitate in the verdict that one who wants to find out what the kindergarten system is will find ample instruction and entertainment in the work.

The New York Medical Monthly is a new publication, the first number of which was issued in May. It is edited by J. Leonard Corning, M. D., and publishes a list of eminent contributors. It proposes to be an 'entirely practical' journal, and the first number promises well. The advertisements of injurious mechanical appliances and patent nostrums of questionable harmlessness, which are usually conspicuous features on the advertising pages of medical journals, are absent. We trust they will be rigidly excluded from future numbers also.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Labels for slides, also slides and material to exchange for same. EUGENE PINCKNEY.
Dixon, Ill.

For Exchange: Seeds of *Orthocarpus purpurascens* and *Orthocarpus attenuatus*, and slides of same, in exchange for good objects, foraminifera preferred.
EDWARD GRAY, M. D., Benicia, Cal.

THE AMERICAN

MONTHLY

MICROSCOPICAL JOURNAL.

Vol. VII. Washington, D. C., October, 1886. No. 10.

On the So-called New Element of the Blood and its Relation to Coagulation.

BY GEO. T. KEMP, PH. D., UNIVERSITY OF PA.*

Hayem, in 1878, called attention to bodies in the blood which were not previously noticed. He called them *hæmatoblasts*, and endeavored to prove that they were early stages in the development of red corpuscles. In 1881 Bizzozero claimed independent discovery of the same elements, and affirmed that they were connected with the coagulation. Much conflicting research followed, and finally Dr. Kemp, of Johns Hopkins University, presented a paper, of which this is an abridgment.

The element is called by the term *plaque*, used by the French observers.

If a drop of 1 per cent. osmic acid be placed on the finger, and the finger pricked with a needle through the drop, the elements of the blood will all be hardened and preserved in their natural appearance.

If a thin film of this blood be examined with a good lens magnifying 600 to 800 diameters, the plaques may be seen floating in the plasma among the red corpuscles and leucocytes.

They are pale, homogeneous, variable in size, about one-third to one-fourth the diameter of a red corpuscle. Seen on surface, they are circular or elliptical, and seem at first sight flat, but are very slightly biconcave, as shown when seen edgewise.

The form of the plaque when thus studied never undergoes change. This is not the case in blood drawn and allowed to clot. To study this the following method is adopted :—The finger is pricked and a good-sized drop of blood squeezed out and taken immediately upon a cover-slip. Then, as quickly as possible, most of it is washed off by a jet of .75 per cent. Na Cl solution from a wash-bottle. The slip is now examined under the microscope. The plaques have the property of sticking to the slip while the other elements are washed away by the jet, so that, on examination, the whole field is found filled with plaques mostly grouped in masses of 2–12 or more.

They are no longer pale and homogeneous with symmetrical outline, but appear glistening and granular, and their contour has become jagged. These changes are more marked the longer the time which has elapsed before the preparation is observed, and they may be seen to take place step by step while a preparation is being watched. This change progresses until only a granular mass remains, the individual plaques being no longer distinguishable. *Pari passu* with these changes processes may be seen to run out from the granular masses, and when coagulation sets in these are usually found continuous with the threads of fibrin.

The threads of fibrin are sometimes deposited as long needle-shaped crystalloids, which are often seen lying in the field free from any granular

* Abridged for this Journal from the original article in the Studies from the Biological Laboratory of Johns Hopkins University.

masses, but the greater number are formed most thickly around those masses from which they often radiate.

If too much blood has been washed away in preparation no formation of fibrin will take place; if in any part of the field the blood remains thick its edges will furnish the best area for observation.

For *hardening* and *preserving* the *plaques* various other methods were tried:—

1. Hayem's solution. Dist. water 200, Na Cl 1, Na_2 So_4 5, Hg_2 Cl 0.5.

In using, dilute with $\frac{1}{10}$ volume .75 Na Cl. It does not act quite as quickly as the osmic acid.

2. Bizzozero's fluid. Na Cl .75. to which methyl violet has been added, in ratio of 1 methyl violet to 5,000 Na Cl.

3. Preservation by drying both spontaneously, and carefully over alcohol flame. Not satisfactory.

Mounting media used were:—

1. Balsam and damar. Used directly with dried specimens or after turpentine or xylol; used also after alcoholic staining, but not desirable, as the alcohol causes shrinkage of even osmic specimens.

2. Glycerin. Not best for unstained plaques or osmic specimens. Works well with stained specimens.

3. Glucose. Very satisfactory for temporary mountings. Used in concentrated aqueous solutions becomes hard and requires no cement.

4. Acetate of potash best medium employed. In it both plaques and fibrin threads stand out clearly and sharply defined.

5. Hayem's fluid preserves the plaques several weeks; but in specimens several months old a granular precipitate is seen, and sometimes crystals are deposited.

Staining readily effected by methyl violet, gentian violet, and fuchsin, used in dilute solutions.

Iodine irrigated under cover-slip stains well, but the stain will wash out in water after long treatment. Bismarck brown, magenta and Kleinenberg's hæmatoxylin and aqueous hæmatoxylin best for permanent stains; acts slower. Anilin blue-black, borax carmine, Frey's carmine and picro-carmine do not act even in 24 hours.

The plaques may be chilled at once on drawing to — 1° to + 2–5° C, and coagulation will not take place. The plaque will retain its natural structure for study, and may be observed to change very slowly.

Various opinions prevail as to the origin of the plaque, summed as follows:—1. That they are young red corpuscles; 2, that they are derived from red corpuscles; 3, derived from white corpuscles; 4, nuclei floating free in the blood; 5, fibrin; 6, globulin depositions from blood; 7, that they are independent elements.

Dr. Kemp, after a summary of opinion regarding these views, and critical examination of the positions of their adherents, concludes in favor of the last, because—1, the plaques are found with the other elements of the blood on drawing fresh into osmic acid; 2, they have been seen with the others circulating in the vessels; 3, there is no sufficient evidence to prove that they are derived from the red or white corpuscles and are other than *an independent morphological element*.

The results of the work all go to show that the breaking down of the plaques is intimately connected with the formation of fibrin.

The granular masses formed by the plaques become centres from which the threads of fibrin radiate. The threads are also deposited freely in the field, and often as long, needle-shaped bodies, but there is generally a thicker deposit of fibrin in the immediate vicinity of the granular masses, especially the large ones, than is noticeable elsewhere.

The plaques, either before or after breaking down, are not morphologically identical with fibrin, so that they do not contribute as such to the

formation of the fibrinous network; the remnants which are seen enclosed by the threads of fibrin are held there mechanically, and are not an essential part of the reticulum.

Some writers teach that it is the white corpuscles which give rise to the fibrin of coagulation. Kemp finds no evidence to support this. The fact that the fibrin is formed in the fluid where plaques are absent suggests that the plaques may not be the cause of coagulation. The fact that fibrin is nearly always deposited more thickly around the granular masses, and even radiating from them, is interesting and suggestive, but not conclusive proof that the plaques give rise to them. The same adhesive property of the plaques which makes them adhere to each other may cause the threads of fibrin to adhere to them as fast as they separate from the medium around them. The fact that fibrin is deposited most thickly in the vicinity of the plaques may be due to something given up by the plaques which produces or hastens coagulation, and that in dilute solutions this substance is more plentiful in the neighborhood of the granular masses than elsewhere. Kemp thinks that it is plain that, though there is no histological connection between the plaques and fibrin, there is a chemical one, the plaques, as they break down, giving up something to the plasma, since conditions which retard the breaking down of the plaques also retard the formation of fibrin to *precisely the same extent*, while reagents, which *preserve the plaques, prevent the formation of fibrin altogether*.

The fact that well-preserved plaques are found inclosed in fibrin taken from the heart some time after death cannot be regarded as conclusive proof that the plaques are not connected with the formation of clot, unless we could know positively what they yielded to the clot, and that all were well preserved.

From all at present known on the subject it would seem that a *ferment* would be most liable to conduct itself so as to produce these effects.

Dr. Kemp's conclusions, briefly stated then, are:—

1. The blood contains a third histological element, the *plaques*.

2. No evidence that this is *genetically* related to either the white or the red corpuscle.

3 Plaques break down at once when the blood is drawn; other elements do not.

4. Their breaking down intimately connected in time at least with clotting of the blood.

5. The connection between the plaque and the clot not a histological but a chemical one.

6. The active agent is most probably fibrin-ferment.

7. Fibrin is deposited histologically independent of any cellular elements of the blood.

8. When the clot is scant, fibrin is deposited as thin needle-shaped crystals.

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Life on a Coral Island.*

BY PROF. W. K. BROOKS.

After the discovery of the Bahama Islands Columbus writes to Queen Isabella that 'this country as far surpasses all other lands in beauty as the day exceeds the night in brilliancy,' and as the scientific expedition of the Johns Hopkins University approached these islands, and the beauties of the land and sea and sky of the tropics began to unfold themselves before our eyes, all the members of our party echoed, in words of their own, the impression of the great explorer.

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This island, Abaco, which lies nearly north and south, is about a hundred miles long, and its eastern edge is bordered by a narrow sound from three to five miles wide, the outer shore of which is formed by a rim made up of

* Extracts from the letter of Dr. Brooks in the *Baltimore Sun*, Aug. 16, '86.

thousands of small islets or 'keys,' separated from each other by narrow, winding channels. Some of the keys are ten or twelve miles around, while others are no larger than a small house. They are high and well wooded, with bold headlands and cliffs, and long, winding bays and inlets.

* * * * * *

We had read many glowing descriptions of the gorgeous beauty of the tropics, but these were all forgotten, and we felt that we were entering a land where everything was new. Our reason refused to put any limit to the wonderful discoveries which filled our imagination, and as we sailed slowly past cliffs bathed in spray from the breakers which rolled in from the ocean, past the mouths of caves which the sea had hollowed out in the limestone rock, past deep bays and long, winding sounds which penetrated deep into the islands, our fancy peopled every cave and tide-pool with strange animals new to science, and we felt all the glow of enthusiasm which we experienced when we first entered a scientific laboratory and prepared to solve all the problems of the unknown universe.

Navigation among the sunken reefs and submerged islands, which are much more numerous than those above water, is very dangerous. A few miles away the ocean is more than three miles deep, with no land nearer than Africa, and the heavy sea which is always pounding upon the outer reefs soon puts an end to any vessel which deviates from the narrow winding channels between the ledges of growing coral: but our pilot steered us safely through the crooked inlet between Whale Key and No-Name Key into the inner sound.

Here we saw for the first time that intensely green sea which has been so frequently mentioned by voyagers among coral islands. This vivid color soon became more familiar, but never lost its novelty, and it still holds its place as the most brilliant and characteristic feature of this highly-colored landscape, and it is totally unlike anything which is to be seen anywhere except in a coral sea.

The water is so perfectly pure and clear that small objects like shells and star-fish are visible on the pure white coral sand at a depth of 50 or 60 feet, and the sunlight, which is reflected from the white bottom, gives to the water a vivid green lustre, which is totally unlike anything in our familiar conception of water. The whole surface of the sound seemed to be illuminated by an intense-green phosphorescent light, and it looked more like the surface of a gigantic polished crystal of beryl than water. The sky was perfectly clear and cloudless, and overhead it was of a deep-blue color, but near the horizon the blue was so completely eclipsed by the vivid green of the water that the complementary color was brought out, and the blue was changed to a lurid pink as intense as that of a November sunset. The white foam which drifted by the vessel on the green water appeared as red as carmine, and I afterwards found in a voyage through the sounds in a white schooner that the sides of the vessel seemed to have a thin coat of rose-colored paint when seen over the rail against the brilliant green.

We came to anchor in the mouth of a beautiful winding bay, in water about thirty feet deep, but so clear that the vessel seemed to float in air, and the motions of the gigantic star-fishes and sea urchins could be studied on the white bottom as well as if they were in an aquarium. The shores of the bay are high and rocky and well wooded down to the water's edge, where the vegetation ends in a fringe of mangrove bushes perched above the pure salt water on their long, stilt-like roots, which arch up from the bottom like the ribs of a great umbrella, to meet several feet above the water at the point from which the main stem arises. Behind us, several miles away, is the 'main-land' of Abaco, separated from us by the green

water of the sound, which stretches in both directions as far as the horizon. In front of us, on the shore of the bay, lies the town of Green Turtle, a much more prosperous and civilized place than we had been led to expect, with freshly-painted two-story stone and frame houses, set side by side close to the straight, narrow main street, which is used only as a foot-path, as there are no horses or cattle nearer than Nassau. The main street, which is called Broadway, is hardly more than ten feet wide, while the cross streets are just wide enough for two persons to pass. They are bordered by stone walls or high fences, and are perfectly level, as clean as the deck of a vessel, pure white, with a bed of solid coral limestone, the inequalities of which are filled with cement.

This description applies to only the better portions of the town where the white natives and a very few of the negroes live. On one side of the harbor a long, low sand spit separates this portion from the much more picturesque portion inhabited by the poorer people, most of whom are negroes. Here the little palm-thatched huts, without doors or windows or chimneys, most of them in the most attractive stages of picturesque decay and dilapidation, without any regular arrangement nestle in a thicket of aloe and cactus and bananas and castor-oil plant, which runs parallel to the white sand beach, and is penetrated here and there by the narrow white foot-paths which lead to the huts.

Beyond the town the island ends in a bold, overhanging cliff, separated by a narrow inlet from a small, low island, Pelican Key, which is covered by a growth of cocoanut trees. From our anchorage we can look out through this inlet, framed between the two islands, and can see the vivid green gradually fading as the water deepens towards the edge of the reef, which is marked by a line of white breakers, heaving and tossing as the swell rolls in from the deep blue water which stretches beyond until it merges with the lighter blue of the cloudless sky.

Every outline is so sharply defined in the pure atmosphere, and so many elements are crowded into the brilliantly-colored picture, that it is more like a landscape traced by fancy in the clouds at sunset than a substantial reality, and the whole is so much like fairy-land that we feel that if we should shut our eyes for a few minutes we should expect on opening them to find the picture dissolving into clouds.

Curbing our fancy, however, and returning to the solid facts about us, science tells us that the history of the country is far stranger than any fairy story, and that, as the geologist measures time, this whole group of islands, stretching for six hundred miles across the map, and furnishing a home where thousands of people are born and pass their lives, and grow old and die, is actually as transient and unstable as a summer cloud. Only a few years ago, as years go with the geologist, every particle of the land before us was diffused through the ocean in invisible calcareous molecules, which have been gathered from the waves and deposited by microscopic animals, and everywhere about us we find abundant proofs that if these animals should cease their constructive labors the whole would soon be diffused through the ocean like the lump of sugar which is dissolved by our coffee.

After we had familiarized ourselves with this distant view, the custom-house officer came aboard and welcomed us to the islands in the name of the British government, and told us that, although we could not be permitted to settle on shore until the next day, we were at liberty to land and explore.

All the members of our party will long remember the kind face of this gentleman, Mr. Bethel, with whom

we soon became well acquainted. He is not only the custom-house collector, but also resident magistrate, postmaster, health officer, superintendent of schools, and the general representative of the government.

As soon as we received his permission to land, a party started off in the yawl, which we had brought from Baltimore on the deck of our little schooner, to visit an abandoned house which was pointed out to us upon a hill-side at a distance from the town.

The boat soon reached the mangroves, and, pushing in as far as possible, we found ourselves surrounded by the life of the tropics. As the tide was out we could reach up from the boat and gather over our heads the oysters which were growing in great clusters on the roots and branches of the trees. The clear water was filled with fishes of strange forms and brilliant colors, and they were perfectly fearless, so that they could be examined without difficulty as they chased and captured their food among the submerged roots. The bottom was thickly covered with beautiful sea-anemones, and everywhere, on the bottom, and on the roots and branches of the trees, and on the rocks at the water's edge, we found a wealth of molluscs and crustacea, which soon taught us to regard the mangrove thickets as rich collecting grounds. We were, however, unable to penetrate through it to the land until we discovered a little cove where the bushes had been cut down. Pushing the boat into this, we reached an open, grassy landing-place, shaded by two or three cocoanut trees and surrounded by a dense forest, except at one point where a narrow path led up the hill to the house.

The front was at first a stronger attraction than the house, and one of the first objects to catch the eye was a great mass of epiphitic orchids on a dead branch close to our landing-place. The species is not one that is prized by orchid cultivators, but the plant, which was much more luxuriant than those which are seen in green-houses, and in full bloom with flowers which diffused a delightful fragrance through the woods, was gathered just before our return to Baltimore, and was safely carried home, and is now here in full vigor and beauty, a living memento of our first landing on a coral island.

The house proved to be a one-story frame building without windows or floor, but out of doors the surroundings were all that a naturalist could wish. The exposed side commanded a view of the island and harbor, while the other three sides were surrounded by a dense growth of shade and fruit trees which had been planted by the absent owner. We also found a large stone cistern, shaded by palms and tamarind trees and orange bushes, and filled with good water.

We had been informed that there were no vacant houses in the town, and although this one was very small and not at all suitable for work with the microscope, a residence in this cool and elevated place in the heart of the forest seemed so attractive that the discovery that it swarmed with mosquitoes did not dampen our enthusiasm, and even after the fine general view of the island, which we obtained from the hill behind it, had shown us that we were separated from the town and from the nearest house by a long winding sound, and should be compelled to go three or four miles for our supplies, we still felt that the attractions of this retired spot would overbalance all the disadvantages in case no better house could be found in the town.

When the excursionists returned to the schooner, however, they found that another member of the party, who had also been house-hunting, had found one in the town which was much better fitted for our use. The owner and occupant was willing to vacate and rent to us, but he could not talk business on Sunday. The next morning a satisfactory bargain

was made, and after our business at the custom-house had been dispatched, we took possession and prepared to land our apparatus and furniture.

The house is small, but by using all the rooms as work-rooms and putting our beds in corners which are of no other use, we have found room for all hands. It is a two-story house, with the walls of stone as far as the second floor, and of wood above, nicely painted and papered, in good repair, with plenty of doors and windows, a large stone cistern of good, cool water, and, on the second floor, a large veranda overhanging the street in front; for, like all the large houses, it is close to the street, which, as a sign on the corner informs us, is Union street. It is a narrow pathway about five feet wide, of smooth white limestone.

We are near the corner of Broadway, and on one side of us all the houses are large, well built, and in good repair, with well-kept gardens. On the other side the street gradually narrows down to an unfenced foot-path, which leads to the brush through a jungle of rank vegetation, through which little thatched huts are irregularly scattered. We therefore have all the advantages and comforts of the better portion of the town, but, being on the border-line, we are sufficiently near the more primitive and interesting portion to establish a familiar acquaintance with the people and to get an inside view of their life. This we accomplish the better, as one of the members of our party, who is a physician, finding that there is no other doctor within a hundred miles, kindly allows the people to call upon him for gratuitous service in his profession. In a few days, as his desire to help those who need him has become known, we are besieged at all hours by patients, who stand in the street and call out, 'Is the pill-doctor at home?' He is now so fully employed that his own studies are seriously obstructed, and he has been forced to establish office hours.

I am surprised to learn from Dr. Mills that in this delightful climate, where the temperature is almost uniform throughout the year, and the thermometer seldom rises above 85 degrees or falls below 80 degrees, there are many cases of consumption. A death from this disease took place in one of the little huts near our house a few hours after our arrival.

Our first day on the island ended in a beautiful cloudless evening, with a gentle breeze and a full moon, and as we sat on our veranda and rested after our hard day's work the sun set and in a few minutes the moon and stars were in full splendor, for we are so far south that the sun drops straight down, and we have no twilight. As we sat and listened to the mocking-birds, which were singing on all sides, and watched the long, graceful, fern-like plumes of the tall cocoanut trees swaying against the clear sky in the breeze and reflecting the moonlight from their glossy surfaces, a feeling of perfect rest after our long voyage stole over us, and while everything reminded us of the long miles of water between us and our friends in Baltimore, we felt almost at home in our new home.

We watched the half-naked negro children at play in our street, and listened with great interest to wild music which came from one of the huts, and was, as we learned next day, the song of friends gathered at the bedside of our dying neighbor; and, at last, we ate our first meal of pine-apples and bananas and sapodillos and fresh cocoanuts, and then turned in, happy in the thought that we could sleep without holding on, and delighted with our first experience of a coral island.

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The Recent Meeting of the American Association.

BY PROF. JNO. H. PILLSBURY, SMITH COLLEGE.

The Buffalo meeting of the Amer-

ican Association for the Advancement of Science, although not showing as large an attendance as some other meetings, was one of the most profitable which the writer has ever attended. The people of Buffalo were very earnest in their effort to do all in their power toward the success of the meeting.

Several very pleasant receptions and excursions were given the members, including an excursion to Niagara and dinner at the International Hotel.

The section of biology in which the readers of the Journal will be more particularly interested listened to a good number of able papers. The following, among those read before the section, were based upon microscopical research to a greater or less degree :—

Prof. W. J. Beal, of Michigan Agricultural College, gave the results of investigation regarding the arrangement of the bulliform or hygroscopic cells in the leaves of grasses and sedges, showing the relative position of these cells in a considerable number of species and the relation of their position to the rolling or falling of the leaf to prevent excessive evaporation.

Prof. J. M. Colter, of Wabash College, Indiana, showed that a much more satisfactory classification of the pines of North America can be given if it be based upon certain anatomical characters of leaves. Dr. W. G. Farlow, of Harvard College, presented some important facts relating to the life-history of several of our United States gymnosporangia, with special reference to the identity of certain forms heretofore described as species of other groups, with early stages of gymnosporangia.

Prof. D. E. Salmon, of the U. S. Agricultural Department, gave the results of a somewhat elaborate series of experiments to determine the cause of immunity from contagious diseases resulting from inoculation with attenuated virus. Subsequently Prof. Salmon presented a paper upon the 'Theory of Immunity from Contagious Disease,' based upon the results of these experiments. Prof. J. S. Kingsley, of Salem, Mass., described in one paper an ingenious method of orientation of small objects, and gave an outline of the results of his observation upon the embryology of Cromgon.

Dr. C. S. Minot, of the Harvard Medical School, presented the results of his researches on the development of the human chorion. In a subsequent paper he discussed certain important homologies in the segmentation of the orum in vertebrates, showing that some of the supposed discrepancies are disproved by the most recent investigations. Prof. C. R. Barnes, of Purdue University, presented a valuable contribution upon the revision of the North American species of the genus Fissidens. Professors Salmon and Theobald Smith contributed interesting facts in regard to nature and variability of the Bacterium of swine-plague, and Prof. S. A. Forbes, of Champaign, Ill., on 'Some Contagious Diseases of Insects,' particularly referring to a contagious disease of the 'cabbage-worm,' and experiments to ascertain if the disease can be caused to propagate itself to such a degree as to be a benefit to the gardener in ridding him of the troublesome pest.

Miss Fanny R. Hitchcock presented some valuable observations in regard to the nature of the crystalline style in *Mya arenaria*.

The papers read before the section, which were not directly based upon microscopic investigations, were as follows :—

'Atavism the Result of Cross-Breeding Lettner,' by E. Lewis Sturtevant, of Geneva, N. Y.

'Plan for Laboratory Work in Chemical Botany,' by Lillie J. Martin.

'A Study in Agricultural Botany,' by E. Lewis Sturtevant.

'Biology of Timber Trees, with

Special Reference to the Requirements of Forestry,' by B. E. Fernow, of Washington, D. C.

'Human Cerebral Fissures, their Relations and Names,' by Prof. B. G. Wilder, of Ithaca, N. Y.

'The Lampreys of Cayuga Lake,' by Professors S. H. Gage and L. E. Meek, of Ithaca, N. Y.

'The Facial Nerve in the Domestic Cat,' by T. B. Stowell, of Cortland, N. Y.

'Vaso-motor Nerves of the Limbs,' by Prof. H. P. Bowdich, of Harvard Medical School.

'Areas of Form and Color Perception in the Human Retina,' by Prof. J. H. Pillsbury, of Smith College.

'Demonstration of an Easy Method of Measuring Reaction Times,' by Joseph Jastrow, of Philadelphia.

'Relative Stability of Organs as Dependent on Phylogeny,' by Dr. Frank Baker, of Washington, D. C.

'Physiological Notes on Ants,' and 'The Dreams of the Blind and the Centres of Sight,' by Joseph Jastrow.

'Work of the U. S. Dept. of Agriculture on Economic Ornithology and Mammalogy,' and 'Do Any of Our North American Bats Migrate?' by C. Hart Merriam, of Washington, D. C.

'Travelling of the Larva of a Species of Sarcophaga,' by W. L. Coffinberry.

'Homologies of the Ear-bones of the Lower Vertebrata,' by Prof. E. D. Cope. ***

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A New 'Synthesis' of Pelagic Organisms.

BY DR. ASPER AND J. HEUSCHER, IN ZÜRICH.

[Translated from the Zoologischer Anzeiger, ix, p. 448. 19 July, '86.]

Since Weismann, in 1870, showed that it was possible in Lake Constance to capture at night numbers of small crustaceans, the same fact has been demonstrated by Forel, Paresi, and Asper for a large number of the Swiss and Italian lakes. The 'pelagic' fauna of these fresh-water lakes consists of Cladocera and Copepoda for the most part, with also gnat larvæ and mites.

Dr. Imhof added considerably to this fauna, viz:—The flagellate genera *Dinobryon*, *Ceratium*, *Peridinium*, and *Salpingœca;* also rotifers *Asplanchna*, *Conochilus*, and *Anuræa*.

Appointed by the Natural History Society of St. Galler to investigate the fauna of the alpine seas of the Swiss Canton, we have, from the beginning of this work, tested the performance of an apparatus used in the lake at Zürich. This 'pelagic-net' was made of fine silk bolting cloth, its meshes not measuring more than 15 micro-millimeters. In the Zürich lake we found as a gathering in this net a turbid yellow-brown fluid, which reminded one of freshly-pressed cider. Its microscopic study revealed an astonishing picture. Every drop contained countless swarms of two species of *Dinobryon*, similar numbers of *Asterionella formosa* Hass., fewer specimens of *Ceratium hirundinella* Müller, and *Anuræa foliacea* Ehrenb., *A. longispina* Kellic., and *Asplanchna helvetica* Imhof, *Triarthra longiseta* Ehr., *Polyarthra Trigla* Ehr., some Heliozoa, and representatives of the Diatom genera, Fragilaria, Synedra, Nitzschia, Surirella, etc.

We have taken pains to determine the approximate number of rarer forms contained in the net. After the net had been drawn through 200 meters the contents were collected in 200 c. c. of water, and from it a dropping tube was filled, a previous experiment having determined that 15 drops were equal to 1 c. c. One drop was found to contain:—

10 *Anuræa foliosa* Ehr.
8 *Anuræa longispina* Kellic.
60 *Ceratium hirundinella* Müller.

The *Dinobryon* and *Asterionella*

forms numbered among the millions, and an enumeration seemed impossible. We concluded then that the net contained 3,000 *An. foliacea*, 2,400 *An. longispina*, and 18,000 *Ceratium hirundinella*. Besides these armies there were the Cladocera and Copepada. To capture these alone we have employed a wider meshed net. We have drawn the net in the open water and near shore, in rough and smooth water, in cloudy days and in sunshine, at various times of day and night, and always reached about the same results.

The same net was used in the river Limmat, which was found also to contain an infinite multitude of the Dinobryon forms washed down out of the Zürich lake. But the Sihl, on the other hand, contained no trace ('keine spur') of these organisms. In a pond connected with the lake by the Wehren-bach they were found, but in much smaller numbers.

The Dinobryon forms and their allies then appear to be in particular the dwellers of the great still waters.

We present this preliminary notice with all reserve. Whether this condition is permanent and similar to that of other waters will be shown as the result of future investigations.

ZURICH, May 20, 1886.

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Recent Improvements in Microscope Objectives.

BY ROMYN HITCHCOCK, F. R. M. S.

Scarcely ten years have passed since Professor E. Abbe, of Jena, presented to the scientific world his theory of vision with the microscope, which resulted from a long series of investigations conducted mainly by Helmholtz and himself. It is not my intention to enter upon a general discussion of this theory, but rather to present, as briefly as possible, an account of the practical results to which it has led. It may be well, however, to briefly allude to some of the fundamental facts underlying the theory, since the subject is not very generally understood by persons not especially conversant with microscopical literature.

So rapidly, indeed, have advances been made in the construction of microscope objectives that even investigators in histology and in other branches of microscopic research are, in many instances, unacquainted with the highest results of the optician's skill, and are firmly convinced that their favorite lenses of twenty years ago are still the best that can be made. Such persons are still ready to fight over again the battle of the glasses which raged long ago between one set of observers who believed in the wide angular aperture lenses, and another set who upheld narrow angle lenses, utterly unconscious of the fact that at the present time the qualities of any microscope objective can be mathematically calculated and numerically stated.

Did time permit, I would be pleased to review the progress that has been made during the last twenty or thirty years, but I must refrain. The microscope is capable of separately defining lines or markings as close together as the 1-115000 of an inch. This is about the limit of resolution with white light, the theoretical limit being somewhat higher. The length of a vibration of red light is about 1-39000 of an inch. How is it possible to resolve a band composed of lines ruled so much closer than a wave-length of light? Obviously, such minute spaces cannot be imaged by the dioptric method illustrated in the text-books in explanation of the action of the microscope. The effect of such a band is to break up the rays by diffraction, and Professor Abbe has shown that, in order to resolve a band of lines as close or closer than 1-39000 of an inch, it is necessary that the several diffraction spectra produced by the illuminating pencils be taken up by the object-glass. These spectra are

imaged back of the objective, in its upper focal plane, and may be seen by removing the ocular and looking down the tube of the microscope.

By the combination of the spectral images, which are images of the source of light, or of the diaphragm, opening, in the conjugate focal plane of the object, the image of the refracting elements is produced, by interference.

The closer the lines the greater will be the number of diffraction spectra. When we observe a lighted candle through a diffraction plate the closer the lines the more images will be seen. It will be obvious, therefore, that since the portrayal of the structure depends upon the gathering in of the diffraction spectra by the object-glass, it is important that all the diffraction spectra should be so taken up, for each series of spectra will produce a definite number of lines in the image, and no more, independently of the structure of the object. The number of spectra that an objective will collect, the successive spectra being formed further and further from the optic axis, will depend entirely upon the angular aperture of the lens. We are thus able to understand the value of angular aperture, and we see at once why it is that resolving power increases with angular aperture.

The spectral images portray only the minute structure of an object. In addition to this we have the images of grosser parts formed by the ordinary dioptric action of the lenses. The skill of the maker is severely tested to bring the dioptric and diffraction images into the same plane. In the resolution of a diatom frustule, such as you will see this evening, we have the dioptric image of the outline and the central longitudinal line and the diffraction images of the cross markings. In the case of Nobert's bands of lines ruled on glass there is no dioptric image.

It results from the facts stated above that the images of minute structures seen in the microscope are interference images, and are, to a certain extent, independent of the details of the structures under examination. In other words, whatever elements will give identical diffraction spectra will be portrayed as identical structures. Moreover, in the case of bands of lines, by excluding certain spectral images and admitting others, the number of lines in the image, supposing the object to be a band of ruled lines, may be doubled. Various other modifications may be made in the image which time does not permit me to mention.

Having thus reviewed the present theory of microscopic vision in a very superficial manner, it remains to consider the improvement in the construction of microscope objectives which the theory has led to. The greatest improvement of late years has been the adoption of a system known as homogeneous immersion, in which the front lens of the objective is brought into optical contact with the object or the cover-glass by means of an immersion fluid having an index of refraction the same as glass. It is assumed that rays from the object pass without refraction from the object to the objective. With such lenses the angular cone of rays entering the front lens is much smaller than that entering a lens without an immersion medium, nevertheless, a greater number of diffraction spectra will be taken in by such a lens.

Owing to the effect of the immersion media, it is evident that while increase of angular aperture in any medium gives greater power of resolution, the same result may be attained by reducing the angular aperture and the use of an immersion medium of higher refractive power. Therefore, the term angular aperture is not sufficiently definite for practical purposes, and Prof. Abbe has introduced the term numerical aperture, which is the product of the index of refraction of the medium multiplied by the sine of half the angular aperture in that medium, n

sin. u. It expresses the resolving power of an objective, of whatever kind it may be, dry or immersion. A table of numerical apertures, with the theoretical power of resolution corresponding to them, is published in the microscopical journals. From such a table I have selected some figures to illustrate the subject.

N. A.	Air Angle.	Water Angle.	Oil Angle.	Resolving Power. (Line *e*.)
1.52			180°	146,528
1.33		180°	122° 6′	128,212
1.00	180°	97° 31′	82° 17′	96,400
.94	140° 6′	89° 56′	76° 24′	90,616

It will be seen that a numerical aperture of 0.94 gives a resolving power equivalent to a dry objective of 140° 6′, angular aperture, a water immersion of 89° 56′, and a homogeneous immersion of 76° 24′. The highest possible numerical aperture in air is 1, in water 1.33, but in a homogeneous medium 1.52.

The resolving power of an objective is calculated by the formula $\delta = \frac{\lambda}{2a}$ in which λ = the wave-length of the light, and a = aperture. According to this formula, the number of lines that can be resolved by an objective of the highest possible numerical aperture is with white light (λ = 0.5269) 146,543 in an inch, with blue light (λ = 0.486) 158,845, and with the actinic rays which may be used in photography ($\delta\lambda$ 0.4000 μ) 193,037. Practically the limit is considerably lower. The homogeneous immersion lenses made by Mr. Zeiss do not generally have a numerical aperture above 1.30.

The greatest resolution yet made, so far as I am aware, with any lens is the 19th band of Nobert's plate, having about 112,000 lines to an inch. It is probable, indeed, almost certain, that this limit can be exceeded with the fine objectives now made, but authentic records that it has been done are as yet wanting. Ambitious amateurs have reported resolutions of 120,000 and more, but the results cannot be accepted without question, particularly when they are in excess of the theoretical limit. As an indication of how easily observers are sometimes deceived in such work, I have a photograph of *A. pellucida* showing spurious lines which were supposed to be an indication of longitudinal markings.

It may be incidentally remarked that the resolving power is a function of angular aperture, independent of magnification. Sufficient magnification is required to cause the markings resolved to subtend an angle such as will enable the eye to distinguish them. Beyond this point no possible increase of magnification can disclose additional structural details.

The question of resolution of close lines or particles is entirely distinct from that of the visibility of isolated lines or particles. A line one millionth of an inch in diameter may be seen, but a space of 1-175000 of an inch between such lines will probably never be seen.

A subject closely connected with the discussion of the aperture of microscope objectives is the consideration of mounting media. The optical character of the substance in which an object is examined is of great importance as regards the visibility of the object. The visibility of an object is proportional to the difference between the index of refraction of the object and that of the medium in which it is mounted. Canada balsam has been universally used, and is certainly a very useful and convenient medium, but more highly refracting media are now demanded, and quite recently Prof. H. L. Smith, of Hobart College, has published* several formulas for preparing compounds with refractive indices of 1.7 to 2.4. The best of these is probably a solution of antimony bromide in boro-glyceride dissolved in glycerin. This medium was first described in January of this year, and is but little known. The very highly refractive medium men-

* *Amer. Micr. Journ.*, vi, 161, and vii, 3.

tioned above is realgar, arsenic sulphide, which may be used alone or dissolved in arsenic bromide.

Dr. Morris, of New South Wales, has used sulphur for mounting and also selenium, the latter having an index of refraction of 2.6. Prof. W. H. Seaman has prepared an excellent medium by dissolving sulphur in anilin.

So great are the advantages of these media that a few persons have been led to believe they in some way increase the resolving power of an objective, and enable one to do as much with a lens of low angular aperture as can be done when balsam is used with another of greater angle. Obviously this is not true. The distinction between visibility and resolution should be clearly drawn.

EDITORIAL.

Publisher's Notices.—All communications, exchanges, etc., should be addressed to Henry Leslie Osborn, Lafayette, Indiana, Purdue University.

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The regular receipt of the JOURNAL, which is issued on the 15th of each month, will be an acknowledgment of payment.

The first volume, 1880, is entirely out of print. The succeeding volumes will be sent by the publisher for the prices given below, which are net.

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Vol. VI (1885), $1.00.

JOTTINGS BY THE WAY.—Our sojourn in San Francisco was made very enjoyable by the cordial hospitality for which the Western Coast is famous. We first called upon a gentleman well known to our readers, Mr. A. H. Breckenfeld, the efficient Secretary of the San Francisco Microscopical Society. It was a great pleasure to find such an enthusiastic and active microscopist, but it was no surprise to us, for we were already acquainted with some of his work, and were prepared to meet an energetic and well-informed student. Through Mr. Breckenfeld we made the acquaintance of other members of the Society, and of the Academy of Sciences, to whom we are indebted for many courtesies. The officers formally tendered us the 'freedom of the rooms' of the Society, which afforded an opportunity to refer to the books in the library, a privilege we made good use of. The Society has a good library of books and periodicals relating to microscopy. It is, indeed, one of the best libraries of the kind we have seen, and as it is always available to members, it affords unusual opportunities for study. Several microscopes are on the tables, and apparatus for mounting is at hand. The cabinet is an exceedingly good one, and includes, in addition to a good general collection of objects, the whole of the late Dr. Edwards' collection of diatoms, mounted specimens, and material. This alone is an exceedingly valuable collection, which was purchased for the Society some time ago. Unfortunately, we were unable to attend a meeting of the Society, as we hoped to do. A meeting was held on the evening of our departure, of which our readers will doubtless have a report before these lines can possibly be printed.

The Society is certainly one of the most active and flourishing in the country. The President, Dr. S. M. Mouser, is engaged, in conjunction with Dr. Ferrer, in studying the microbes of disease, having a fine lot of apparatus for the purpose recently imported from Germany by Dr. Ferrer. The Vice-President, Prof. E. G. Wickson, has charge of the experimental grounds of the University of California, where we had the pleasure of spending some time with him one day to our interest and profit. Mr. C. W. Banks, Corresponding Secretary, we were unable to meet, greatly

to our regret, but we saw various evidences of his interest in the Society in the form of valuable donations. Mr. Breckenfeld has been studying the fresh-water *Hydra*, and we are able to promise an illustrated article from him on the subject before long.

At the Academy of Sciences we found Dr. Harkness hard at work over his Fungi, of which he has a large and growing collection. At a later day, or rather evening, we joined a gathering around the festive board, over which the Doctor presided with the genial qualities of the best of hosts, and revelled in the exuberance of good and congenial spirits there present.

At last our voyage is nearly at an end, and the coast of Japan will loom above the horizon ere three more hours pass. Even now some passengers have their glasses out, eagerly seeking for the first glimpse of the isolated peak of Fusi Yamo. But a mist over the horizon obscures everything yet, and though there is still nothing around us but the rippled surface of the heaving water, we must bring this to a close, and get ready with camera and plates to make a faithful record of all we may see of interest in the strange land we are approaching. H.

—o—

The British Association for the Advancement of Science held its 56th annual meeting this summer at Birmingham.

Sir J. William Dawson, F. R. S., F. G. S., principal of McGill University, Montreal, in his presidential address calls attention to the occasion, in 1884, when the Association met in Montreal, and when many of its members attended the meeting of the American Association in Philadelphia, and refers to the project of an international scientific convention, in which the great English republic of America shall take part.

He refers to the wonderful strides of progress which make such international affairs possible; and we may well stop a moment to contemplate with pleasure the stride of progress in the feeling of brotherhood which is fast uniting the scattered members of the human family. That America can furnish a president for the British Association is a matter, too, for pride.

Dr. Dawson's presidential address is an able *résumé* of present opinion upon the Physiography of the Atlantic Ocean. It treats of the condition of the earth before an ocean could be; the dividing of the water from the land; formation and growth; continents and seas: the history of the Atlantic, its climate, and the relation of its climate to the glacial period; the transmission of life across the ocean.

In closing the address on the 'Geological Development of the Ocean.' Dr. Dawson says:—'We cannot, I think, consider the topics to which I have referred without perceiving that the history of ocean and continent is an example of progressive design quite as much as that of living beings.'

'The vastness and might of the ocean, and the manner in which it cherishes the feeblest and most fragile beings, alike speak to us of Him who holds it in the hollow of His hand, and gave to it of old its boundaries and its laws.'

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Mr. John H. Long has published an article in the *Bulletin* of the Illinois State Microscopical Society on the microscopic examination of butter, in which he very squarely contradicts Dr. Taylor's statements. The facts brought forward by Mr. Long, however, may not be so important in practice as they seem to be; for although it is true that butter fat does sometimes appear crystalline in parts of commercial packages, the fact is perfectly familiar to all observers (and has not been overlooked by Dr. Taylor), and need not, therefore, give rise to any difficulty.

Mr. Long seems to doubt if the crystals of butter are characteristic, but if he relies upon 'A few experiments' to 'convince any one that he [Dr. Taylor] is wrong on nearly every point' we must confess that it seems scarcely fair that conclusions, apparently so well established, should be so easily overthrown. We are inclined to believe that Dr. Taylor can and does do all he claims, and, so far as we know, no person who has visited his laboratory has as yet detected an error in his observations, and he has made many. It may be, indeed, that Dr. Taylor has gone rather too far in attempting to distinguish between different races of cows by the form of the butter crystal, but we are aware of instances in which his inferences have been borne out by the facts, however accidental or incredible it may seem. H.

—o—

Measuring the Rate of Ciliary Motion.—An article recently published in the *Zeitschr. fur Mikr.* by M. Flesch, contains some reference to the application of stroboscopic observation in microscopy. The author believes that it will find many applications in the future. Thus far, however, we are not aware that it has led to any important discoveries. Some time ago Mr. George Hopkins constructed an instrument, which was described in the *Scientific American*, and more recently Mr. Chapman exhibited a similar apparatus, devised by himself, at a meeting of the Washington Microscopical Society. We were not able to be present at that meeting, and have not since had an opportunity to see the apparatus in operation, so it is with regret that we have to refer to the subject without practical knowledge.

The essential feature of the device is a moving diaphragm, which, by rapidly admitting and shutting out the light, produces an intermittent illumination, the speed being under control of the observer. The most convenient position for the diaphragm is probably beneath the stage of the microscope. It is important that the speed should be perfectly under control. To use the instrument, suppose it is desired to know the speed of vibration of the cilia of an infusorian, it is only necessary to cause the diaphragm to move at such a speed that the moving cilia will appear to be motionless. If the speed is slower the cilia will seem to move forward; if faster the direction of the ciliary motion will seem to be reversed. Having once found the speed at which the motion seems to cease, by increasing the speed another rate will be found, just double the former, at which the cilia will also appear stationary.

Contrary to what might be anticipated, it is stated that no inconvenience is felt in observing with the intermittent light, the interruptions being so rapid that the eye fails to observe them. No doubt it will be possible to make this a valuable accessory for research, and we would be glad to hear of the experience of our readers who may have the opportunity to test it in practice.

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Some Things Bacteria Do Not Do.—There is a very strong disposition to attribute much more to the action of microbes than the facts of observation justify. Unfortunately we cannot appeal to common sense to regulate such matters, for that would not be a strictly scientific method, but the most absurd and unreasonable statements will gain circulation and credence, and if it becomes worth while to controvert them at all it must be done at the cost of much labor and time in laboratory work. Not long ago some person—very likely a person who ought to have been more discreet about putting forth such a notion, for we believe it did come from a person of note, although we cannot recollect the name—suggested or stated that seeds would not germinate without the presence of bacteria. As though

nature required to produce a crop of microbes to induce the growth of every plant under the sun. The idea has received the *coup de grace* through some recent experiments of Laurent, to determine whether diastase is a product of bacterial growth. Seeds were caused to germinate in Koch's gelatin and plum-juice, and no trace of bacteria was found. Diastase is a product of the growth of plants; and although bacteria are very important agents, take the world through, there remain a few phenomena which take place without their intervention. We throw out this suggestion as a hint to those who need it, and their number seems to be increasing. We are not sure but a prevailing desire for notoriety has something to do with the starting of many crazy notions that find their way into print.

NOTES.

— Dr. A. Föttinger has found chloral hydrate to be a good medium for preserving polyzoa and the lower animals. In the case of polypa, when fully expanded, crystals of chloral hydrate are dropped into the water, and in the course of a short time the colony becomes insensible, when the specimen may be placed in alcohol without any contraction or change of form. Star fishes may also be treated in the same manner to advantage. The chloral seems to act as a narcotic from the effects of which the animals may recover. —H.

— Dr. W. Morris has also devised a new mounting medium which is very easily prepared. Mix equal parts of sulphur and arsenic disulphide and $\frac{1}{20}$ part of mercury biniodide. This mixture is melted on a piece of mica and the fumes condensed on a cover-glass, and the object mounted by remelting the medium on the cover-glass. As we understand the process, the object being thus enclosed in the new medium is then protected by mounting in Canada balsam in the usual way.—H.

— Verily, there is no end of the strange things that can be done. We often read of them, but cannot give our readers the benefit of them all. Here is one they may try, but we prefer not to waste any plates on it ourselves. Dr. H. Vaillanes has devised a photo-micrographic apparatus, and when he finds that all parts of an object are not in focus at one time, he overcomes the difficulty by making two or three exposures on the same plate, focussing the different parts independently so as to get them all sharp in the picture. The first question that occurs to us is: Has he ever tried it? If so, there must be a great difference of opinion as to what is a good photo-micrograph.—H.

— The well-known microscopist and physicist, Dr. G. Royston-Pigott, has declared his belief in the animal nature of diatoms. This is a rather surprising view at this age of the world, but particularly so when we consider the basis upon which it rests, viz.: 'Their peculiar power of movement and * * conjugation, as well as their unaccountable strength of movement.' These seem very uncertain characteristics to distinguish between the animal and vegetable kingdoms. If only biologists could be satisfied with such off-hand distinctions it would be an easy matter to mark out the dividing line between protophytes and protozoa.—H.

— Mr. E. Debes has published an interesting article treating on the collection of living diatoms in the *Zeitschr. f. Mikr.* He says that most fresh-water species are found in greatest number in the spring and early summer, and again in the autumn. In the early spring, at the time of melting snow, as the ice disappears from the ponds, the attached stipitate forms such as *Gomphonema*, *Meridion*, *Melosira*, *Synedra*, and *Fragilaria* are found; later, as the water becomes warm, these all disappear and give place to unattached, free species, which are those almost exclusively found in the fall.—H.

— The function of the pulsating vacuoles of infusoria has long been a subject of speculation. As regards their structure, it is maintained by some that they have definite membranous envelopes, but this is denied by others, and it is now generally conceded that they are mere cavities in the protoplasm. M. Z. Fiszer believes, with O. Schmidt, that they communicate with the exterior of the body through a special exit, which allows of the escape of the fluid in the vacuoles. According to this view they constitute a part of a circulatory system to supply oxygen from the water, and perhaps also to carry off excretory products. The water taken in at the mouth parts with its oxygen to

the particles of protoplasm with which it comes in contact, and then accumulates in canals which radiate from the vacuoles. These canals have been observed in *Paramecium aurelia* and other infusoria. From the canals it flows into the vacuoles, and is expelled by the contraction of the surrounding protoplasm.—H.

— A new hardening fluid has been proposed by Dr. Joseph Heinrich List, who has found it superior to any other for hardening the exceedingly soft parts of Coccidæ, while leaving the other parts in a good condition for examination. It consists of a half-saturated solution of corrosive sublimate with a drop of picro-sulphuric acid added to each cubic centimetre. From what the author says of it we are inclined to think the solution worthy of a trial for very soft tissues intended for dissection.—H.

— Some interesting observations on the origin of the ferment fungus of the grape have recently been made by G. Cuboni. He finds that in the sap of the vine, in March and April, oval cells which seem to be identical with *Saccharomyces ellipsoideus*. These are derived from the fungus, *Cladosporium herbarum*, which is always found on the vine. The conclusion is that the *Saccharomyces* is the torula condition of *Cladosporium*.—H.

— The German Gesellschaft für Anthropologie has appointed a 'Hair Commission' for the study of hair in its anthropological relations. The examination of hair for this purpose involves considerable labor, but it is important work which may be carried on by any microscopist who will take the trouble to collect the hair of different races of men. The particular features to be considered, macroscopic and microscopic, are given in the Societies' publication.—H.

CORRESPONDENCE.

To the Editor:—I have a copy of Quekett's '*Treatise on Use of Microscope*,'* 2d edition, 1852. I find in it no allusion to Spencer's objectives nor to the *Navicula Spencerii*.

Joseph LeConte.

Berkeley, Cal., Aug. 27, 1886.

—o—

To the Editor:—As the originator of the discussion concerning certain matters supposed to be contained in some edition of Quekett's treatise on the microscope, I may, perhaps, be allowed space in which to say that Mr. Brooks need spend no time in searching for such a work as *Tuckett's*, for so far as I know there is no such book, and the use of the word arose from a misreading on the part of the compositor. My copy of Quekett is the second edition, and the name of Mr. Charles Spencer is not mentioned in the book so far as I have been able to find. The only Spencer referred to is a gentleman who had invented a lamp which is described.

A. L. Woodward.

53 Lansing st., Utica, N. Y.

—o—

To the Editor:—On further examination I find that the facts stated by me in the September number are substantially correct, but I find my memory at fault in regard to the edition of Quekett. This should have been the *first*, not the *second*. As covering the whole ground, and at the same time pertinent to the tenor of my article, I annex the following editorial by Mr. Phin, taken from '*The Young Scientist*,' vol. iv, No. 11, Nov., 1881, on the death of Charles A. Spencer:

'Thirty years ago the scientific world was thrown into a ferment by the announcement that "*an object-glass, constructed by a young artist of the name of Spencer, living in the back-woods, had shown three sets of lines on a very delicate diatom, when other glasses of equal power, made by the first English opticians, had entirely failed to define them.*" This passage, which marks an era in the history of the microscope, occurs in the first edition of Quekett's work on the microscope, but has been expunged from subsequent editions. At that time Ross had declared that an angle of aperture of 135° was as great as could be given to the object-glass of a microscope. Spencer, with a true American unbelief in the impossible, went to work, and in a short time succeeded in making glasses having an angle of aperture of 172°, and since that time the angle has gone on increasing; its increase being an accurate indication of the advancement of microscopy. Spencer was an entirely self-taught optician, and his talents and success made American microscopes known all over the world. He died at Geneva, N. Y., on the 28th day of September, 1881, at the age of 68 years. A fine portrait of Mr. Spencer, together with a lengthy biography, will appear in the forthcoming number of the "*American Journal of Microscopy*."'

Chr. C. Brooks, Ph.D.

393 E. Eager St., Baltimore, Md.

* Referred to in your August number.

To the Editor:—My copy of the *second* edition of Quekett was destroyed when my library was burned, but I *think* that it was in the second edition that Quekett excluded all notice of Spencer and his lenses. In the *first* edition he describes the *Navicula Spencerii* and gives a plate of it, now before me. On page 440 of this edition he devotes half a page to the subject. The plate is No. 9.

Very truly yours, John Phin.

Industrial Publishing Co.,
15 Dey St., New York City.

MICROSCOPICAL SOCIETIES.

San Francisco, Cal.

The regular semi-monthly meeting of the Microscopical Society was held on June 23d, Dr. Mouser presiding.

Mr. King, of Santa Rosa, who was present as a visitor, donated an unusually rich gathering of *Isthmia nervosa*, and also a fine slab of fossil diatomaceous earth from an extensive deposit found near Santa Rosa. It contains only fresh-water forms, and as they are practically identical with those in a deposit previously found some twenty miles away there is good reason to believe that the two deposits are continuous.

Specimens of a scale insect found on oak trees were shown under the microscope by Mr. Wickson, who briefly outlined its interesting life history.

Much interest was excited by the exhibition of some collections of animal and vegetable life found in and around Mono Lake by Dr. H. W. Harkness during his recent trip to that locality. Notable among the latter class were specimens of the rare bacterium which has been provisionally classed as *Bacterium rubescens*, although Dr. Harkness believes there are strong grounds for regarding it as specifically new. It is found in immense quantities in Mono Lake, and aggregated masses of it are of a beautiful rose color. It seems to have both a still and a motile stage. No spore formation has been discovered in the preliminary examinations, but culture experiments are now being carried on which will no doubt disclose its complete life cycle. Numerous very active infusoria were found associated with the bacteria, and Dr. Harkness reports having found many species of diatoms, some aquatic insect larvæ, minute crustaceans, and also fresh-water algæ, in this remarkable lake, the water of which is so intensely alkaline that it was formerly thought incapable of supporting either animal or vegetable life. An official analysis of the water of the 'Dead Sea of California,' as it has been called, shows the remarkable proportion of nearly 52 parts of solid constituents in 1,000.

Specimens were also shown of the evaporated alkaline sediment from Owens Lake stained a bright red by the presence of enormous numbers of the above-mentioned bacterium. Some further communications regarding the flora and fauna of the Mono Lake region have been promised by Dr. Harkness.

A slide of young oysters was shown by J. G. Clark.

Dr. C. P. Bates donated a handsome walnut cabinet to the society's rooms, and a vote thanks was unanimously tendered him for the gift. In a letter accompanying the same, he stated that it was intended as a receptacle for the very valuable collection of cleaned *diatomaceæ* recently presented to the society by William Norris. This unique collection consists of nearly seventy large vials of carefully cleaned diatoms preserved in distilled water. It contains specimens of the more extensive deposits of California diatoms, as well as of the principal deposits from other parts of the world. The large and interesting fossil deposit of marine diatoms, discovered by Mr. Norris several years ago at Jack's ranch, near Monterey, Cal., is well represented in the collection and is particularly rich in fine discoid forms. To the student of the *diatomaceæ* this collection will be of the greatest assistance, and by its acquisition the society's already fine stock of diatomaceous material has been considerably enhanced in scientific value.

A. H. Breckenfeld, *Rec. Secr.*

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San Francisco, Cal.

The announcement of an unusually attractive programme drew together a large attendance at the meeting of the San Francisco Microscopical Society, July 14, 1886. In addition to the members of the society, a number of prominent physicians were present. Vice-President Wickson occupied the chair.

The current numbers of the leading scientific journals of the day were placed upon the tables.

The 'Concentric' form of microscope, manufactured by the Bausch & Lomb Optical Company, was exhibited by Mr. Hirsch. Its distinguishing characteristic

is that the centre of gravity remains practically unchanged at any inclination of the body, from horizontal to perpendicular. The arm of the microscope forms a segment of a circle, and by means of a sliding adjustment of this arm, the instrument can be fixed at any inclination, with perfect stability in all positions.

After the exhibition of various interesting objects under the microscope, the lecturer of the evening, Dr. Arning, was introduced. He stated that he was about returning to Europe, after sojourning for a number of years in the Hawaiian Islands for the express purpose of studying that mysterous disease, leprosy. After alluding to the difficulties surrounding researches of this kind in a comparatively uncivilized country, far from the great scientific centres, he said that while his investigations had revealed many important and interesting facts, yet in some respects his attempts had been baffled. A long search for a possible source of dissemination of the germ of leprosy in food, water, etc., was unsuccessful. The distinctive micro-organism of leprosy is a minute red-like fungus—*Bacillus leprœ*. Hansen, a Norwegian investigator, seems to have been the first to discover this bacillus. He found it abundantly in leprous tubercles, and announced the fact in 1879. Since that time Neisser, Koch, Unna, and others have confirmed and extended the observations of Hansen. These bacilli are slender, non-motile rods, about half as long as the diameter of a human red corpuscle. In uncolored sections they are nearly or quite invisible, even under high amplifications, but where appropriate staining processes are employed they can be rendered beautifully distinct. In form and size they very closely resemble the bacillus of consumption (*Bacillus tuberculosis*)—so closely indeed, that the distinction by mere inspection is by no means easily made. The color reaction is also remarkably similar. The last-named organism, however, can be successfully 'cultivated,' while all of Dr. Arning's attempts to obtain a 'pure culture' of *Bacillus leprœ* met with failure, although in his experiments he employed every known culture medium, and tried some not hitherto used, such as the favorite native dish 'poi.' Not even on excised tubercle would the bacilli flourish. Finally, almost by accident, he obtained a *comparatively* pure growth of the desired organism. A small piece of excised tubercle from the chin of a leper had been placed in a small glass vessel for maceration. After an absence of nearly eight months Dr. Arning examined the preparation (which had in the meantime been kept supplied with water by his laboratory assistant) and found a gray scum on the surface of the water. The bottom of the glass vessel was covered with a detritus, consisting of micrococci, putrefactive bacteria and other fungi. The scum was found to consist almost entirely of aggregated masses (Zoogloœa) of a bacillus, which Dr. Arning feels justified in stating was undoubtedly *Bacillus leprœ*, although the rods were slightly shorter than usual. Upon attempting to continue the culture of a portion of this scum in water, an attenuated growth, still comparatively pure, was obtained. At this interesting juncture Dr. Arning's experiments were interrupted by reason of his departure for Europe, but he hopes to be able to resume them before long.

It has been a disputed point as to whether or not the bacilli of leprosy grow inside of cells. That they do so has been denied by Unna, but some beautiful double-stained preparations made by Dr. Arning seem to demonstrate beyond all possible doubt that such is at least a frequent, even if not the invariable, method of growth. Dr. Arning further stated that in the anæsthetic red patches peculiar to this disease no bacilli had been found. Neither did they appear in the sores due to the killing of the nerves leading to those points, while in the tuberculous patches large numbers of free bacilli were always found. From these and other indications he inclines to the opinion that the disease is propagated by the accumulation of bacilli in the large nerve trunks. In the blood of leprous patients these organisms are not found.

In the internal organs of the victims of this disease great changes are found. Lepers are often booked as having died of consumption. In many such cases Dr. Arning is convinced that the breaking down of the lung structure is due to the ravages *not* of *Baccillus tuberculosis*, but of *B. leprœ*. In tuberculous consumption, the bacilli are originally found in the 'giant cells,' but in leprosy there are no such cells. Another point of difference is that there is seldom or never any hemorrhage of the lungs in leprous patients. After alluding to the presence and describing the appearance of the bacilli in the spleen, kidneys, and other organs of lepers, Dr. Arning stated that in the present state of knowledge on the

subject it is impossible to explain how the virus enters the system. Many inoculation experiments have been made, but, while it would perhaps be premature to describe them as failures, yet they have hitherto proven almost resultless. The progress of the disease is extremely slow. In fact there is a peculiar latency about it which is exceedingly baffling to investigation. Although leprosy is probably the most ancient disease known (it having been recognized at least as early as 1500 B. C.), yet there are few disorders about which less is known.

The difficulty of pronouncing an accurate prognosis in the early stages of the disease was alluded to. Intimately connected with this was the question of segregation, with its accompanying horrors. Should all cases showing the least primary lesion of tissue—which might or might not develop into the dread disease—be ruthlessly torn away from the closest ties of family or friendship to a terrible isolation with doomed and dying wretches? In view of all the known facts, the speaker was of the strong opinion that this course would never be justified. In conclusion Dr. Arning said that years of patient and accurate research would be required for the solution of the many difficult problems presented by this subject, and in view of its great importance to the world in general and to the people of this coast in particular, he commended it to the especial attention of the members of the medical fraternity.

He then exhibited a large number of objects, illustrative of the subject, under several fine instruments. Various staining processes had been employed in the preparation of the specimens, and the bacilli in every case were sharply and beautifully differentiated from the surrounding tissues.

The discourse was listened to with the greatest interest, and at its close a cordial vote of thanks was unanimously tendered to the lecturer.

A. H. BRECKENFELD, *Rec. Secr.*

NOTICES OF BOOKS.

General Biology. By William T. Sedgwick, Ph. D., and Edmund B. Wilson, Ph. D. Part I. Introductory. New York. Henry Holt & Co., 1886. (pp. 193.)

We have just received a copy of this work and have looked through it with the greatest satisfaction.

As chemistry is the study of chemical phenomena, so biology is becoming more and more the study of the phenomena of life, and the old dry bones of the classificatory studies are being more and more cast aside for a study of vital processes and mechanisms. This work takes a new departure, and is the first book of its kind. It takes for study one animal and one plant and describes all its structure and all its functions, telling the student at the same time how to see and the meaning of what he sees. Living matter or protoplasm, then the cell, then the structure of the fern, and then of the earth worm; finally, the animal and the plant compared are the subjects taken up.

For the general reader who wishes to know where biologists stand at present, as well as for the student, the work is an admirable presentation. It is not designed for primary students, but is the book to put into the hands of college men who know something of chemistry and physics. We would call especial attention to the common sense displayed in this note (p. 21):—'The student should understand once for all that the principal points observed must be recorded by notes and by *sketches*, good or bad, whether he can draw or not. * * * * The aim should be to represent the natural relations of parts rather than their minute details, and accidental displacements should be disregarded.' As for the publishers' part the work is most successful. It is uniform in style with the well known American Science Series of Holt & Co. The illustrations, which are copious, are of the first quality, the authors themselves being able artists and having been assisted by Mr. J. H. Emerton.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Labels for slides, also slides and material to exchange for same. EUGENE PINCKNEY.
Dixon, Ill.

For Exchange: Seeds of *Orthocarpus purpurascens* and *Orthocarpus attenuatus*, and slides of same, in exchange for good objects, foraminifera preferred.
EDWARD GRAY, M. D., Benicia, Cal.

Infusorial Earth from Saco, Me., in exchange for slides of *Volvox globator*, or Spines of foreign sea-urchins.
D. E. OWEN, Brunswick, Maine.

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On the Variability of Pathogenic Organisms, as Illustrated by the Bacterium of Swine-Plague.

BY DR. THEOBALD SMITH*

From one of a number of spleens taken from cases of swine-plague in Nebraska, a bacterium was obtained which resembled the bacterium of swine-plague so closely, as regards its morphological and pathogenic characters, and still differed from it in certain minor biological features, that it seemed justifiable to regard one as a variety of the other, or both as varieties of a third form.

The bacterium was obtained as follows:—the spleen, though sent in sterilized bottles, contained several kinds of putrefactive microbes. By introducing a bit under the skin of mice, in the dorsal region, a disease was caused which, in symptoms, duration, and lesions, was identical with that produced by the subcutaneous injection of pure cultures of the bacterium of swine-plague. Pure cultures were obtained from these animals and, by inoculating with these cultures, the disease was transmitted through a number of mice. As a complete description of the bacterium of swine-plague is already on record,† I will confine myself to a brief résumé of some important resemblances and of the minor differences.

This bacterium resembles the bacterium of swine-plague in form, size, and mode of staining. Like the latter, it is motile in liquid media and fails to liquefy gelatin. Both grow alike on potato and agar-agar. Both fail to affect the microscopical appearance of milk, in which they multiply. In neither has spore formation been observed. Finally, both are killed by a temperature of 58° C. in from 15 to 20 minutes. As regards the pathogenic effect, both produce the same lesions in mice, rabbits, and pigeons. In these animals the lesions are very characteristic and hardly to be confounded with those of other bacterial diseases of the same animals hitherto described.

The differences are few and, possibly, unimportant, but they reappeared so uniformly as to leave no doubt in my mind as to their constancy. The one first observed was the early formation of a complete membrane on the surface of liquid cultures. In cultures of the bacterium of swine-plague a complete membrane is almost never seen, excepting occasionally in advanced cultures which have stood quiet for some time. Cultures left undisturbed for a week or longer merely present a whitish ring, made up of bacteria, on the sides of the culture-tube at the surface of the liquid. This membrane is formed within 24 to 48 hours, whether the culture liquid was inoculated from mice, pigeons, or rabbits. Two potato cultures, one of the bacterium of swine-plague, the other of the bacterium under consideration, grew side by side under the same bell-glass, identical in color and mode of growth. After several weeks a tube of beef infusion peptone was inoculated from each culture. On the following day one was covered by a mem-

* Read before A. A. A. S., Aug., 1886.
† Second Annual Report of the Bureau of Animal Industry, Department of Agriculture, 1885.
Department of Agriculture Report for 1885.

brane, the other had none. This same result was obtained in inoculating liquids from gelatin cultures. This microbe also grows more vigorously in nutrient liquids, forming, after one or two weeks, an abundant deposit. Cultures of the bacterium of swine-plague contain but a very slight deposit at the end of the same period.

Another difference was observed in gelatin tube cultures. The bacterium under consideration failed to grow at first, both in tubes and on plates, while the bacterium of swine-plague, sown on the same plate in lines by its side, was visible to the naked eye in two days. When another preparation of gelatin was used, which had become faintly turbid on boiling, both bacteria grew equally well, and the bacterium of swine-plague much better than formerly. The favorable change was simply due to a greater alkalinity of the culture medium, the more sensitive of the two bacteria being the one under consideration. This microbe also failed to induce the disease in two guinea-pigs, which are very susceptible to the bacterium of swine-plague.

In summing up we find that this microbe differs from the bacterium of swine-plague in forming a membrane on liquids, in failing to grow in neutral gelatin, and in not being fatal to guinea-pigs. Several pigs inoculated with this new microbe failed to contract the disease. We may safely assume, however, that it was the cause of swine-plague in Nebraska, since it is quite difficult to produce swine-plague by subcutaneous inoculation.

These two microbes may, at least for the present, be regarded as varieties of the same bacterium. We may also assume that the apparently unimportant biological differences, a greater demand for oxygen, and a more alkaline medium, may have a very important, though still unknown, bearing upon the disease in the susceptible animals.

It is unnecessary to reopen here any discussion as to the propriety of separating bacteria into well-defined species. The view of Nägeli, that it is difficult or quite impossible to make any such distinctions, has been completely set aside by the facts which new methods have established. The possibility of making pure cultures of bacteria, and of determining thereby that certain definitely reappearing forms are constantly allied to certain well-marked, easily distinguished biological and pathogenic properties, makes a distinction into species not only proper but necessary for the time being. The facts presented point to a variation of bacteria, so well established among higher forms of life, but not yet noted among bacteria. Whether the variation may be ascribed to both forms or only to one; whether one is better adapted to a parasitic existence than the other; whether the differences are brought about by causes external to the susceptible animal—in other words, by a saprophytic life of which the bacterium is capable to a certain extent; these questions can only be presented and not answered in the present state of our knowledge.

It is not necessary, in order to produce the same pathological effect, that two bacteria should be of the same species from a phylogenetic standpoint, *i. e.*, that they should have descended from the same ancestral form. Morphological differences must be subordinated to physiological ones. If a microbe has acquired the power of living in a limited supply of oxygen and of producing certain substances which act as poisons to the living cell, it matters very little as to its form. Hence it is quite conceivable that two microbes which are morphologically different may have acquired, in the course of long periods of time, the same physiological or pathogenic powers. I say conceivable, for no two have yet been found which produce precisely the same disease, if we except the various pus-producing organisms. The two forms before us are, however, morphologically identical. They can-

not be distinguished under the microscope, either when taken directly from the infected organism or from pure cultures. We have, then, a close resemblance in morphological characters and in the more important biological properties, with a few slight but constant differences already mentioned

There is another thought to be presented in this connection which may be of value in the future. It is probable that varieties of other germs may arise, either through the effect of long periods of time, in the same locality, or through changes incident to places far separated from one another. What effect would the transportation of one variety have upon the severity of an epidemic thereby produced in another locality? May not modification be produced within short periods of time, so that the infection spreading from one centre of disease, after being latent for a time, becomes the cause of a mild or a virulent epidemic? These questions now need renewed observation with the new light thrown upon them by the biological study of the disease germs themselves.

That this view is not new, and that it is looked upon with favor, the following extracts from Virchow's remarks at the Berlin Cholera Conference in the summer of 1885 may be of interest:—

'I have always believed that we should succeed at some time in determining that the same bacteria, at different times and under different circumstances, might possess different grades of virulence..... As I am a naturalist, I can only put the question, Does not the changing virulence of the causes of disease best explain the difference in epidemics? ....Are there not periods more favorable to the development of the microbe, periods during which it multiplies more vigorously and forms within itself more active substances?'

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Water Bath for Use in Imbedding.

The October number of the American Naturalist (vol. xx, p. 910) contains a description of a water-bath apparatus for paraffin imbedding, of the pattern in use at the Museum Comp. Zool. at Harvard. It is described by the author, not with reference to urging its introduction, but for the benefit of any who wish to fit out a laboratory. The bath is a copper box 18 cm. long, 9 cm. broad, 8 cm. high, with an oven near the bottom for warming slides: the oven is without a door. The oven is 1 cm. high and 12 cm. long, and about 1 cm. above the bottom of the box. The top of the box is perforated with four small and two large holes, and these are copper-lined wells, three of them 4 cm. deep, one 7 cm. deep. The layer wells are 6 cm. in diameter. They each receive a copper bowl, which fits them nicely, furnished with a bent brass handle upon the side. One is for soft, the other for hard, paraffin. The box is completely closed to the exterior except at two small openings, one for the introduction of a thermometer, the other for the introduction of water. The bath is of small size and is designed to be attached to the worktable of a single student. The advantage of this plan is that each worker of a laboratory is able to control the heat to suit his particular needs. There is greater expense in this plan for more gas used and the cost of the baths. The bath is supported upon the side of the table and may be readily packed up and transported to the seashore, or other scene of labor. The bath is made by the Educational Supply Company, No. 6 Hamilton Place, Boston, Mass., and sells for $6.50, or with thermometer for $8.00. The writer, Dr. Whitman, mentions in his account a device for suspending the object being imbedded in the paraffin; it is a coiled wire which is soldered to the margin of the tank and extends down into the cavity, and acts as a shelf on which the object may rest, thus keeping it out of the dirt which is sure to accumulate near the bottom of the tank.

The bath which we have had in

use in the laboratory at Purdue University now three years is one which was designed after the description, by Mr. W. Bateson, of the bath in use at Dr. Sedgwick's laboratory, at Cambridge, England. This bath was constructed by a tinsmith in the city of Lafayette; cost $4.00. It is an oblong box 16 in. by 10 in. by 6 in. of tin-lined copper, supported on four legs, at a height of 11 in. from the table. The portion beneath the box is also enclosed so that the lamp flame may burn undisturbed by current through the door. The top of the box is perforated with fifteen holes, some of them two, others two and one-half, inches in diameter. Copper disks cover these holes tightly when not in use. The vessels used in imbedding are porcelain crucibles which fit the holes closely and hang down into the box, held only by the side of the crucible. An oven for drying slides is placed on one side of the box: it is four in. from the bottom, is four in. deep, 8 in. long, and 1½ in. high; it is shut in by a lid hinged to the side of the box above the oven. There is in the top of the box a small hole with a collar for a cork to hold the thermometer, and a second for heat regulator if desired. The water is never allowed to reach the bottom of the oven, and thus the oven and the crucibles are surrounded by steam whose temperature is determined by a thermometer which dips down so as to have its bulb on the level of the bottoms of the crucibles. The depth of the bath allows the presence of a considerable amount of water, and the temperature of the bath is thus kept very even indeed without the aid of a regulator. We do not consider the closed wells desirable, but prefer to have the steam immediately surround the imbedding dish. Porcelain crucibles are desirable to use because so easily cleaned, and because the white color makes the object appear to stand out very prominently. It is desirable also to have the oven as near the level of the crucibles as the construction of the bath will permit, for the oven should not be bathed in the water but, only in steam, the temperature of which is under control by help of the thermometer.

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The Bacterium of Swine-Plague.

BY D. E. SALMON AND THEOBALD SMITH*

The bacterium of swine-plague, as it was observed in several outbreaks in the east, may be quite easily found in the spleen of animals which have succumbed to the disease. Cover-glass preparations of the spleen pulp, stained in a solution of methyl violet and mounted in xylol balsam, reveal the presence of elongated ovals or true bacteria, usually in pairs, and then appearing like figures of eight. When not too deeply stained, a narrow, well-stained periphery, of nearly uniform width, surrounds a paler, sometimes nearly colorless, centre. The stained border may then be compared to the line forming the figure of eight. The bacterium is readily stained by other anilin colors also. In such a preparation the bacterium measures about .0012 mm. to .0015 mm. in length, and about .0006 mm. in width. In the various culture media the bacteria vary slightly both in size and form from those observed in cover-glass preparations of the spleen, being smaller when multiplication is very rapid, larger when it is retarded.

It multiplies more readily in slightly alkaline than in neutral media. It grows readily in meat infusions, in milk, on nutrient gelatin, agar-agar, blood serum, and potato. When cultivated in nutrient liquids it is *motile*, its movements being very vigorous during the first and second days of cultivation. Later a whitish ring forms around the glass at the surface of the liquid, which, in advanced cultures, sometimes becomes a more or less complete membrane. In milk it multiplies without producing any change distinguishable by the naked eye. In

* Read before A. A. A. S., Aug., '86.

gelatin, spread out in thin layers on glass plates, colonies are formed which become visible to the naked eye after 48 hours as spherical or sub-spherical, homogeneous masses, bounded (optically) by a smooth, regular outline. The gelatin is *not* liquefied. In tubes of gelatin each bacterium multiplies into a round colony about $\frac{1}{4}$ the size of a pin's head; when numerous, a continuous whitish line or band appears in the needle track capped by a very slight surface growth. On potato it forms a continuous patch of a dirty straw color, from $\frac{1}{2}$ to 1 mm. thick. The bacterium does not produce spores, so far as we have been able to learn. Cultures of all ages are killed by an exposure for from 15 to 20 minutes to a temperature of 58° C. Micro-organisms containing spores do not succumb thus easily.

This microbe may, therefore, be readily distinguished from others if we take into consideration its microscopic appearance, its *motility* in liquid media, and the *absence of liquefaction* during its multiplication in gelatin.

Besides these important distinctive characters, its pathogenic effect on the lower animals is not less characteristic.

In mice the disease is best marked and the lesions most pronounced when very small quantities of culture liquid are introduced beneath the skin. Death then occurs in from 8 to 14 days, and quite suddenly. The bacteria are easily demonstrated in all the internal organs. The spleen is enormously enlarged, and throughout the liver, in most cases, patches of coagulation-necrosis are found. If larger doses are injected, the animals die within 4 or 5 days, and the above lesions are not yet developed.

In rabbits the introduction beneath the skin of small quantities of culture liquid is invariably fatal in from 4 to 5 days. Locally, the muscles are slightly necrosed and the lymphatics enlarged. The spleen is very much increased in size. The bacteria are found in all the internal organs. In guinea-pigs the pathogenic effect is similar to that of rabbits, although the former seem somewhat more refractory.

In pigeons a large dose is required to produce death. They may die in 24 hours, probably from the effects of the particular ptomaine formed by the growth of the bacterium in the body generally, or they may live from 2 to 12 days. In such cases a large sequestrum forms at the place of inoculation, and occasionally there are microscopic changes in the internal organs. Usually the bacterium is present in the liver, sometimes in the spleen. This bacterium has no effect on fowls.

These meagre statements concerning its pathogenic effects are sufficient to distinguish it from all other known pathogenic bacteria.

Klein recently described a microbe obtained from swine-plague in England which seems to resemble the above bacterium in many ways. He describes it as spore forming, however, which is not true of the microbe under consideration. Moreover, its growth in various media, by which it might be recognized, has not been worked out yet. He describes its growth in liquids, its motility, but leaves us in doubt whether it liquefies gelatin or not; how it grows in milk, on potato, etc. He asserts that it has no effect upon pigeons, but gives no information as to the dose used. It is therefore impossible to state at present whether the two microbes are the same, or whether two diseases very much alike are caused by different organisms.

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Muscle and Nerve in Sponges.

BY DR. R. VON LENDENFELD.*

Australian species of *Euspongia* show some unlikeness to common bath sponge, *E. officinalis*. Massive, with short, round, finger-like processes. Each of these contains a wide cylin-

*From Amer. Mag. Nat. Hist., 5 ser., vol. 17, p. 372. Orig. article in Sitz. König Preuss Akad., Berlin, 1885, pp. 1015–20.

drical cavity running lengthwise, like a wide oscular tube. Tubes open below into a system of anastomosing lacunæ. Dermis is rich in pores. In the mesoderm there is a band of membranous tissue, which runs from the outer surface toward the interior. It is of uniform thickness throughout. Cells run out at each end to extremely fine points, .1 mm. × .003 mm. These have an oval nucleus about their middle and on one side of the axis. Near the nucleus is a small quantity of ordinary protoplasm, while all the rest of the cell consists of a substance which differs essentially from the contents of ordinary fusiform cells. It contains small, distinct, strong, doubly refractile granules imbedded in a homogeneous transparent substance which is slightly but simply refractile. Granules are, in fact, regularly arranged, so that a sort of transverse striation of the fibres is produced. These bands are strongly contractile, and contract in a radial direction. The author concludes from this observation that the membranes are muscles, and, further, that these muscle cells are to be regarded as a form transitional between the smooth and striped muscle cells.

In transverse sections through the margins of the groove there is to be seen a peculiar organ seated upon the upper and outer margin of the muscular membrane. The membrane is suddenly increased to twice or three times its diameter elsewhere. This line of thickening is seen in sections not to consist of fusiform cells, but of large, globular, very distinct nuclei, imbedded in a granular substance no doubt belonging to the cells whose boundaries are indistinct. From the marginal thickenings threads issue laterally and run tangentially in the exterior dermis of the sponge, and may be traced a considerable distance. Above and on these destal thickenings there stand fusiform sense-cells. Their basal ends, diffused over a broad zone, are in direct connection with the thickenings; no ramification of basal processes was observed. The cell body has the ordinary form, .03 mm. × .002 mm., broadest in the middle. In the cell body, after treatment with osmic acid, there are found dark granules like those characteristic of Hydra (Jickeli).

The author's interpretation of these observations is as follows:—

The whole thickening is composed of ganglion cells, whose contours are not distinct, and the granular threads, leading from them are nerve fibres. They may be compared with the annular nerve-ring of Cycloneural medusæ (Eimer), and indicate that the sponges, being capable of a development similar to that of the Cuidaria, were probably not so different from them as we commonly suppose. We must, however, bear in mind that the muscle and nerve are not sub-epithelial but mesodermal.

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The Bacillus of Malaria.

[From the Lancet for Aug. 21, 1886; copied from Journ. Am. Med. Assoc. Oct. 2, '86.]

In 1879 Professor Tommasi-Crudeli published in the Atti della Reale Accademia dei Lincei, at Rome, a memoir on the distribution of the subsoil water of the Roman Campagna, and on its influence in the production of malaria. In this research, which proved the starting-point of new studies on the etiology of malaria, the author traced the origin of this morbigenous ferment, discarding many errors and prejudices of old medicine and maintaining that the causal agent of the disease could only be a living organism.

Towards the close of the same year Tommasi-Crudeli and Klebs published in the same *Atti* a memoir embodying the results of inquiries on malaric airs and soils, and of experiments on rabbits, proving that the living organism is a schizomycete, named by them *Bacillus malariæ*. As the result of researches on the individuals affected with malaria, Marchiafava and Celli announced that within the red-blood globules are con-

stantly found plasmatic bodies, *corpi plasmatici*, endowed with lively amœboid movements, in which the hæmoglobine is transformed into melanine (melanæmia); and in a further memoir which they have published this year they suggest, as a more probable hypothesis, the opinion that those plasmatic bodies are the living organisms which produce malaria. Thus Marchiafava and Celli confirm, in substance, Tommasi-Crudeli's opinion that a living organism is the cause of malaria, but they regard its form as differing from a schizomycete.

These observations are embodied in a note with which Todaro prefaces a communication by Tommasi-Crudeli in the April *Lancet* on 'a bacillus found in the malaric atmosphere around Pola (Istria).' This bacillus resembles the most typical forms of the *Bacillus malariæ* which Tommasi-Crudeli and Klebs found in the air and subsoil of the Roman Campagna, which is *par excellence* the home of malaria. Since identity of form does not necessarily imply equality in infective power, T.-Crudeli reserves his definite opinion on the bacilli discovered in the air of Pola until they shall have been submitted to experimental research, a plan of which he has sketched.

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Histological Records.

We are reminded, by the appearance of Mr. Alling's *Microscopical Records*, of the matter of keeping a record of the history of every specimen which the microscopist preserves. In the present age of careful histological work a great deal may depend upon what is too insignificant a detail to be remembered unless the memory is helped by an exact record. Two forms of record are used—one the card catalogue, the other the book catalogue. By one or the other of these two a record should be always kept of every histological operation. As to which it shall be the choice of the individual should decide. For some reasons the book scheme is better, and many will prefer it. Whatever scheme is chosen, the record should be kept very exactly.

Thus, to copy one of our own :—

No. 201.—Spinal cord—kitten. May, 1886.

	Mo.	*Day.*	*Hour.*
*Corrosive sublimate and acetic acid	5	19	3.00 P.M.
H 20	"	"	3.15 "
50 p c. alcohol	"	20	10.00 A.M.
70 p.c. "	"	20	12.00 "
Borax carmine	"	27	11.00 "
Absolute alcohol	"	28	8.00 "
Chloroform	"	29	12.00 "
Chloroform and parrafin	"	29	3.00 P.M.
Parafin at 60° cent	"	30	11.00 A.M
Removed from bath	"	30	11.45 "

Cleared with turpentine and mounted in chloroform balsam.

We do not select this because it shows the best possible treatment to be pursued, but because it was the first one hit upon. An examination of the record shows that it was left over the proper time in water to wash out the corrosive, and also left somewhat over time in the 50% alcohol. But the value of the record is that it is an exact record of what has happened to the section numbered 201, and when that section is studied it forms a good basis for a study of the method by comparison with other sections. It so happens that the nerve ganglion cells show beautifully in the section in question; fibres may be traced from the poles a long way off into the gray matter. The nuclei are distinct, but their structure is not shown beyond a confused granularity. The value of a record like this becomes evident at once upon comparative study of half a dozen cords with the details of the preserving, staining, and imbedding varied each time. It is the fussy and laborious portion of the histologist's work, but the part which removes his work from the easy region of guessing to the more satisfactory region of scientific accuracy. An exact record of the processes kept up during the preparation of a couple of hundred operations makes of the thoughtful histologist an independent worker, who is prepared for nice work, and

*Corrosive sub. saturated aqueous solution acidulated slightly with acetic acid. The numbers refer to the time the object was placed in the fluid opposite which they occur.

to invent methods suited to any special requirement he may meet. It takes more time during the process, but saves time in the end, and no one who expects to be a fine worker in histology can afford to neglect it. For the anatomist who cares for cell relations more than cell structure such great care is not necessary. If the cells but keep their place, it is enough; but to be sure of anything about cell structure the study must be slow, with constant care that the cell is kept as perfectly uninjured as is possible.

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The Germ Theory.

BY ROMYN HITCHCOCK, F. R. M. S.

The truth of the germ theory is still far from being established in the minds of a great many thoughtful members of the medical profession. Honest scepticism, founded upon careful consideration of the experiments relied upon to sustain the theory, is the right of every scientific man. But unless it can be shown that the demonstration is imperfect, that there are evident, or at least probable, sources of error which can be pointed out, mere disbelief in the theory looks very much like unreasoning stubbornness, or imperfect knowledge of the subject.

Few persons, physicians or others, are aware of the thoroughly scientific basis of the germ theory to-day. Few have even a faint conception of the immense amount of work of a crucial character that has been done in the laboratories of Germany, France and the United States, to test this theory. The literature is voluminous, and not generally accessible, while the abstracts and notices of it that have been published in English periodicals give but a faint idea of the amount and character of the work done to sustain the conclusions. Such being the case, doubts concerning the theory are perhaps proper, and an indication of reasonable conservatism, but disbelief and opposition to it can only be due to imperfect knowledge or perverted judgment.

As an indication of the manner in which the theory is occasionally attacked, we may cite an instance when a gentleman, an able and respected practitioner of medicine, compared the action of a culture fluid of disease germs with that of the poison of a rattlesnake, pointing out that, since the snake poison cannot be regarded as a living organism, we have no reason to suppose that the organisms of the culture fluid are the active agents in that. Perhaps not. But a very important fact in this connection is here ignored. The germ culture can be indefinitely increased, while the snake poison cannot. The culture fluid affords nutriment to the living organisms, and under proper conditions of temperature they will continue to multiply for an infinite number of generations, and the successive cultures will be as active in producing disease as the first.

The precise connection between the living organisms and the disease they produce is still the subject of investigation. That specific living organisms do produce specific diseases when they multiply in the body, or in culture tubes, is no longer a matter of doubt; but just how they act is, perhaps, not fully understood. It has lately been observed that a culture fluid, in which microbes have been growing, retains its active properties even after the living organisms are entirely destroyed. In other words, in this instance, at least, the fluid contains a poisonous principle in solution which gives rise to a specific disease just as certainly as do the cultures of the germs themselves. Thus, although the parallelism between the poison of a snake may be strengthened by this view of the case, yet the fact remains that the poison of certain diseases is produced and propagated by the growth of microbes.

This view, which has been gradually gaining supporters for several years, removes one great difficulty that has always been in the way of

those who have endeavored to explain how the microbes produce their effects. One can more readily study and understand the action of a poison upon the system than of an almost invisible bacterium. Professor L. Brieger, of Berlin, in studying the physiological properties of some of the ptomaïnes, obtained by him from different substances, found that, in their effects upon the organs and tissues of the body, they very closely resembled those of the alkaloids produced from the higher phanerogamous plants, such as the atropines, etc. The ptomaïne produced by the bacterium of swine-plague has been successfully employed by Drs. E. D. Salmon and Theobald Smith to produce immunity from the disease in at least some of the animals which were otherwise susceptible to the disease and died from it. Dr. H. G. Beyer, U. S. N., having ascertained by physiological experiment that the ptomaïne produced by the bacterium of swine-plague, lately discovered by Drs. Salmon and Smith, acted in many respects like atropine, made the suggestion that an attempt should be made to produce immunity from disease by the administration of those of the alkaloids which the ptomaïnes most resembled in their normal action on the tissues or perhaps also their physiological antagonists.

This important suggestion seems new to us, and, no doubt, deserves the attention of the investigators in this field of research.

The germ theory to-day rests upon the results of experiments as carefully and critically conducted as the researches in a physical or chemical laboratory. The successive steps in its demonstration are, in brief, the isolation of the germ to be studied, its propagation for many generations without contamination with other germs, and finally the production of the disease by injecting the culture fluids into the body of a healthy animal. When this chain of evidence is complete, and the effects are found to be invariably the same through an indefinite number of successive cultures, scientific research can scarcely attain more positive results.

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Globiferi, New Sense Organs in Echinoidea.

BY DR. OTTO HAMANN.*

In the Echinoidea there may be found in the skin, besides spines and pedicellariæ, organs hitherto undescribed which are to be called globiferi in allusion to their form. They are seated upon a movable peduncle of various length, and are globular bodies of various shape according to the species. In *Sphærechinus granularis* the head of the globifer consists of three sphæres united to each other at their points of contact, each showing a circular aperture under a low power. In the peduncle there is a calcareous rod to support the head. They are distributed over the whole skin and occur in most echinoids. Investigation of fresh globiferi separated from the living animal shows that they are glandular and emit secretion through the pore; they evacuate this by muscles running concentrically with the aperture of the ball. Each globifer contains a gland with its aperture.

Neither the Holothurides nor the Asteridia possess such organs. In them the gland cells are distributed in the skin. In the Echinidea, with their long spines, this would be ineffective, but mounted on stalks they may be controlled like the pedicellariæ, and are to be considered weapons of defense.

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Worms Frozen in Ice.

Professor Leidy refers, in the Proc. Ac. Nat. Sci., Philadelphia, 1885, p. 408, to finding organisms in ice, and stated that Dr. S. C. Thornton had submitted to him a bottle containing water melted from ice in which was contained a number of worms. On

*Amer. Mag. Nat. Hist., 35, p. 387.

melting some fresh ice from the same locality living specimens were found. This ice was full of air bubbles and water drops. Professor Leidy recognized the annelid as new, and applied to it the name *Lumbricus glacialis*. It was 4–6 lines long and 0.15 to .25 mm. thick. The ice in which the annelids occurred was full of air bubbles. In clear ice none were found. This suggests the caution that, in selecting ice for using, spongy ice from a stagnant pond should be avoided.

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A New Form of Fresh-Water Cœlenterate.

BY DR. M. USSOW.*

Owsjannikow and, later, Grimm have mentioned a parasite upon the egg of the sterlet (*Accipenser ruthenus*) of the river Volga. This parasite proves, upon investigation, to be a cœlenterate like the fresh-water genus *Hydra*, and forms a new genus and species called by Dr. Ussow *Polypodium hydriforme*. Its life cycle includes three phases, viz: 1. Parasite in the egg of host, in the form of a cylindrical spirally-wound pouch with numerous buds upon it. 2. Free living stage derived from No. 1 by budding from stolon upon it; it has 24 or 12 or 6 tentacles. 3. The mature sexual stage not differing much externally from 2.

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Tree-Climbing Cray-Fish.

To show how a flood or oversupply of water will at certain times alarm these little creatures, a gentleman residing in Freeport, Illinois, informed me that not many months ago they had some very heavy rains that greatly increased the volume of the little river running through the town. The water gradually rose until numbers of quite large trees were submerged, and the stream was almost twice its ordinary width. Such an unusual occurrence naturally attracted considerable attention, and my informant and a number of others visited the trees several times, and when the river was at the highest they presented a strange appearance from a little distance. Their trunks seemed to have changed color from the water up to the branches, and on closer inspection it was found that they were completely encased with cray-fish, which covered every available space, crowding upward by hundreds, clinging to the bark and to each other, in some spots packed one upon another four and five deep; every moment added to the throng, new ones emerging from the water, while those above, urged on, crept out upon the branches, and completely covered them, presenting a novel and interesting sight. The animals in many cases retained their positions for several days, and did not seem to be affected by their stay out of water. The occasion, however, was taken advantage of by the people, who came with buckets and brooms and swept them from the trees by hundreds, storing them up for future use. The cray-fish in certain portions of the Western country is a pest to the agriculturist, and the work of these little creatures often greatly increases the labor and expense of breaking up land, especially after the burrows or mounds have stood for many years, the vegetation that has grown upon them often increasing their size to mammoth proportions.—*From 'Some Peculiar Habits of the Cray-Fish,' by* C. F. HOLDER, *in Popular Science Monthly for October.*

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—The November number of the *Popular Science Monthly* contains a most interesting article upon Chevreul, the veteran French chemist, who has recently celebrated his one hundredth birthday. In 1806 he published his first important scientific work. At 1825 he was mentioned in the *Lancet* as one of the ablest of French chemists. He is a proof of the proposition that study in itself is not very killing, and that regular habits and diet are commendable.

*From Morphol., Jahr. b. 12, p 137.

EDITORIAL.

Publisher's Notices.—All communications, exchanges, etc., should be addressed to Henry Leslie Osborn, Lafayette, Indiana, Purdue University.

Subscriptions, and all matters of business, should be addressed to the Business Manager, P. O. Box 630, Washington, D. C.

The address of Mr. R. Hitchcock is Osaka, Japan.

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A pink wrapper indicates that the subscription has expired.

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The regular receipt of the JOURNAL, which is issued on the 15th of each month, will be an acknowledgment of payment.

The first volume, 1880, is entirely out of print. The succeeding volumes will be sent by the publisher for the prices given below, which are net.

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FROM JAPAN.—Our pen has been idle upon microscopical subjects for many days, because the conditions have not been favorable for writing since we have been in Japan. To evolve editorial articles out of one's inner consciousness, while travelling for two months and waiting another month for books and papers (which are not at hand even yet), is not satisfactory to either the writer or to the long-suffering reader who may be induced to con the pages with vain hopes of finding something new. These few lines, therefore, are only written as an assurance of our continued existence in active life, and in explanation of apparent idleness as regards the *Journal*. We have the satisfaction of knowing that our readers do not lose anything by our silence. Nevertheless, we shall continue our regular contributions henceforth.

The articles on Photo-Micrography will be continued as soon as our books of reference arrive. We cannot give formulas from memory, and are, therefore, obliged to defer the articles on printing for a short time. We have not even a microscope yet, and have been here a month and have seen algæ in ponds and in the trenches about the rice-fields in the greatest abundance, which we imagine to be made up of many undescribed species; and probably the first dip will show a multitude of unknown infusoria that Dr. Stokes would revel among for many days. If we could only command his skill with the pencil, what treasures we would take away with us. We must try what photography will do.

The field for microscopical work here is a rich one, but it is doubtful if we shall be able to cover much of it. We shall collect some, and study the algæ as much as possible, but we have other work in hand which is of more importance just now, the results of which will be seen at Washington after our return. That cannot be neglected; but we shall endeavor to take home some material for others to study in the form of diatoms at least, and perhaps will occasionally be able to send some good material of this kind by mail to subscribers who may desire it. This we say without having made a single dip yet, so we really do not know how rich the finds may be; but those who wish to take the chances of getting something from Japan may enclose a five-cent stamp for postage, and when we make a good find we will be glad to share with them. Our address is given under 'Publisher's Notices.'

H.

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BUTTER ADULTERATION.—Dr. Thomas Taylor has by no means given up the position he has taken with regard to the fats of butter, lard, and beef, and we have very recently had several communications from him upon the subject. These communications were of a personal nature, and more especially for our information—the subject being new to us—than to impart very much in addition to what Dr. Taylor has already published. As the matter was new to us with respect to its detail, and as it has proved very interesting, as well as very convincing with regard to the value of the method for detecting adulteration of butter, we shall set forth some of

the matter of the correspondence for the benefit of our readers. We first received some time ago slides from Dr. Taylor containing crystals from the fat of beef taken from the caul fat of the ox. We then, after examining them, obtained a sample of butter known to be good and subjected it to microscopic examination. It contained no crystals of any kind except a few crystals of *halite* or common salt. This was a sign that the butter was good, according to Dr. Taylor's test, for butter ought to show no crystals of fats, because the fats of the butter have never been heated and allowed to cool and crystallize after the manner required by the condition for the formation of these crystals. The butter thus examined was then heated in a watch-glass to boiling, over a Bunsen lamp, and allowed to boil vigorously for a few moments, and then set aside to cool. Examined shortly after boiling, it contained no crystals, but after several hours it was again examined. It now presented a very different texture from that proper to butter; was granular, and broke up readily into a number of very small rounded masses. A bit of it was placed upon a slide and covered with a drop of oil. In this it readily broke up into a mass of very minute grains, distinctly visible to the naked eye, but very small. Microscopic examination showed these to be small spherical bodies, with a general mutual resemblance.

The same facts as these were described in Dr. Taylor's article in this *Journal*, 1885, p. 163, and there figures were given of the butter crystals. Our observations were made for the purpose of confirming this description, and were in accord with those of Dr. Taylor. Very recently we have received from Dr. Taylor a set of thirteen very beautiful photo-micrographs, illustrating this subject. Two of these were taken by Mr. Walmsley, of Philadelphia, and the rest by Dr. B. Persh, of Washington. We cannot leave them without one word upon their beauty as works of photo-micrographic art, and perhaps that word can be as well said at the beginning as at the end of what I have to say of them.

Of the photo-micrographs, four are of beef fat, and show plainly the characteristic crystal (see page 164, fig. 26–8) as figured in Dr. Taylor's article already referred to. Two of the micrographs are of lard crystals, and are much better than the drawing of the lard crystal, fig. 26–7. Two more of the micrographs represent the crystals of butter which here resemble figures 26–3, and 26–5; the figures being rather diagrammatic, while the micrographs look precisely like the view of butter crystal as seen in one focal plane. The other five pictures are from slides of oleomargarine. Of these, two contain, evidently, a great deal of butter, for in the picture at least one half the crystals are evidently butter crystals; but besides these are numerous crystals of beef and lard. From these photo-micrographs there would be no difficulty in picking out at once the one made from pure butter, and as these were made from pure butter it follows that pure butter can be detected any time, microscopically, in this way. But while this study is full of interest for the study of the various butter crystals, and it is beginning to appear that various butters may be distinguished by slight variation in the butter crystals, it is not necessary in examining butter and its substitutes to detect frauds that the butter crystals be seen at all. The butter of the stores is not so formed as to give rise to any fat crystals. The fats in it are never heated beyond the temperature of the animal body, and hence are not placed under the conditions required for crystallization. Therefore, butter unadulterated ought to show no crystals whatever present. Only yesterday, Nov. 13, we received from Dr. Taylor two samples, one of butter, the other of

oleomargarine. We requested several persons to taste these and pronounce upon their relative merits, and attempt to distinguish them by the taste. The butter was universally pronounced to be the inferior article, and the experimenters, who had been farm-bred boys, though they didn't know oleomargarine by the taste or look, judged that sample the better article, and hence they concluded it more likely to be butter. To the taste it was butter, but under the microscope there was a great difference between the two. The butter sample was destitute of fat crystals of any sort, but the oleomargarine was largely composed of two sorts of crystals, resembling the one fat and the other lard. We do not wish to enter the butter-crystal war, chiefly from lack of sufficient time to investigate the matter fully for ourself, but of the value of this test for separating the true from the false in the existing butters we feel assured so far as we have been able to inform ourself.

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Test of Water Purification.—A most interesting account of the application of refined and delicate biological methods of investigation to practical uses is given in an article by P. F. Frankland, Ph. D., associate of the Royal School of Mines, which first appeared in the Proceedings of the Institution of Civil Engineers, and which we take from Van Nostrand's Engineering Magazine for Oct., 1886, p. 316. In attempting the purification of water for domestic uses, there were found to be two sorts of injury; one which resulted from the presence of large amounts of organic matter in decomposing state; this could readily be detected by chemical examination. A second where the absolute amount of organic matter was far below the injurious limit; but where there were present micro-organisms which, if introduced into the body, might be the cause of contagion. Chemical examination would be helpless here, and yet the water really more dangerous than water which might fail to pass the chemical tests. Thus, in testing the value of various methods of purifying water, the chemical method alone would not be sufficient. The culture method of Koch is so simple in principle as to be readily understood. The micro-organisms multiply so rapidly that from one a vast number soon descends. If the organisms be reared in a fluid medium, where the conditions for rapid growth are furnished, it is impossible to infer from the number present how many were present to begin with. But if the organisms be distributed through a medium suitable for their multiplication, and then deprived of the power of movement, the number of colonies arising from the multiplication of these isolated individuals indicates the number of organisms introduced. Koch complied with these conditions by introducing gelatin in his culture medium, and this medium, with the sample of water mixed through it, spread out upon a glass slide and left to develop under a glass cover. The imprisoned organisms, growing rapidly, form thus isolated colonies, which may be readily recognized by the naked eye or with a low magnifying power, and give a ready means of determining their abundance in the water to be tested. Until the method of water examination by gelatin culture was devised, there were no available means by which the relative efficiency for the removal of micro-organisms of different filtering materials could be estimated upon a quantitative basis.

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Seaside Laboratories.—Every reader of the *Journal*, who has not already done so, will please and instruct himself by consulting two articles which have recently appeared upon zoological marine laboratories. One is the description, by Mrs. Whitman, of Dohrn's Zoological Station at Naples, a valuable account of which appeared in the October Century Magazine. Mrs. Whitman, besides

being the wife of an able zoologist who has been a Naples worker, herself is an able student of zoology, having studied in this country, in Cambridge, England, and at Naples. The article is of great interest, as is every fresh word about that most interesting place. The other article is by Ernest Ingersoll,* descriptive of the American Station at Wood's Holl, the summer headquarters of the United States Fish Commission. This, under the direction of Professor Spencer F. Baird, has become the most completely equipped enterprise of its kind in existence, its object being the study of all that relates to the fisheries. Begun in 1876, it has grown in strength and efficiency until it demonstrated its value, became an object of envy abroad, and is now being followed by the English, who are establishing a British Commission with a similar purpose.

Besides the two laboratories, we have on our coast every summer the laboratory of Professor Hyatt, at Annisquam, on Cape Ann, for beginners in zoology as well as all who wish to go; Prof. Agassiz's laboratory at Newport, R. I., restricted to the use of a few naturalists, and the Chesapeake Zoological Laboratory, under the direction of Prof. W. K. Brooks, of Johns Hopkins, for the use of advanced and special students in zoology (or botany if they wish). The work of all these sea-shore laboratories each summer adds much of importance to our knowledge of American Atlantic marine zoology.

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Desmid Material Wanted.—We are in receipt of a letter from Mr. J. Harbord Lewis, F.L.S., of 145 Windsor street, Liverpool, England, dated 25th October, 1886. The letter is evidently intended as a personal communication to Prof. R. Hitchcock, the writer not knowing of his absence from this country. The writer encloses an advertisement of fine mounts of British desmids, which he offers for sale at prices varying from 4*s.* to 1*s.* 3*d.* He is anxious to obtain American desmid and filamentous fresh-water alga material, and offers to make suitable return in slides. 'Materials may be in the rough, just as gathered; and it is advisable to have exact locality, date, and the preservative used, for sake of reference, in case anything good turns up.' Since the offer of Mr. Lewis was intended for Mr. Hitchcock, who has studied these plants very fully, we do not wish our readers to understand that everyone is requested to exchange on the terms mentioned, but we suggest that any desmid collector who desires to improve this opportunity confer for himself with Mr. Lewis.

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Appochromatic Objectives and Eye-Pieces.—The price-list of the new Zeiss Objectives and Eye-Pieces, from selected glass of the Technical Glass Foundry (Schott & Gen), Jena, Germany, has been handed to us, and we quote a few of the prices mentioned in that list:

Dry System,	.30 ap.,	25. mm.,	1 in.	Mk. 140
"	.30 ap.,	16 mm,	$\frac{2}{3}$ in.	Mk. 100
"	.60 ap.,	12. mm.,	$\frac{1}{2}$ in.	Mk. 170
"	.95 ap.,	6. mm.,	$\frac{1}{4}$ in.	Mk. 220
Water Immrs.,	1.25 ap.,	2.5 mm.,	$\frac{1}{6}$ in.	Mk. 300
Homog. "	1.30 ap.,	2. mm.,	$\frac{1}{12}$ in	Mk. 450

The prices of the eye-pieces vary from 20 marks to 40 marks.

The price-list is issued by F. J. Emmerich & Sons, 138 Fulton street, New York city, who reckon the mark, adding duties and other expenses, at 37½ cents.

The original price-list of these objectives, issued by Zeiss in German, is a valuable document, as it is full of information for the microscopist. A full translation of the article is given in the current number of the Journal of the Roy. Mic. Society. We shall include an account of this article in our December number.

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Typographical Errors.—We take the present occasion to correct two bad typographical *errors* which have appeared in the *Journal*, and

*See Harper's Weekly, vol. xxx, Oct. 2, '86, p. 635.

ask the indulgence of our readers, since they happened at a time when the *Journal* was changing hands. The first is the reading *Haricula*, page 138, in the letter signed W., the other is Tuckett in the letter of J. P. Thompson, page 159. The former of these should read *Navicula*, the latter *Quekett*.

NOTES.

— We are in receipt of postal box of slides from Theodore Hinrichs, Pratt and Fulton streets, Baltimore, sent to us for examination. The slides all bear the title, Marpmann's Microscopical Institute, Esens, Germany, for which Mr. Hinrichs is the sole American agent. The slides are *B. cholera*, *Micr. bombyeis*, *Micr. stimulator*, *Bacill lactis*, *B. anthracis*, *B. flavescens*, *Saccharomyces conglomeratis*. These are all finely stained and mounted and show superior technical skill in handling such objects.

— We note from *Science Gossip*, No. 261, p. 210, Sept., 1886, the announcement of four parts of vol. iv of Cole's Studies in Microscopical Science. The subjects discussed are :—Studies in Vegetable Physiology, as illustrated by the vegetable cell; The Mammalian Testis; The Normal Kidney; The Sea Fans. 'The work is continued on exactly the same lines as heretofore, and the colored illustrations are equal to any of their predecessors in careful drawing and artistic finish. The slides accompanying each part are in Mr. Cole's best style of mounting.'

— *Journal of Morphology* is the title of a new journal which is announced by Prof. C. O. Whitman, of Milwaukee, Wisconsin. The journal is to be an American journal of animal morphology, to admit all worthy articles on embryological, anatomical, or histological subjects. Only original articles, which deal thoroughly with the subject in hand, will be admitted to its pages; short notes, desultory observations, etc., being excluded. Its size is to be crown octavo; a number will contain 100 to 150 pages, and from five to ten double plates. From the excellent reputation of Prof. Whitman and the corps of supporters who are mentioned in his circular, as well as from knowledge of the excellent presswork of the publishers, Ginn & Company, of Boston, we confidently expect a very creditable production. The first number is promised early in 1887.

— *The National Druggist*, published weekly in St. Louis, is a live and interesting paper. With much that a commercial periodical would be expected to furnish, such as price-lists, numerous advertisements, etc., it contains in addition a great deal of interesting matter, and has one column exclusively devoted to microscopy. In two recent numbers an article by the editor, H. M. Whelpley, has been published upon the importance of the microscope in pharmacy. It points out the value of the microscope in detecting adulterations, and refers to the fact that much can be seen with a very inexpensive instrument. The article is a timely one. We can't buy pure drugs of the retail dealer because he can't get them, and he claims that no blame rests on him for selling adulterated articles. But if he could detect the adulteration, as he often could by a very slight microscopic examination, the wholesale dealer would be very soon forced into honest dealing.

— Dr. John S. Newberry, the distinguished professor of geology in Columbia College, opens the November number of *The Popular Science Monthly* with the story of the great ancient ice-sheet which once covered half our continent, and which, more than any other single cause, gave to it its present surface configuration. With the aid of illustrations the record left by this mighty agency of the past is very clearly interpreted for the general reader, who will obtain from the account an insight into the mode of working of nature's forces that only years of special study could afford.

— The suggestion of Prof. J. H. Pillsbury upon a convenient way to prepare lantern slides is a most excellent one. He suggests the use of a thin film of gelatin such as can be procured from any lithographer. Upon this, with a needle or other sharp-pointed instrument, the picture to be used in the lantern is copied by tracing with deep or shallow scratches. The scratches will appear on the screen as black lines or dots upon a white ground. The films may be conveniently used in the lantern by placing them between two glass plates of ordinary lantern size. This method recommends itself to us as far better than the old one of coating a slide with gelatin and drawing a picture with pen and ink. We think a combination of the two schemes might be still better, viz: To coat the lantern slide with gelatin over the area to be scratched,

and then scratch the gelatin surface as Prof. Pillsbury suggests. Any person who has patience and can draw a line could thus prepare many slides for his lantern at comparatively low cost.

— Dr. H. DeVries has been making a study of the vacuoles of vegetable cells, and the results which he has achieved are of considerable interest. He has proved that a vacuole is not merely a sap cavity hollowed out in the protoplasm, but that it has a distinct inclosing membrane different from the rest of the protoplasm. For this membrane he proposes the name *tonoplast*. His mode of distinguishing it was by the use of a 10% solution of potassium nitrate, which almost immediately kills the rest of the protoplasm but does not kill the inclosing membrane of the vacuole until the lapse of some time. The dead protoplasm may then readily be stained by means of eosin or other suitable dyes, while the living tonoplast remains unstained and may therefore be readily distinguished. He further finds that the tonoplast agrees in essential structure with what has been termed the primordial utricle of the cell or the inner cell membrane. Like it the protoplasm composing it is firmer and less permeable than the rest, and they resemble each other also in the fact that they excrete certain definite substance, as cellulose, vegetable, acids, etc. Dr. DeVries also ascribes the phenomenon which Darwin called 'aggregation of the protoplasm' to be contraction and division of the vacuoles.—From *Western Druggist*, Oct., '86, p. 391.

— Prof. C. S. Minot, in Zeitsche f. Wiss Mikroskopie, iii, p. 173, states with regard to absolute alcohol: 'My experience has led me to question whether absolute alcohol which retails in America at one dollar a quart is, I will say, not a necessity, but even an advantage for the preservation or hardening of histological material, or at least of vertibrate tissues. One frequently encounters the direction to employ absolute alcohol in conjunction with this or that method. After repeated tests I have found 96% entirely sufficient for all the manipulations for which the absolute had been recommended. At present I know of no application of absolute alcohol in histology which I can regard as anything but an unnecessary extravagance.' Prof. Minot further objects to the permanent preservation of material in alcohol stronger than 80%. It is the custom of some of the best histologists to permanently keep their material in 70% alcohol in vials, and to keep these in jars of alcohol of about the same strength, thus preventing change so far as possible in the small vials. The use of strong alcohol for permanent preservation is of no advantage whatever, as 70% is strong enough, and the stronger alcohols shrink and distort the specimen Before imbedding, the specimen must stand a day or so in strong alcohol.

— In the same article from the Zeits. f. W. Mikros., Prof. Minot says that 'Benzole can replace the much dearer xylol for cleaning sections, cleansing lenses, diluting Canada balsam, etc. Pure benzole has the property of evaporating without leaving a residue.'

— *Picric acid carmine.* From the same article we extract the following: There is a good way to secure a permanent picro-carmine solution without the use of ammonia. 'Boil one gramme of the best powdered carmine with 200 c.c. of water plus an excess of picric acid for half an hour. Allow it to stand and cool, decant the clear fluid, add fresh water, and, if necessary, picric acid; boil, cool, and decant; repeat this operation until all the carmine is dissolved. Place the decanted fluid in an evaporating dish, add about 19 thymol, and stand in a warm place until the volume is reduced to 25 c.c.; let the solution cool; filter; wash out the residue, which should be on the filter, with 25 c.c. water. It gives a stronger differential coloring of the tissues than Ranvier's picro-carmine; but overstaining must be carefully avoided. For sections hardened in alcohol or with Kleinenberg's picro-sulphuric acid, two to five minutes are sufficient; for bone, etc., decalcified with picric acid, less time; for Müller's fluid specimens considerably more time is required. The fluid stains fibrous connective tissue deep red; striped muscle dull red; smooth muscle, blood, and horny tissues bright yellow; glands reddish-yellow. In the kidney it gives differential colorations of the various portions of the tubules.

It gives a quite sharp nuclear coloration, but produces less contrast between the nucleus and the protoplasm than does Ranvier's picro-carmine. It is, however, easily made equal and equivalent to the latter by adding very dilute ammonia to the picric acid over solution until it begins to assume a rich wine-red shade, which is quite distinct from that of the acid solution.

— The October number of the *Journal of Microscopy and Natural Science* (vol.

5, p. 210, 1886) contains an article giving an account of the various alkaloids and other crystalline bodies, with notes on their microscopic identification, and two plates of figures illustrating the shapes of the crystals.

— The fifty-ninth meeting of the Society of German Naturalists and Physicians has recently been held in Berlin. It is divided into thirty Sections, of which twenty-one were more or less medical, and some of the Sections had as many as 400 members. Professor Virchow gave the introductory address.—*Sci. Amer'n*, Oct. 30, 1886.

— The *Practitioner and News* (Sept. 18, '86, p. 210) contains an account of the death of a boy, Polymieux, from hydrophobia. The boy bitten by a dog was inoculated at Pasteur's laboratory two or three days after the biting, and died on the twenty-second day in spite of most careful treatment under Pasteur's eyes.

— Dr. M. D. Ewell, of Chicago, sends us an extract from the *Chicago Law Times* upon 'the limits of normal vision.' In it the statement of Tidy's Legal Medicine, p. 248, to the effect that at a distance of one foot from the eye a person of normal sight can scarcely see an object less than one twenty-fifth of an inch, is subjected to actual test. As the result of several tests, it was found that in the case of most acute vision, a bit of black paper 1 mm. square could be seen at a distance of 36 inches, was seen clearly defined at a distance of 5 inches and 11, and the mean distance of 19 persons tested was 26′ 4″ for visibility, and 5′ 10″ for clear definition.

— In reply to a correspondent, Dr. P. Ehrlich, in the *Zeitschr. für. Mikr.* gives a method of preparing a solution of hæmatoxylin that will keep for years. It is in brief, as follows :—

Hæmatoxylin solutions, as is well known, rapidly decompose, with the formation of a bluish precipitate, which by dissociation of the alum is a basic lake-forming alumina compound and free sulphuric acid. The author attempted, therefore, to prevent the formation of a basic lake compound by the addition of acid. The first experiment with acetic acid led to most satisfactory results. The mixture employed was as follows :

Water,	100 c. c.
Alcohol (absolute),	100 c. c.
Glycerin,	100 c. c.
Glacial acetic acid,	10 c. c.
Hæmatoxylin,	2 grammes.
Alum in excess.	

The mixture ripens in the light for a long time until it acquires a saturated red color, when it remains unchanged for years.—H.

— W. Migula states that the contraction of the protoplasm of algæ and desmids can be entirely prevented by treating them on a cover-glass with a one per cent. solution of perosmic acid. After 10–20 minutes this may be replaced by potassic acetate. Desmids especially are said to retain their form and show the structure of their plasma very well when thus treated. —H.

CORRESPONDENCE.

Indiana Academy of Science.

To the Editor :—The next meeting of the Indiana Academy of Science will be held at Indianapolis Dec. 29, 1886, at 10 A. M.

John C. Branner,
O. P. Jenkins,
Committee on Programme.

Greencastle, Ind., Oct. 9, 1886.

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We have received from an old subscriber a letter containing two questions: 1. Whether benzine can be substituted for benzole in microscopic technique? and 2. Whether absolute alcohol can be made readily by the use of some dehydrating substance, such as quicklime? We leave the first question unanswered and invite response. As to the second, absolute alcohol—that is, 100% alcohol—is not necessary for paraffin imbedding, but, on the other hand, 95% will not answer. The exact percentage of water which may be present we cannot say, but our experience shows that alcohol with 5% of water present—that is the commercial article—will not answer, though if the percentage be only 2 or 3, or possibly 4, of water, it can apparently be used as well as the absolute. We have tried dehydrating with quicklime and with copper sulphate on a small scale, but it has never proved a success. The last trace of alcohol will not be removed by turpentine unless the alcohol be of high proof, and we have never been able to use other than a very high proof alcohol, higher than any commercial alcohol we have ever found. We know of laboratories where absolute alcohol is made for histological work, copper sulphate being preferred, but, unless the amount to be used is very con-

siderable, we think it pays better to purchase it of the chemists.

Note.—We have unfortunately mislaid the communication of the correspondent referred to above, and would thank him to communicate with us further.

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Mr. Christian, of Richmond, Va., has informed us, too late for more than brief mention in this number, that he has made two photo-micrographs of a new diatom, for which he proposes the name *Melonavicula Marylandica*, which is said to be the missing link in the structure of diatoms —a disk form with meridian line and nodules. There are two species of this new genus. Mr. Christian* will send prints to any one who will write for them.

MICROSCOPICAL SOCIETIES.

Washington, D. C.

Forty-seventh regular meeting, Tuesday, Sept. 28, 1886. Prof. Seaman favored the Society with his impressions and observations of the meeting of the A. M. S. at Chautauqua. The speaker showed lists of tables in operation at working session, and of objects shown at the public exhibition. Among the items of interest was the exhibition of photographic methods by Hon. J. D. Cox and others. He was struck by the extent to which the old forms of microtome had been superseded by the Thoma and its variations. As to cells and cements, he had been pleased with two cements, viz., that of Dr. James, of St. Louis, made by passing oxygen through linseed oil and dissolving the product in a suitable medium, and the rubber cement made by Brown, of Camden, N. J. Both of these struck him favorably. Whitney's wax cells seem to do away with the objection most commonly urged against this form of cell, viz., the cloudiness appearing after the lapse of time. These cells are made by building up wax in the usual manner and then coating the cell with Brown's cement. A solution of balsam in xylol seems a good mounting medium and cement also. The speaker had been experimenting with a new metallic soap varnish, which he had found to make an excellent cement. Particulars will be given soon.

Dr. Taylor gave an account of his debate at Chautauqua with Prof. Weber, and also stated that he had secured an excellent photograph, by Walmsley, of the beef fat crystal, showing it to be branched and foliated, as he had claimed.

Dr. Reyburn gave an account of his visit to Pasteur on August 8th last. After describing the laboratory he gave an account of the method of preparing the vaccine material, which is procured by trephining rabbits and injecting virus into the upper part of the spinal cord. After ten days or so the rabbit dies, usually suddenly. A portion of the infected cord is heated in veal broth and the mixture diluted so as to form fluids of ten different strengths. In using the vaccine an ordinary hypodermic syringe is used, the needle of which is first sterilized in a solution of bichloride of mercury, and the vaccine is then injected, usually near the waist, beginning with the weakest dilution and increasing the strength each day. He came away with a feeling of distrust with the method, and that seemed to be the feeling of English physicians with whom he had talked. There seemed to be a lack of accuracy and care. In a practice of thirty years, twenty of which had been in Washington, he had never known of but one genuine case of hydrophobia. Upon inquiry of other physicians, their experience had been similar to his.

Dr. Schæffer showed a copy of Hassall's microscopic anatomy, with plates, 1849, a scarce work, and also showed a sample of saccharine, the new coal-tar product lately discovered.

E. A. Balloch, *Rec. Secr.*

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Washington, D. C.

At the 48th regular meeting of the Washington Microscopical Society, held Oct. 12th, 1886, Dr. Schaeffer made a few remarks on *Phytolacca decandra*. The speaker said that there were two points of interest to which he desired to call the attention of the Society with regard to phytolacca. 1st. The use of an extract of the berries as a dye; and 2d, a peculiar arrangement of the ducts in the flower stalk. He had been experimenting with a solution of the berries in alcohol, and also in a saturated solution of borax as a dye. From his experiments he thought that perhaps the dye might be useful in staining vegetable preparations. He showed some stainings which had been exposed to light since Oct. 4th without change. The stain is a deep homogeneous red.

*Address: Thomas Christian, 1418 Main st., Richmond, Va.

In the flower stalk he had found some ducts which seemed to be complete rings, resembling the so-called fairy rings in some species of plants. Upon immersion in glycerin they became detached. Specimens of tissues stained by the dye, and also of the ducts, were shown.

The 49th regular meeting was devoted to an exhibition of specimens, consisting chiefly of diatoms and urinary deposits, which had been prepared for the Society by some of its members during the summer. Dr. Schaeffer showed crystals of diabetic sugar prepared after Beall's method of evaporation upon the slide. Dr. Taylor showed photographs of the butter crystal, and those of beef fat and lard, and also photographs of oleomargarine, showing clearly the differences between these articles. The photographs were by B. Persh and Walmsley.

E. A. Balloch, *Rec. Secr.*

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San Francisco, Cal.

The regular fortnightly meeting of the San Francisco Microscopical Society was held September 8, Dr. S. M. Mouser presiding.

After the routine business had been disposed of, the Secretary exhibited some specimens of 'jasperized' wood from the petrified forest at Chalcedony Park, A. T. This material, by reason of its extreme hardness and great beauty, is beginning to be extensively used in the manufacture of jewelry and for various ornamental purposes. Under the microscope, the woody fibre with its characteristic markings was seen to be perfectly preserved. In fact, it is in many cases possible to determine not only the genus, but even the species, by a microscopical examination. In the specimens which were examined, some chalcedonic concretions of unusual regularity and beauty attracted much attention.

Some exceedingly minute 'jumping seeds' from Calaveras county, each probably containing an insect larva, were shown by the President and referred to Dr. Bates for further examination.

A number of very handsome slides of algæ and foraminifera, mounted by A. Durrand, F. R. M. S., who was present as a visitor, were examined with much interest.

The advisability of giving the annual exhibition during the ensuing month was discussed, and the matter was referred to a committee.

A. H. Breckenfeld, *Rec. Secr.*

San Francisco, Cal.

The semi-monthly meeting of the San Francisco Microscopical Society, held at its rooms, 120 Sutter street, Sep. 22, 1886, attracted a large attendance.

The committee appointed at the last meeting to examine into the advisability of holding the annual reception next month reported strongly in favor of the proposition, and after some discussion it was unanimously decided to hold the reception on the 16th prox., provided a suitable hall could be obtained for that date. From present indications there is scarcely a doubt that as regards the number of exhibitors, the number of microscopes used, and the variety and beauty of the objects shown, the coming exhibition will be the best ever held on this coast.

Pursuant to announcement Dr. Stallard delivered a brief address on "Endarteritis," or morbid development and subsequent degeneration of the interior coat of arteries. The structure of the three layers of tissue of which arteries are composed was described in detail. The interior coat, it was explained, was most liable to become morbidly affected. When the blood is forced through an artery at an abnormal velocity the interior layer manifests a disposition to resist the increased pressure by thickening, and should the pressure be of long continuance it frequently results in the formation of a tissue lining the interior of the artery which, constantly increasing in thickness, obstructs the flow of blood through the vessel more and more, until in many cases the artery is completely closed. This morbid growth is frequently traversed by pseudo blood-vessels, but ultimately becomes completely disorganized, usually by fatty degeneration. During the complete or partial obliteration of an artery, nature usually attempts to remedy the evil by a greater flow of blood through the adjacent smaller blood-vessels, and under the unusual pressure these frequently burst.

Dr. Stallard then exhibited a very large number of preparations showing arteries in their normal condition, as well as during the gradual progress of the disease. Some twenty fine microscopes were used for this purpose. The preparations were stained with various re-agents and were much admired for their beauty and interest. The subject was further illustrated by a large number of photographs and drawings, all well executed.

The Secretary exhibited a slide of the beautiful diatom *Arachnoidiscus Ehrenbergii*, the frustules of which had been

electro-plated with gold by Dr. A. Y. Moore, of Cleveland. The slide was not only strikingly beautiful, as seen under the binocular microscope with a ½-inch objective, but the plating process was evidently of value in rendering the markings more distinct. In this particular case, the true elevation of the radial costæ was much more obvious than in the natural diatom.

A. H. BRECKENFELD, *Rec. Secr.*

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RICHMOND (VA.) MICROSCOPICAL SOCIETY.

In one of the recent meetings of the Society Mr. Christian exhibited an interesting test slide (his own preparation) ingeniously mounted, with a view to discover any astigmatism of the eye. It consists partially of diatoms of the *Navicula* shape. If the eye of the observer can see simultaneously all the lines of the objects in the field well defined and resolved, then his eye is practically without astigmatic defect.

The object of the important test-slide is very obvious, as incomplete perceptions are often erroneously attributed to the inferiority of the objective used, when in fact they are the result of an astigmatic defect in the observer's eye. Results of observations among microscopists often differ because the operators of instruments are frequently not aware of the astigmatic condition of their eyes.

NOTICES OF BOOKS.

Microscopical Records, based upon a plan presented by Prof. S. H. Gage, B. S., at a meeting of the American Society of Microscopists held in Chicago in 1883. By Chas. E. Alling. Rochester, N. Y., 1886.

This work is a blank book with spaces for entry of all items which require to be preserved of the treatment of microscopic objects. Blank spaces are provided, numbered, and spaced for the insertion of common name, specific name, locality, collector, preparator, method of hardening, staining, clearing, mounting, date, and remarks. There is also an alphabetical index at the back of the book, and blank pages for recording various formulæ.

The book is handsomely gotten up, bound in half Russia, with spring back, and sells for $3.00 or $4.00, according as there is space for 500 or 1,000 catalogue numbers. It is worthy of hearty commendation, and has been well received. Something of the sort should be a part of every collection of objects, and this is the neatest thing of its kind which we know anything about.

Wells, S.; Treat, Mary; and Sargent, T. Leroy: Through a microscope: something of the science, together with many curious observations, indoor and out, and directions for a home-made microscope. Chic., The Inter-State Pub. Co., [1886.] 3–126 p. il. S. cl., 60c.

The Methods of Bacteriological Investigation, by Dr. F. Hueppe. Translated by N. M. Biggs, M. D. N. Y.; D. Appleton & Co.; pp. 218; 31 wood-cuts; 1886.

The author has attempted to supply the want of a complete and comprehensive representation of the methods of bacteriological investigation, acting under the wish of Geheimrath Koch, his teacher.

The work treats, under separate chapters, of—1. Spontaneous generation, and the principle of sterilization. 2. Forms of bacteria and microscopical technique. 3. Culture methods. 4. Inoculations for the determination of the causal relation of bacteria growth to decomposition and disease. 5. General biological problems. 6. Special hygienic investigation. 7. Bacteriology as an object of instruction.

The book is both descriptive and critical. It gives, with description of the author's methods and views, the methods of others, with abundant references to their writings, and is historical in its mode of treatment. The chapter upon microscopical technique, clear and full (pp. 28–92), giving classification of the bacteria, full directions for staining and cover-glass preparation; this, and the chapter on culture methods, will be described in greater detail in another place in this *Journal*.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Labels for slides, also slides and material to exchange for same. EUGENE PINCKNEY.
Dixon, Ill.

For Exchange: Seeds of *Orthocarpus purpurascens* and *Orthocarpus attenuatus*, and slides of same, in exchange for good objects, foraminifera preferred.
EDWARD GRAY, M. D., Benicia, Cal.

Infusorial Earth from Saco, Me., in exchange for slides of *Volvox globator*, or Spines of foreign sea-urchins.
D. E. OWEN, Brunswick, Maine.

Pathological and Histological Slides (very fine) in exchange for other good slides.
F. M. HOYT,
160 Washington Park, Brooklyn, N. Y.

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Hydra.—A Sketch of its Structure, Habits, and Life History.*

BY A. H. BRECKENFELD.

Among the many noteworthy achievements of that pioneer microscopist, Antony van Leenwenhoek, was his discovery of the remarkable little creatures, commonly called 'fresh-water polypes,' which have, since that time, received so much attention from microscopical observers. His announcement thereof, dated Christmas Day, 1702, appeared in the '*Philos. Transactions of the Royal Society*' for January and February, 1703, in which, in the quaint language of that olden time, he describes the novel appearance and plant-like 'budding' of these animals.† For some reason, however, the discovery attracted but little attention, and gradually lapsed into almost complete oblivion. But in the summer of 1740, the animal was practically rediscovered by Trembley, a Genevan naturalist. The investigations of Leenwenhoek had not come under Trembley's notice, so that when he first observed the presence of *Hydræ* he was deceived by their plant-like appearance, and regarded them as belonging to the vegetable kingdom. After observing them more closely, however, their remarkable contractile powers excited his surprise, and he then entered upon a series of experiments to determine the question of their proper classification. The results obtained were so wonderful and so contradictory, that they only served to increase his perplexity, and finally he sent some living specimens, together with an account of his investigations, to the eminent naturalist, Réaumur, and the latter decided that the remarkable little organisms were animals. Although his doubts on that score were now removed, Trembley unremittingly pursued his researches with special reference to the polype's truly remarkable power of reproducing lost parts, which peculiarity he was the first to investigate. From time to time he communicated the results obtained to other observers, and the enthusiasm with which he studied and wrote seemed contagious, for his researches excited the greatest interest throughout Europe. Cuvier, the great naturalist, speaks of him as 'immortalized by his discovery of the reproduction of the polype.' His investigations were soon verified by eminent scientific men in other countries, and, in 1743, Henry Baker, a Fellow of the Royal Society of London, published a '*Natural History of the Polype*,' in which he introduces the subject as follows:—'The accounts we have been favored with from abroad concerning the little creature called a polype, have appeared so extraordinary, so contrary to the common course of nature and our received opinions of animal life, that many people have looked upon them as ridiculous whims and absurd impossibilities.' He then proceeds at great length to confirm the experiments of Trembley, and records many

* Read before the San Francisco Microscopical Society, July 28th, 1886.

† By the courtesy of the managers of the Mechanics' Institute of San Francisco, whose library contains a full set of the 'Transactions,' etc., I was permitted to photograph the original delineation of *Hydra* as made by Leenwenhoek's 'limner.' From the negative thus taken fig. 26 was photo-engraved.

new ones of his own. In 1744 Trembley published the results of his extensive studies, and of this work it has been well said by Allman that it 'marked out one of the great epochs in the history of biological research.'

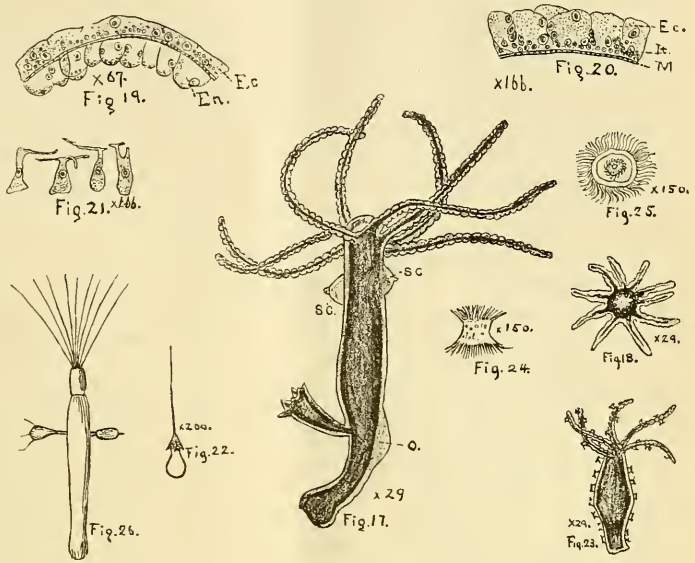
As to classification, the genus *Hydra*, Linn., ranks only a little above the Protozoa. It is the lowest form of the great animal sub-kingdom Cœlenterata (or Sac-animals), which is divided into two classes, Hydrozoa and Actinozoa, and *Hydra* is the type of the former class, just as *Actinia* (the Sea-Anemone) is that of the latter. Some 6 or 7 species of the genus have been described, but only 3 of them, *H. viridis*, *H. vulgaris*, and *H. fusca*, seem to be well founded, the others being probably only varieties.

Hydra consists essentially of an elongated nodular sac of protoplasmic substance, imbedded in which are found large numbers of colored granules. At the upper end of this sac is a simple opening, the mouth, and just below this is a circle of tentacles, usually from 6 to 10 in number, (fig. 17). At the lower extremity the body is furnished with a flattened suctorial disk, by means of which the animal usually attaches itself to filaments of algæ, rootlets of duck-weed, and similar objects, while its slender tendril-like tentacles are slowly and gracefully waving about in search of prey. Sometimes it uses this disk as a sort of float, and hangs head downward, suspended from the surface of the water. The body and tentacles of *Hydra*, when fully extended, seldom measure over $\frac{1}{4}$—$\frac{1}{2}$ of an inch in length, except in the case of the rare species, *H. fusca*, where the animal sometimes attains a length of several inches, owing to the extraordinary development of the tentacles, which, in that species, are many times the length of the body, while in *H. vulgaris* they are but very little longer, and in *H. viridis* usually somewhat shorter. The tentacles are hollow, each being traversed by a canal communicating directly with the body cavity. The body and tentacles of *Hydra* are possessed of most remarkable extensile and contractile powers. At one moment the animal may be extended to such a degree that the tentacles are almost invisible by reason of their fineness; when, upon being disturbed, it instantly contracts until it appears like a minute jelly-like lump, studded with a few stubby knobs. It then slowly expands until it is again fully extended. While it usually remains attached to the same object for a long time, it has the power of changing its position, either by a leech-like crawling movement, or by floating passively in the water until it comes in contact with some other object to which it wishes to adhere.

Hydra is extremely voracious. It subsists entirely upon animal food, consisting mainly of minute worms and the smaller entomostraca. When the prey has been caught by means of the tentacles extended for that purpose, these contract, and the unfortunate victim is forced with remarkable violence into the digestive cavity of the polype, the softer parts being there absorbed, and the undigested portions ejected through the mouth.

With regard to the histology of the subject of our sketch, many very diverse views have been held. Ecker, one of the first investigators of its minute structure, came to the conclusion that it was not composed of cells, but of a sort of sarcode, or, as he called it, 'unformed contractile substance,' thus bringing it into close structural affinity with the rhizopods. But better optical appliances and improved methods of research have amply proven the fallacy of these views, and it is now universally conceded that *Hydra* is composed exclusively of cells and cell-derivatives. The most valuable researches on the subject are those of Kleinenberg, and to his admirable monograph, published in 1872, I am indebted for much valuable information.

The body of *Hydra* is resolvable into two distinct layers, an inner—the endoderm—and an outer—the ectoderm. The tentacles are mere tubular prolongations of these membranes. The endoderm (fig. 19) consists of a single layer of large nucleated cells of protoplasm, destitute of an investing membrane, but enclosing, in many cases, a vacuole filled with clear fluid. According to Kleinenberg a few isolated cells of the endoderm are furnished with one or more very delicate cilia. Later observers have asserted that the entire endodermal layer is ciliated, and it is further stated that strong amœboid movements are shown by the cells of the endoderm, more especially in those lining the body cavity. The important fact is now considered well established by recent investigations of T. J. Parker and others, that the digestion of the solid food particles swallowed by *Hydra* takes place in the protoplasm of these endodermal cells, the latter acting almost exactly like an aggregation of amœbæ. In the endodermal cells of *H. viridis* are also imbedded the green granules which give to that species its distinctive color. Their function is not definitely known. It is an interesting fact that, after the most searching investigation of their optical and chemical properties by Kleinenberg, Cohn, and others, it has been made a matter of the strongest probability that these green corpuscles are identical with the chlorophyll of the vegetable cell. A singular theory regarding them was broached about four years ago by Dr. Karl Brandt, who considered them as parasitic algæ, and even bestowed upon them a generic and specific name, that of *Zoochlorella conductrix*. This theory has been very forcibly assailed



Hydra Viridis.

EXPLANATION OF PLATE.

Fig. 17. *Hydra viridis*, expanding its tentacles, × 29 *diam.*

Fig. 18. Tentacles and mouth *H. viridis* 5 minutes after being cut from the body, × 29 *diam.*

Fig. 19. Part of transverse section of body (after Kleinenberg), × 67 *diam.*

Fig. 20. Transverse section of ectoderm (after Kleinenberg), × 166 *diam.*

Fig. 21. Neuro-muscle cells (after Kleinenberg), × 166 *diam.*

Fig. 22. Nemato cyst or thread cell, × 200 *diam.*

Fig. 23. *Hydra viridis* with parasitic trichodinæ, × 29 *diam.*

Fig. 24. *Trichodina pediculus* Ehr., lateral view, × 150 *diam.*

Fig. 25. *Trichodina pediculus* Ehr., under side, × 150 *diam.*

Fig. 26. *Hydra* copied from original drawing of Leenwenhoek.*

ABBREVIATIONS USED IN ALL THE FIGURES.

Ec. Ectoderm.
En. Endoderm.
S. C. Spermatic Capsule=testis.
O. Ovary.
Me. Nerve muscle cells.
It. Interstitial layer of cells at base of ectoderm.

*From photograph by author, from original paper in *Philosophical Transactions*.

by Prof. E. Ray Lankester and others, but is still strenuously upheld by some observers. Dr. Hamann, in recently published observations, agrees with Brandt that whenever chlorophyll is present in animals we have to do with independent unicellular algæ. He states positively that he has removed the green bodies from *H. viridis* and has cultivated them in water, where they grew vigorously and multiplied rapidly by repeated division. In the same journal in which these results are given (Zeitschr. wiss. Zool., xxxvii. p. 457), a directly opposite view is advocated by Marshall, who kept a green *Hydra* for 6 weeks in the dark without any change in these granules being perceptible. He therefore concludes that they are not algæ but characteristic of the animal itself. The question is evidently still attracting considerable attention.

The outer membrane of *Hydra*, the ectoderm (fig. 19 E. c.), is a somewhat more complex structure. Kleinenberg finds that externally it is composed of a layer of large cells of nucleated protoplasm. Below these and running up between them are numbers of small cells with comparatively very large nuclei, constituting what he names the interstitial tissue, (fig. 20 i. t.), in which the so-called nematocysts (or thread cells) and also the reproductive bodies are formed.

Finally, beneath these and in contact with the endodermal layer is a narrow, clear zone, in which contractile fibrillæ are imbedded (figs. 19 and 20 m. L.) Kleinenberg makes the very important statement that these fibrillæ are processes of or extensions from the above-mentioned layer of large external cells. That is to say, the ectodermal cells taper towards the endoderm, being prolonged into fine processes which frequently divide, and when these processes meet the endodermal layer they bend sharply at right angles and run parallel with the long axis of the body (fig. 21). These fibres are bound together by a soft, colorless connective tissue into a thin membrane which is everywhere interposed between the endodermal and ectodermal layers.

The careful and ingenious experiments of Kleinenberg and others leave scarcely a doubt that it is to this thin layer of so-called 'muscle processes' that the great contractibility of *Hydra* is solely due. And while the muscle processes are highly contractile, the large ectodermal cells of which these processes are mere continuations remain perfectly passive. Therefore the entire cell can certainly not be called a muscle cell. How, then, is it to be regarded? Kleinenberg thinks the only logical conclusion to be arrived at is to consider these ectodermal cells of *Hydra*, for which he proposes the name of 'neuro-muscle cells,' as the lowest developmental stage of the nervous and muscular systems which has yet been discovered, the component parts of nerve and muscle not having yet been differentiated as in the case of the higher animals, but each single cell exercising a double function, inasmuch as the long processes contract and act as muscle, whereas the cell-bodies from which they emanate act as motor-nerves by receiving a stimulus from the surrounding medium and transmitting this to the fine processes, causing these to contract. He points out that nerve and muscle are always coexistent; that they are functionally dependent upon each other; that *Hydra* shows absolutely no trace of a separate nervous system, but it *does* possess a muscular tissue in the shape of contractile fibres, which fibres are, however, only the prolongations of the large ectodermal cells. The latter are demonstrably *not* contractile. They form the entire external boundary of the animal. All outside impulses, therefore, can only reach the muscular layer by striking the external non-contractile cells and being transmitted by them. He therefore believes the neuro-muscle cell of *Hydra* to be the starting

point from which diverge the complicated nervous and muscular systems of higher animals.

It remains to be seen whether or not this certainly brilliant and attractive theory will stand the test of additional research, but it is impossible to withhold admiration for its ingenuity, or to deny its importance, especially in its bearing upon the question of nerve-terminations, and that of the evolution of nerve and muscle.

The curious nematocysts or thread-cells (fig. 22), to which a benumbing property has been ascribed by most observers, originate in the interstitial tissue, but as they become mature they are pushed towards the surface of the ectoderm. Each consists of an oval capsule, coiled within which is a delicate spiral elastic filament, provided with 4 short recurved spines. This can be suddenly unrolled with considerable force, and by its projection into the body of the polype's prey it is supposed that the latter is frequently benumbed so that its capture by the tentacles is rendered easier.

At certain seasons of the year the reproductive organs of *Hydra* may be observed. They consist of spermatic capsules and of ovaria. The first of these arise as conical whitish elevations from the body wall, just below the circle of tentacles (fig. 17, s. c.) They are usually from 2 to 5 in number, but in some abnormal cases as many as 20 have been observed. In them are formed the ciliated spermatozoa which are subsequently ejected through the apex of the capsule at about the same time that the egg is extruded from the ovarium.

Like the spermatic capsules, the ovarium (for in *H. viridis* there is usually but one) is formed in the interstitial cells of the ectoderm, but nearer the fixed extremity, appearing as a large round protuberance. (It is shown just beginning to form at o, fig. 17). With only very rare exceptions both sets of organs are formed upon the same individual, the spermatic capsules generally being developed first. When the ovarium has reached a certain stage, the soft protoplasm of the enclosed egg gradually exudes from an aperture in the apex of the investing membrane (still remaining attached, however, to the ovarium), and is then fertilized by the spermatozoa which, about this time, issue from their capsules. The process of segmentation then sets in, and a thick, hard shell is secreted in about 4 days. After the formation of the shell, the egg severs its connection with the parent *Hydra* and sinks to the bottom. The boundaries of the contained cell walls gradually disappear, and by a curious apparent retrogression the contents of the egg are once more a continuous mass of protoplasm. In this is formed a cavity which ultimately becomes the body-cavity of the young *Hydra*. The succeeding stages of development are slower, and finally, usually in 6–8 weeks from the secretion of the shell, the young animal is liberated, closely resembling the parent in everything except size. It will thus be seen that *Hydra* has no larval stage, differing in this respect from all other hydroids. During the period of embryonal development, a great mortality is caused by the growth of the mycelium of fungi, by the spores of which the naked egg has been infected. Out of 1,500 eggs gathered and studied by Kleinenberg, about 1,100 were destroyed in this manner. These figures are also interesting as an indication of the persistent industry of this investigator.

Hydra also multiplies by gemmation, a process strikingly analogous to that of 'budding' in plants. A little swelling on its body surface gradually elongates, at the free end a mouth is formed, below which is developed the crown of tentacles, and thus a young *Hydra* makes its appearance, the entire process being usually completed in a few days. (See fig. 17). The communication

between its body-cavity and that of the parent is at first uninterrupted, and food captured by either individual seems to be appropriated by both. Gradually, however, a constriction occurs at the point of contact, and finally complete separation ensues. Very frequently several young *Hydræ* are attached to the parent, and buds are in turn often developed on these before they leave the parent stem. Carpenter copies an old figure from Trembley's work in which an individual of *H. fusca* is shown with no less than nineteen young polypes attached in various stages of development. Kleinenberg has made the interesting observation that where an individual of *H. viridis*, with a numerous progeny attached, was placed in a glass containing very little food-material, in the course of a few weeks first the bodies and then the tentacles of the young animals were re-absorbed by the parent *Hydra*.

Of all the many marvelous properties possessed by this remarkable little organism perhaps the most extraordinary is its power of reproducing lost parts. The researches of Trembley and Baker on this peculiarity are even at this date well worthy of perusal. To quote from one authority :— 'If the body be cut into two or more —even into forty—parts, each portion continues to live and develop a perfect new animal. If the section be made lengthwise, so as to divide the body, all but the end, the two portions become re-soldered, and form a perfect being; if the pieces be kept asunder, each becomes a *Hydra*, the two possessing but one posterior end; if the section be made towards the head, the two bodies will be perfected and remain attached to the one head If a tentacle be cut off, a new animal is formed from it. When one end of the body of a *Hydra* is introduced into another, the two unite and form one; the head cut off one may be engrafted upon the body of another which wants one; and when the body is turned inside out, the outer surface, which has thus become the inner, will perform the ordinary digestive functions, and the animal will continue to live.'

Most of these statements have been verified times without number, but the correctness of the last one (referring to turning the *Hydra* inside out) seems to lack confirmation, although the experiment is described at considerable length by Trembley, who was certainly otherwise a careful observer. A Japanese naturalist, Prof. Mitsikuri, is reported to have recently succeeded in verifying Trembley's experiment, but all other investigators appear to have completely failed therein; and it certainly seems to me that, in view of the strongly-marked difference in character and function between the endoderm and ectoderm, a forcible reversal of the relative position of these layers would make the assimilation of food absolutely impossible, and would, therefore, inevitably result in the speedy death of the polype.

As might be expected in the case of an animal whose vital powers are so phenomenal, abnormal growths of *Hydra* are of frequent occurrence. Double rows of tentacles, loops in the body, 'Y' shaped tentacles, &c., have often been seen.

Hydra is frequently found infested by large numbers of small ciliated infusoria, viz :—*Trichodina pediculus*, Ehr. (fig. 23). They either adhere closely to the body and tentacles of the polype or glide rapidly to and fro over those surfaces, unaffected by the stinging organs or by the contractile movements of their host. Most authorities state that their presence is not detrimental to *Hydra*, but I have invariably found that when the latter was thus infested it did not thrive well. Another infusorian, *Kerona polyporum*, is frequently found similarly infesting the polype.

The geographical distribution of *Hydra* is known to be very wide. Certainly throughout the temperate zones this interesting organism is plentifully found in suitable localities.

Probably its favorite habitat is on the radicles of the lesser duck-weed (*Lemna minor*). I have also found it quite often on *Vaucheria*, and occasionally on other algæ. It is distinctly visible to the unaided eye, and after having once been pointed out it will ever afterwards be easily recognized. I have only succeeded in finding two species in California, *H. viridis* and *H. vulgaris*, and these appear absolutely identical with those species as found in the Eastern States and in Europe. Mr. King, of Santa Rosa, reports having found *H. fusca* recently in Mark West creek.

The little 'plant animal' which we have been considering to-night has been a celebrity in the scientific world for nearly a century and a half. Nor is this to be wondered at, for in the whole range of microscopic life there are few, if any, animals possessing equally attractive features to the investigator. Its graceful movements and interesting food-habits, its comparatively simple structure, its plant-like appearance, its wonderful methods of reproduction, and the important light which many facts in its histology have thrown upon the elucidation of structure in the higher animals, all invite attention and study. Nowhere is more strongly illustrated the practically inexhaustible nature of microscopical research, for, notwithstanding the fact that *Hydra* has been the subject of continued observation since the days of Leenwenhoek and Trembley, yet even its latest investigators, while adding to our knowledge, have also opened up a new series of questions calling for additional patient search, improved methods of study, and increased optical facilities. We may rest assured, therefore, that although *Hydra* was one of the very first 'revelations of the microscope,' it will nevertheless be profitably studied as long as that magic lens has a single devotee.

New Members of the Infusorial Order Choano-Flagellata. S. K.—IV.

BY DR. ALFRED C. STOKES.

Monosiga limnobia, sp. nov.—Fig. 1.

Body broadly obovate or top-shaped, somewhat changeable in form, longer than wide, tapering posteriorly to the pedicle; flagellum long; pedicle three to four times the length of the body; contractile vesicles, two, oppositely situated near the centre of the lateral borders. Length of body $\frac{1}{250}$ inch. Habitat.—Pond water. Solitary.

This form, aside from its distinctive shape, may be readily recognized by the unusual equatorial position of the contractile vesicles, these being commonly located near to the posterior extremity.

In respect to its habitat it seems somewhat careless. It was first obtained from pond water that, with *Proserpinaca* and other aquatic plants, had been standing for several months in an aquarium; it was again taken from the fresh waters of a deep pond in early spring, and again on *Utricularia* from the cedar swamps of the New Jersey pine barrens. In all these localities it retained its characteristic form, its solitary life, and the distinctive position of the contractile vesicles. The rich color of the cedar-swamp water had not altered the peculiar pale-green tint so noticeable in the endoplasm of *Monosiga* as well as in the members of the allied genera.

Salpingœca eurystoma, sp. nov. Fig. 2.

Lorica vase-shaped, about one and one-half times as long as broad, somewhat inflated centrally, thence tapering posteriorly to the pedicle; anteriorly constricted, and thence rapidly expanding to the aperture, which forms the widest part, its margins strongly and conspicuously everted; pedicle subequal to the lorica in length; enclosed animalcule ovate or sub-pyriform, occasionally connected with the lorica by a fine posteriorly

developed ligament; contractile vesicles, two. Length of lorica $\frac{1}{2\,6\,0\,0}$ inch; width of the anterior aperture $\frac{1}{3\,0\,0\,0}$ inch. Habitat.—Pond water; on filamentous algæ or other fine vegetable fibres. Solitary or scattered.

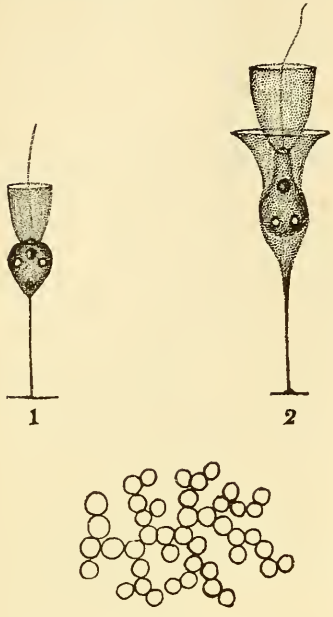


Fig. 27.—New Fresh-Water Infusoria.

Five individuals of this easily recognizable species have been observed attached at almost equidistant points to a vegetal fibre. These constitute the entire number thus far noticed, and even these few seem somewhat variable in two characters. With two individuals the enclosed zooid was connected with the lorica by a posteriorly developed ligament; in one the lorica was at its hindmost border so suddenly tapered that the pedicle seemed a delicate solid stem, while in the remaining four the lorica was apparently continued for about one-half the entire length of the stem by means of a hollow gradually-narrowing footstalk. As this was the prevailing condition in the few observed, it is shown in fig. 2.

Desmarella irregularis, sp. nov.
Fig. 3; diagram.

Bodies ovate, constricted beneath the insertion of the membranous collar, somewhat gibbous, scarcely changeable in shape; laterally united into irregular colonies formed of as many as fifty individual zooids, the external or superior surface usually being unevenly convex and the periphery more or less circular, the clusters frequently separating into smaller companies and remaining temporarily attached through the intermedium of one or more extremely fine filaments; flagellum five or six times as long as the body; contractile vesicles, two, opposite, near the centre of the lateral borders; nucleus single, spherical, subcentrally situated; endoplasm granular. Length of body $\frac{1}{2\,5\,0}$ to $\frac{1}{3\,0\,0\,0}$ inch. Habitat.—Pond water. Movements not rapid.

This previously undescribed form, the first member of the genus thus far obtained from American waters, is remarkable for several characteristics. Its compound colonies are noteworthy in respect to the number of individual animalcules composing them, as many as fifty having been observed in a single irregularly extended and somewhat convex cluster. The individual zooids are united either by the direct contact of their lateral borders at a single point of contact, or through the intermedium of a very short extension on each side of the body. It is probably this usually inconspicuous portion which is drawn out into the fine thread-like extension of the sarcode when the original colony-stock separates in two parts, the filaments eventually breaking and the clusters then floating independently of each other. These partially separated portions increase the irregular appearance so noticeable in most of the colonies. The flagellum of each zooid is of extraordinary length, and often distally bulbous.

Explanation of Fig. 27.

1. *Mono siga limnobia.* 2. *Salpingœca eurystoma.* 3. Cluster of *Desmarella irregularis.*

The change of shape in the present species consists chiefly in the assumption of a subspherical contour, after prolonged confinement beneath the cover-glass. At other times the alteration is very slight.

In all the Choano-Flagellata, so far as I am aware, excrementitious fragments are extruded, and food-particles are engulfed at some point within the area surrounded by the base of the collar, the collar itself presenting two distinct currents of its substance, an external upward and an internal downward one, the latter conveying the food-particles directly to the ingestive region. With the present species of *Desmarella*, however, while the excrementitious matters are expelled from the space within the base of the collar, the food is engulfed at a point near the basal attachment of that appendage but external to it, a wave of the body sarcode advancing to receive and surround the adherent morsel. The external current of the collar-like film is here the reverse of that which obtains in the species of the other genera of this order, as is evidenced by the movement which slowly carries the adherent particle downward toward the body, but that the internal flow is upward, as is probable and almost a necessity under the circumstances, I have not been able to positively see, since the floating materials so soon come within the influence of the whirling flagellum. This peculiarity in food habit is an important and interesting characteristic of this species at least; it is probably an unobserved custom in all the members of the genus.

The colonies were abundant in the water collected from a shallow pond in the early part of December, 1885, and left standing in a warm room. Their movements are rotary, and comparatively slow.

The species differs from *Desmarella phalanx* (Stein) S. K., the hitherto only known fresh-water form, in the general aspect of the colony, that of the former resembling *D. moniliformis*, S. K., in being composed of zooids laterally united in long chains. A cluster of the species here described is represented by the diagram shown in fig. 3, each little ring there representing one zooid.

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Imbedding in Celloidine.

For the benefit of those of our readers who have not seen accounts of the method employed in the use of celloidine for section-cutting we copy the following accounts from (I) Sedgwick & Wilson's Biology* and from (II) Prof. C. S. Minot's Notes on Histological Technique.†

I. The celloidine method is especially applicable to delicate vegetal tissues. After dehydrating the object thoroughly in alcohol, soak it 24 hours in a mixture of equal parts of alcohol and ether. Make a thick solution of celloidine in the same mixture and soak the object for some hours in it. It may then be imbedded as follows:—Dip the smaller end of a tapering cork in the celloidine solution, allow it to dry for a moment (blowing on it if necessary), and then build upon it a mass of celloidine, allowing it to dry for a moment after each addition. Transfer the object to the cork and cover it thoroughly with the celloidine. Then float the cork in 82–85 per cent. alcohol until the mass has a firm consistency (24 h.). It must then be cut in the microtome with the oblique knife, which must be kept dripping with 82–85 per cent. alcohol. Keep the sections in 82–85 per cent. alcohol until ready to mount them; then soak them for a minute in strong alcohol, transfer to a slide, pour on chloroform until the alcohol is removed, drain off the liquid, quickly add a drop of balsam, and cover.

II. Prof. Minot, in his 'Notes,' says:—

* Page 189.
† Zeitsche f. w. Mikros., vol. iii, p. 174.

For imbedding are needed—

a. Mixture of equal parts of ether and alcohol.

b. A thin solution of celloidine in *a*. This solution should be syrupy and flow easily.

c. A thick solution of celloidine in *a*, of about the consistency of thick molasses.

d. An imbedding-box, made by fastening a roll of paper around a cylindrical cork with a pin.

e. A sinker, which may be conveniently made by casting a piece of lead around a wire nail.

f. Alcohol of 80 to 85 per cent.

In regard to these, all of which are in familiar use, the following points may be noted :—The mixture of ether and alcohol is very difficult to keep, and ought to be renewed every few days, because of the loss of ether. For the same reason the celloidine solutions are best used fresh ; accordingly, when from the loss of ether the solution begins to turn unclear or milky, it may be poured out and allowed to dry completely, and then redissolved. Dirt may be removed from the solution by settling and decantation. The imbedding box is like that recommended by Blochmann ;* is is, however, unnecessary to roughen the cork, and it is advantageous to cover the end, which makes the bottom of the box, with celloidine. The celloidine ought to be thoroughly dried before the cork is used, so as to form a firm coat to prevent the air in the cork from escaping to form bubbles in the celloidine. The box should be considerably deeper than the specimen, so that when the latter is imbedded half or three-quarters of an inch of celloidine shall cover it, so as to allow room above the specimen for the bubbles to accumulate, which form during the hardening in alcohol. It is convenient to make the sinker with a flat bottom. The alcohol for hardening should be as cold as possible, for the bubbles in the celloidine are apparently due to the too rapid extraction of the ether ; their formation is certainly hindered by lowering the temperature.

Mounting celloidine sections. For clarifying celloidine sections, various essential oils have been recommended, but none of them are entirely satisfactory so far as we have tried them, for they either attack the celloidine-like oil of cloves, or cause it to pucker like oil of origanum.

Chloroform works much more satisfactorily. If the sections are thoroughly dehydrated in 96% alcohol, they will clear up almost instantly ; if they are not quite thoroughly dehydrated, a little cloudiness appears, and the celloidine puckers considerably. Alcohol stronger than 96%, or weaker than 95%, ought not to be used for this purpose.

Much more satisfactory is a mixture, for which we are indebted to Dr. E. K. Dunham, communicated with his consent. This mixture is three parts of white oil of thyme with one part of oil of cloves. I am inclined to think that 4 : 1 may prove an even better proportion. The mixture clarifies the sections very readily and softens the celloidine just enough to prevent the puckering, which is so annoying with the thyme alone. Dr. Dunham has certainly made a very welcome addition to the technique of the celloidine method.

To mount the series of celloidine sections, I venture to unreservedly recommend the following method:—The fastening of the sections to the slide with shellac. The sections, as they are cut, are placed in numbered dishes to preserve their order ; they are then stained, either all alike or, as is often advantageous, by various methods ; dehydrade thoroughly in alcohol ; place the sections on the slide in the desired order, keeping them covered with alcohol ; when they are arranged the alcohol is drained off by tilting the slide. It is necessary that the sections on the

* Zietsch. f. w. Mikros., i, p. 226.

slide should be readily dehydrated; hence it is sometimes necessary to wash them again with fresh 96 per cent. alcohol as they lie upon the slide. The sections are now well covered with a perfectly clear 10 to 12 per cent. solution of refined shellac, and the slide at once exposed to a gentle warmth (30°–40° C.) until the shellac is completely dried. It is possible to mount the preparations at once in fluid balsam, but I find it more convenient, on account of the greater certainty of escaping air bubbles, to clear up the shellaced specimen with oil of cloves, (other essential oils may be used as well). The oil may be removed in the ordinary manner, by cigarette paper, all the more readily because the preparation will stand pretty rough handling. The oil of cloves ought not to be left on the slide for more than half an hour, as it gradually softens the shellac.

The shellac used should be that known as 'refined,' which gives a perfectly clear solution. The sections should be thoroughly covered, and the thicker they are the more shellac is required. If sufficient shellac is used, the finest histological details are preserved, so far as I have been able to observe, unaltered during the drying process. Without enough shellac, ruinous shrinkage occurs. If the sections were imperfectly dehydrated there appear opaque whitish spots in them after the drying. In this case wash the slide over with 96 per cent. alcohol until the opaque spots have disappeared; drain off the alcohol by tilting the slide, add a little fresh shellac and dry again; if necessary, repeat the process until the dried specimen has no trace of cloudiness.

This shellac method has other applications. It can, of course, be applied to ordinary sections from which the imbedding substance has been removed. It is, however, particularly serviceable for mounting teased preparations, isolated cells, and small organisms. These may be transferred from alcohol to shellac, and after they have been arranged in the latter on the slide in such positions as may be desired, the preparation is dried, and the mounting may then be accomplished without the fragments moving from their place.

——o——

Appochromatic Objectives and Compensating and Projection Eye-Pieces.

FROM DR. C. ZEISS' CATALOGUE.*

In the construction of the appochromatic objectives new glass and greatly improved methods of correction have been employed, so that there is a far more perfect concentration of the rays than heretofore, and, in the case of the chemically effective rays, there is neither focal difference nor spherical aberration.

They also allow very high eye-pieces to be used without detriment to the accuracy or brightness of the image, thus giving high magnifying power with relatively long focal length, and enabling a series of amplifications to be obtained with the same objective.

The natural colors of objects, even in the more delicate tints, are reproduced unaltered by these objectives, in consequence of the very slight intensity of the residual tertiary spectrum. The spherical aberration outside the axis is so completely corrected that the sharpness of outline existing in the centre of the field of view is maintained almost up to the margin, although the focal adjustment between the centre and margins is necessarily somewhat different in consequence of the unavoidable curvature of the surface of the image.

The construction of each objective is based on calculations which extend to the smallest details of optical action. Every element, radii of curvature, thickness, diameter, and distance of lenses from one another, are all accurately adjusted and numerically determined for each objective, with re-

* Copied from article in Journ. R. Micr. Soc., 1886 p. 849.

gard to the spectrometrical constants of the various kinds of glass employed, and the numerous conditions which have to be simultaneously fulfilled. The technical execution is carried out exactly on the data furnished by these calculations, with the strictest check on all the elements in the various stages of manufacture, and without any subsequent empirical touching up.

In the test given below the objectives are given according to their aperture. In the second column are the different focal lengths, while the third column gives the corresponding amplification obtained with the objective (the quotient of the conventional distance of distinct vision, 250 mm., divided by the focal length of the objective).

The objectives are constructed according to order, either for the Continental length of tube of 160 mm. or for the English of 250 mm. (or 10 in.) The three dry objectives, of 6–12 and 24 mm., focal length, are, however, made exclusively for the English tube-length, as these objectives are not adapted for the Continental form. The tube-length is measured from the upper surface of the setting of the objective to the upper margin of the body-tube on which the eye-piece rests.

Great care must be taken to preserve the correct tube-length, as any deviation materially injures the performance of the objectives, particularly those for homogeneous immersion.

The settings of all objectives are engraved with the name of the firm and also with the aperture, focal length, and length of the body-tube for which they are adjusted. In ordering it is desirable that these three points should be specified, so as to avoid any mistake as to the particular objective required; (thus: appochrom., 1.30–2.0 mm., short tube).

The apertures are the guaranteed minimum values; the real aperture is nearly always rather higher. The focal lengths are exactly as stated:—

	Num'cal Ap'rt'e.	*Equivalent focal lgth. in mm.*	*Objective Magnification for 250 mm.*
Dry.....	0.30	24.0	10.5
		16.0	15.5
	.60	12.0	21
		8.0	31
	.95	6.0	42
		4.0	63
Water immersion	1.25	2.5	100
Hom. immer.	1.30	3.0	83
		2.0	125
	1.40	3.0	83
		2.0	125

The dry objectives of 0.95 aperture and the water immersions are always provided with correction-collars. The divisions on the collar give the thickness of cover-glass in hundredths of a millimeter. The correction for the proper thickness of cover must always be carefully made when using these objectives, or otherwise there will be a considerable falling off in their performance.

The homogeneous immersion objectives are only supplied in fixed settings, as any alteration in the distance of their lenses interferes with the perfection of the correction. Slight variations in the thickness of the covers from the medium value, 0.16 mm., for which the objectives are corrected, have no influence on the image, but considerable variations should be compensated for by slightly lengthening the body tube with thinner covers and shortening it with thicker ones.

The slightly thickened cedar-oil ($\eta_D = 1.515$) accompanying the objectives (and to be obtained at any subsequent time) should alone be used. Other substances should not be employed unless measurements of the refractive index and dispersion show exact correspondence with it. Mixtures of fennel oil and such like endanger the objective.

To meet the desire for the highest possible objective magnification the homogeneous immersions are also made with a shorter focal length of 2 mm., as well as with one of 3 mm., although it must still be regarded as an open question whether any decided advantage can be gained by the former. The impassable barrier to the increase

of useful magnifying power, which is fixed by the limit of aperture at present attainable, can already be reached, without loss, by an objective of the focal length of 3 mm., as the latter objective will bear the application of correspondingly higher eyepieces without any appreciable detriment to its performance.

The objectives (homogeneous immersion) of 1.30 aperture have so great a working distance that they will work through covers more than 0.3 mm. in thickness. With an aperture of 1.40 the working distance is reduced to 0.25 mm. These objectives require very careful handling, because, in order to obtain the larger aperture, the metal setting of the front lens has to be turned extraordinarily thin, so that any blow or strong pressure upon the front objective is likely to injure it. For both reasons, therefore, the objectives with the slightly lower aperture are undoubtedly more convenient for regular use. The larger aperture will, however, of course allow of a rather higher degree of optical performance being reached.

No attempt is made to exceed an aperture of 1.40, as the small percentage of possible increase would render the objectives almost valueless for any scientific investigation.

With regard to the price of objectives which, especially in the case of the dry series, may appear to be very high in comparison with the usual charges, it must be borne in mind that the appochromatics are far more complicated in their construction, and if their special qualities are to be maintained, they must be far more difficult to manufacture than the ordinary objectives. Moreover, the number of such objectives manufactured must be extremely limited, even with the resources of a large factory. The objectives, however, like all the productions of our firm, stand on an absolutely free basis. The glass employed is, by our instrumentality, accessible to any one, and no optician is, in the least degree, prevented from producing the same objectives as good and as cheap as he can.

[*To be continued.*]

EDITORIAL.

Publisher's Notices.—All communications, exchanges, etc., should be addressed to Henry Leslie Osborn, Lafayette, Indiana, Purdue University.

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The regular receipt of the JOURNAL, which is issued on the 15th of each month, will be an acknowledgment of payment.

The first volume, 1880, is entirely out of print. The succeeding volumes will be sent by the publisher for the prices given below, which are net.

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TO OUR READERS.—With this number the *Journal* closes its seventh volume and enters upon a new volume and a new year. As our readers are well aware the former editor, Prof. Romyn Hitchcock, who has managed it from the start and brought it to its present good repute, is now far away in Japan. He watches it still with the deepest interest, but from afar.

His absence from this country for an indefinite period rendered it necessary that the *Journal* should pass into the permanent charge of those who would treat it as their own. Early in the present year its business interests were placed in the hands of Mr. Rufus W. Deering, of Washington, D. C., who will still control its entire business arrangements and keep the office of publication at Washington. During the past summer we undertook, temporarily, the editorial charge pending the adjustment of certain details, and are now happy to announce that the present arrangement

has been made a permanent one, thus making the future responsibility of conducting the *Journal* entirely our own. Work at Purdue University, Lafayette, Ind., requires a residence there from September until June, but this will not interfere with the regularity of publication or impair our usefulness in any way.

We watched with interest the progress of this *Journal* when entirely unconnected with it, and have found from the first that it maintained a high stand. Its aim has been to inform of the things useful or necessary to those who use the microscope, results of microscopical studies, detailed information, matters of technique, scientific notes and news. It has been made a valuable and authentic medium of information on microscopical matters. Of its admirable success its readers are already aware.

Our intention is to continue in the future to manage the *Journal* on the same principle. We understand the microscope to be an instrument for investigation, and shall in editing it bring together from all sources at our command all matters which are likely to be most helpful to those who, like ourself, are its users. Our readers must decide how well we are succeeding in this. We recognize the fact that a mass of valuable information exists out of reach of most readers which ought to be collected and set forth in the most available shape. We are happy also to realize that in our attempt we are to be seconded by the sympathy and aid of the old contributors, with most of whom we have personally corresponded, and we are gratified to feel that they extend to us the confidence they exhibited in the former editor both by personal assurance and by their contributed articles.

Our readers want to know what to expect for another year, and we may say in general that we shall not depart widely from the course we have pursued in the past four numbers. We shall be able to present from time to time articles from Prof. Hitchcock, who has promised to send us much that will be interesting from Japan. Almost all our old contributors have been personally corresponded with and willingly assured us to expect their articles as heretofore, and many new ones have promised their help. We shall present in the form of brief abstracts some of the most important results of investigation in biological and other science so far as they are not too special for our columns, giving due prominence to those which include new and helpful methods in the use of the microscope. We intend also to especially emphasize in the *Journal* the collation of new items upon technique, in which new histological methods, both vegetable and animal, shall be described in the plainest possible language. Thus volume viii, when complete and indexed, will be a valuable record of the year's work in microscopical science and as well a practical guide in the details of histological work.

Our want at present is a wider circulation and more contributors. With these two wants satisfied we are confident that we can enlarge and extend very much the usefulness of the *Journal*. It is firmly established upon its present basis, but we want to enlarge it and especially to be able to attract to it a larger number of well illustrated original articles. This we feel certain of being able to do if we can find the means for publication. We urge each one of our subscribers to give us their substantial support by the prompt renewal of their subscriptions, and request them to recommend us, as they can, any who may become subscribers. We need a hearty backing, and with that we can promise a good number every month.

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Rhizopods of Fresh Water.—Two contributions to the literature of the rhizopods from the pen of Surgeon-Major Wallich, M. D., of England, were published in the *Annals of Natural History* last year,

for separate prints of which we are indebted to the author, that are worthy of careful attention.

The first is entitled, 'Critical Notes on Dr. A. Gruber's Contributions to the Knowledge of the Amœbæ,' which has already been noticed in these columns. It will be remembered that Dr. Gruber put forward certain views relative to the nuclei and their importance in the discrimination of species, and discussed the general structure of these organisms. Dr. Wallich reviews the article of Dr. Gruber at some length, and criticises his conclusions. As regards nuclei, Dr. Wallich considers that their number may vary to 'any moderate extent,' and cites the case of *Arcella vulgaris*, which sometimes shows several nuclei; in one specimen six were distinctly seen. This specimen had also nine peripheral contractile vesicles. In the main, however, Dr. Gruber's observations in regard to the relations of endosarc and ectosarc and the phenomena of movement have led him to conclusions quite in accord with those held by Dr. Wallich, and by him published long ago.

The second contribution is entitled, 'Critical Observations on Prof. Leidy's "Fresh-Water Rhizopods of North America," and Classification of the Rhizopods in General.' This is an interesting review of some of the literature pertaining to the subject, but it is too lengthy for satisfactory notice here. We can only allude to a few of the criticisms which the author makes of Prof. Leidy's excellent work.

Dr. Wallich first maintains that he had fully established the presence of both a nucleus and a contractile vesicle in *Gromia*, and that he no longer regarded it as a typical reticularian form, but as early as 1865 had shown that it belonged to the highest type of rhizopod structure.

Through a very curious and unfortunate misapprehension, Dr. Leidy seems to have mistaken Dr. Wallich's account of the varieties of *Difflugia proteiformis* and *D. pyriformis* which were described in 1864. Dr. Leidy refers these forms to *Nebela*, and alludes to them as 'described as transition forms of *D. symmetrica*,' although Dr. Wallich did not so describe them. Evidently there has been an error, and a very curious one.

Dr. Wallich does not approve of the generic distinction *Quadrula*, the only species of which is *Q. symmetrica*, Leidy. He maintains that the species so named is identical with his *Difflugia symmetrica*. Moreover, Dr. Wallich doubts the value of the many specific distinctions which Prof. Leidy makes under the genus *Difflugia*, and considers that the seven types of the genus described by himself include also all of Prof. Leidy's *Nebelæ*.

The discussion of the relations of the rhizopod tests, and their significance in classification, cannot be satisfactorily treated in this place. Dr. Wallich has presented the subject in a masterly manner, and we must refer the reader to his article. We especially commend this subject to the consideration of observers. Certainly the innumerable variety in form and texture of the tests cannot afford a sufficient character for distinguishing species, even in such a blind and artificial system of classification as we now have for the rhizopods. Consider the Foraminifera for a moment. What great variations in the shells we find among them, yet how closely they are related in plan of growth. External form can only be regarded as a specific feature when we discover it to be reasonably constant under different conditions; and even then it is only a convenient character for purposes of description and recognition of forms. H.

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Prof. Hitchcock has informed us that he desires to change the conjecture of his in the letter 'Jottings by the Way,' September number of this

Journal, p. 175, the creatures being not the Nautilus, as he at first supposed, but probably a species of *Velella*.

NOTES.

— Mr. Debes recommends the cultivation of diatoms for biological purposes. The collections should be placed in a cool, airy place, shielded from the sun, and only provided with a very small supply of water. It is better to keep them only thoroughly moistened, for with more water, unless it be constantly changed, fungi are likely to grow and the culture becomes turbid and foul. Cultures may be continued for months and years, success depending largely upon the proper regulation of the supply of water. It has been observed that in most cultures the species change, new forms at first only found singly, replace the originally most abundant species, but after a while these disappear and are in turn replaced by their predecessors.—H.

— Mr. E. W. Holway has sent us a well-made photograph of a spider's foot. Such exceedingly yellow specimens as the spider's foot usually is, are difficult subjects to photograph, requiring long exposure and restrained development to bring out the detail. The one before us was taken with a ⅔ objective, A ocular and achromatic condenser used with a bull's-eye and blue and ground-glass shades, and received an exposure of 18 seconds. Mr. Holway states that he has had some difficulty in photographing fungus spores — some of them photograph well, while others do not. We do not know why there should be any such discrepancy of results. Perhaps some reader can explain it.—H.

— We believe it will be doing a service to pharmacy to call attention to the fact that a really efficient compound microscope may now be had at a cost considerably less than it has been possible to obtain one heretofore. The Chicago College of Pharmacy has recently imported twenty additional instruments from E. Leitz, Wetzlar, Saxony, which we have carefully examined. They are really efficient, honestly made instruments, capable, we believe, of answering all the ordinary needs of the pharmacist, and the price for which they may be had at retail, $25, seems to us as low as is possible to produce a really good instrument. The stand is, of course, very simple, but firm and well made. It has a plain brass stage with spring clips, a straight or unjointed back, a horse-shoe base, a good fine adjustment, a concave mirror, adjustable in two planes, one eye-piece and two objectives, one of the latter about equivalent to a two-thirds, and the other to a one-fifth, giving a range of magnifying powers of from about 50 to about 400 diameters. The objectives are of better quality than those ordinarily sold in the student series, the higher power easily resolving *Pleurosigma angulatum* by central light. The instruments are not now for sale in this city, or, so far as we know, in this country, but some of our enterprising opticians will probably soon keep them in stock.— *Western Druggist.*

— Speculations of physicists upon the size of atoms and molecules are now founded upon experimental data, and it is probable that the size of the ultimate atoms of matter is known to a very close approximation, and even their weight has been calculated. Not long ago we gave some results of calculations of this kind. Sir W. Thomson has found that the mean distance between the centres of contiguous molecules is between the $\frac{1}{10}$ and the $\frac{1}{200}$ of a millionth of a millimetre. Prof. G. J. Stoney has calculated the weight of a molecule of hydrogen to be a twenty-fifth grammet. Grammets are decimal divisions of a gramme, of which the first is a decigramme, the second a centigramme, etc.

— Mr. Walter Gardiner, who has been engaged in the study of the continuity of protoplasm in plant-cells for a number of years, has found valuable assistance in these investigations in the use of staining agents. The so-called 'intercellular protoplasm' of authors consists of mucilage, and is not protoplasm at all, although it stains like the latter with the usual agents. But he was able to distinguish the two substances by the use of methylene blue, which stains cell-walls and mucilage but does not stain protoplasm, and Hofmann's blue, which stains protoplasm and cell-wall but not mucilage.

— As an example of patient watching with the microscope we are much pleased to cite the recent researches of a lady, Miss Pereyaslavsteff, who is the director of the Sebastopol Zoological Station. She has succeeded in tracing the course of the development of several species of rotifers from the egg to the adult form by watch-

ing specimens under the microscope. The process occupies about three days from the laying of the egg, and during two nights the observer must not sleep, as constant watching is necessary for about thirty-six hours to follow the changes in the egg. Rotifers that do not survive confinement must be placed in watch-glasses to deposit their eggs, which are then placed under the microscope.

— Two new botanical journals have recently made their appearance in Italy, named, according to the fashion of *Linnæa*, *Grevillea* and *Hedwigia*, after two distinguished botanists—De Notaris and Malphighi. Three quarterly numbers have now been published of *Notarisia*, a journal devoted to the interests of phycology, issuing from Venice, and edited by Sigg. De Toni and Levi. A very useful feature in this publication is the list in each number of the phycological literature, and the descriptions of all new species published during the quarter. *Malpighia*, of which the first monthly number is issued, edited by Sigg. Borzi, Penzig, Pirotta, and published at Messina, is of a more general character. Besides reviews, short notices, and a bibliography, it contains articles 'On the Atomic Weights of Living Things,' by L. Errera; 'On the Structure of the Nictaries of *Erythronium dens Canis*,' by S. Caloni; 'On Soredial Sporidia of *Amphiloma Murorum*,' by A. Borzi; and 'Researches on a Species of *Aspergillus*,' by F. Morini.—*Nature*, p. 626, Oct. 28, 1886.

— We note the following announcement in *Zoologiescher Anzeiger*, Sept. 27th, 1886 :—Lehrbuch der Vergleichenden Microscopischen Anatomie, with reference to comparative histology and histogeny. By Dr. Hermann Fol. Lieferung I—The Technique of Microscopical Anatomy. Bogen, 1–13, with 1–84 figures in wood-cut. 1884. Price, 5 marks.

MICROSCOPICAL SOCIETIES.

San Francisco, Cal.

The annual reception tendered by the San Francisco Microscopical Society to its friends at Pioneer Hall, Saturday evening, Oct. 16, '86, proved to be a most enjoyable affair. Long lines of tables were ranged along three sides of the hall and on the platform. On these were placed forty-five microscopes (the largest number ever exhibited at any one time on this coast), embracing examples of the best work of such renowned opticians as Zentmayer, Ross, Beck, Zeiss, Crouch, Bausch & Lomb, Gundlach, Nachet, Bulloch, Baher, and others. Among the objectives used, in addition to the productions of the makers already named, were choice specimens of the skill of Tolles, Spencer, Powell & Leland, Hartnack, and Swift. Nearly all the lamps with the instruments were screened with Japanese shades, which not only produced a pretty effect, but added to the comfort of visitors and exhibitors by protecting their eyes from a glare of light. The list of guests comprised many of the prominent names in social and scientific circles of this vicinity, and the occasion was evidently a thoroughly enjoyable one to all concerned.

1. The first exhibitor on the list, Dr. C. P. Bates, showed an interesting slide of living infusoria, chiefly *Monadina*. The strange forms and erratic gyrations of these lowly organisms always prove attractive to observers. 2. At the next table the circulation of the blood was beautifully shown by Dr. J. M. Selfridge, in the mesentery of the living frog. 3. Crystals of gold and silver were displayed by George C. Hickox under his large Beck binocular. Some large fern-like crystals of gold were particularly admired. 4. E. J. Wickson showed a fine series of living scale insects under four excellent instruments. As the ravages of insect pests in this State are at present attracting so much attention, this exhibit was received with peculiar interest. The red orange scale (*Aspidiotus aurantiæ*) was a most striking object. 5. A. H. Breckenfeld exhibited the head of a jumping spider, whose six gleaming eyes gave it a peculiarly ferocious appearance; the head of a male wasp, showing the beautiful structure of the sucking lingua or tongue, and a slide of young oysters (rolling in fluid) to which polarized light imparted gorgeous hues. 6. The exhibit of Chas. W. Banks was, as usual, a large and varied one. An ingenious apparatus for showing the combustion of various metals in the electric arc received many admiring comments. Under another microscope were shown the brilliant effects produced by the passage of the electric spark through a film of loose carbon. It was one of the most effective displays in the line. A number of other attractive objects were shown by Mr. Banks, notably a fine slide of a brittle star-fish (*Ophiocoma neglecta*), beautifully shown under dark-field illumination. 7. At the next table Dr. J. H.

Stallard had a fine array of seven microscopes, under which were arranged slides illustrative of the structure of normal and also of diseased arteries. The various tissues had been skilfully differentiated by various staining processes, and the distinctive features of each slide were carefully explained by the exhibitor. 8. The elegantly-sculptured egg cases of the house-fly were shown by William Payzant, and their beauty was a revelation to most of the spectators. The same gentleman exhibited a slide of the pretty little 'brine shrimp' from the evaporating pans of the salt works near Alameda. 9. The next exhibitor, W. F. Myers, showed a slide on which the delicate and beautiful structure of the mosquito was effectively displayed. He also exhibited an attractive mount of red marine algæ. 10. L. M. King was announced to exhibit living rotifers, but at the last moment these were so disobliging as to die. In their place the slide contained a fine example of the larva of the day fly (*Ephemera vulgata*). 11. An exhibit resembling the most delicate frostwork was shown by A. S. Brackett. It consisted of the beautiful crystals of muriate of cocaine strikingly displayed on a dark ground. A neat placard, giving the name, derivation, uses, and chemical characteristics of this salt, was a commendable feature of this exhibit. 12. Perhaps the most unique object on the entire list was that shown by Prof. Hanks It was an insect of a species now extinct, perfectly preserved, without the least apparent distortion, in a block of amber, wherein it had rested for untold ages. As compared with this perfect specimen of nature's embalming the mummy of Egypt's most ancient king is a thing of yesterday. 13. Henry C. Hyde's exhibit consisted of the blood-red crystals of platino-cyanide of magnesium, selected diatoms shown with dark-ground illumination, and the resplendent scales of the Brazilian diamond beetle. A noteworthy feature of the exhibit was that each mount was illuminated by a minute electric incandescent lamp, attached to an arm with universal movement. The light was shown to be perfectly manageable, intense in quantity, and soft and pure as to quality. To the microscopists present this exhibit was of especial interest. 14. At the adjoining table the next exhibitor, Arthur M. Hickox, showed the crystal of brucine, using polarized light. Brucine is an alkaloid extracted from *Strychnos nux-vomica*, and its oddly arranged crystals polarize brilliantly. 15. Dr. Thomas Morffew exhibited a slide showing the perfection to which microscopic engraving on glass can be carried. He also showed one of Möller's wonderful 'Typen-Platten' of diatoms, the name of each being photographed beneath it. 16. The president of the Society, Dr. S. M. Mouser, showed a fine line of specimens of anatomical and pathological subjects. An injected ileum of the rat was much admired for its beauty. A slide of *Bacillus anthrax* was shown with one of the new Zeiss lenses made of the recently perfected optical glass. The crisp definition of this objective was particularly noticeable. 17. J. Z. Davis followed with several slides of vegetable sections which had been double-stained. The different layers of tissue were sharply defined and the coloring was brilliant. 18. A slide of *Bacillus tuberculosis* was the subject chosen by Dr. F. Riehl. Using a dry lens and an amplification of 275 diameters, the bacilli were shown with great clearness. 19. The absorption bands in the spectra of various colored solutions were shown by Professor Thomas Price with a micro-spectroscopic ocular. This method of testing has become of great value in many directions, notably the detection of blood-stains. The presence of almost inconceivably small particles of coloring matter can be made manifest by this instrument. 21. The last exhibitor was F. L. Howard, who showed a fine mount of the beautiful Polyzoan *Bicellaria ciliata*, using polariscopic illumination to produce the glowing tints so much admired. The ingeniously-contrived microscopic lamp of this exhibitor also received much favorable attention.

A. H. Breckenfeld, *Rec. Secr.*

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San Francisco, Cal.

The regular semi-monthly meeting was held at No. 120 Sutter street, last Wednesday evening, Nov. 10. Dr. S. M. Mouser occupied the chair.

A number of unusually fine examples of lacunæ, in quartz crystals containing fluid and bubbles, were shown by J. Z. Davis.

Dr. J. H. Stallard drew attention to the enormous development of the biliary ducts in jaundice, and to other changes of structure in the liver incidental to that disease. In illustration of the subject a number of slides were shown, in which the ducts, crowded with biliary resin, the excessive development of fat cells, and other morbid conditions, were clearly shown.

Mr. Wickson stated that he had recently found insects in large numbers on some

laurel trees in the Experimental Gardens at the State University. At first sight they appeared to belong to the *Aphidæ*, but a closer inspection showed them to be neuropterous insects of the genus *Psocus*, which embraces some sixty species. They are very active in the larval and pupal stages, as well as in the perfect form. They live in groups, usually on the under side of the leaves. A microscopical examination shows them to have free mouth parts. The compound eyes are exquisitely beautiful, and many other points in their anatomy are of great interest. From the fact that the laurel leaves upon which these little creatures have made their appearance in such numbers are very badly infested with scale, Mr. Wickson thinks it quite possible that this species of *Psocus* may be a natural enemy of the scale insect, finding its food in the eggs or young of the latter. Experiments are now being carried on with a view to testing the correctness of this conjecture.

A. H. BRECKENFELD, *Rec. Secr.*

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WASHINGTON MICROSCOPICAL SOCIETY.

At the 50th regular meeting the paper of the evening was by Prof. E. S. Burgess, and was entitled Notes on the Larger Fresh-Water Algæ of the District of Columbia.

Prof. Burgess said:—The object of this paper is to give a few hints upon collecting and preserving algæ and on their distribution, in the hope that some of the members may be induced to enter upon this branch of microscopical study.

I. *On Collecting.*—The time for collecting our larger fresh-water algæ, using that term for those which possess visible fronds, or individuals, is, according to my experience, in March, April, and early May. Microscopic algæ, it is usual and true to say, are to be collected at any time of year, whether winter or summer. But the larger algæ are not so prodigal of their presence. My outfit for collecting is varied at different times, according to object and to the number and size of specimens I am desirous to obtain and weight I am willing to carry. My favorite outfit is a five-quart tin pail with cover, in which I put eight wide-mouthed quarter-pint bottles with corks. These reach just to the top of the pail and nearly fill it. Between the interstices they leave I place little round wide-mouthed vials, such as are used for homœopathic pills, and of which a gross is to be constantly kept on hand.

A fourth requisite in this outfit is a small supply of white paper cut into little oblong labels, an inch or two long, to be used with every bottle when filled, recording the place, and to be inserted into it and held fast by the cork. A fifth requisite is a pair of pinchers, and a sixth is a dipping tube with a rubber bulb, to be used in isolating small objects out of the water.

II. *On Preserving.*—Specimens for subsequent microscopic examination I have found best preserved by mounting in King's Fresh-Water Algæ Fluid, in cement cells, and in this it has been my practice to put up one to four specimens of every form collected for permanent preservation and for examination of their structure. This fluid may be obtained from the Educational Supply Co., of Boston, Mass., or from Rev. J. D. King, Cottage City, Mass. I have used glycerin and also glycerin jelly. Glycerin contracts the endochrome of most species by absorbing water and is therefore undesirable. Glycerin jelly with the firmer species sometimes yields good results, but King's fluid does so regularly, except with the Oscillarias, for which I do not yet know a satisfactory medium.

But while specimens for the study of structure are best preserved in King's fluid, the small size of the part so preserved can give, in case of the larger species, but a poor idea of the external appearance of the plants; and, to supply the lack of this, I formed the plan of applying to our larger fresh-water algæ the same method as is so common with the marine forms, that is, mounting specimens upon sheets of paper or cards, so displayed as to exhibit the branching so far as possible. To these I add other specimens of the same, with their branches not displayed nor drawn out, but left in the position naturally taken, to show the plant in the mass, and as it is most likely to strike the eye of the beginner. These card specimens are prepared by floating the plant in water, inserting the card under it, and lifting the specimen out with such care as to drain off all the water and yet leave the specimen centrally placed and with the disposition of its parts desired. This is a much easier task with most marine algæ than with the soft and gelatinous substance of the algæ from fresh-water lakes and streams, and the height of difficulty is reached in such a plant as Tetraspora, which may float on the water in a gently undulating mantle of green, thin and beautiful as a lady's veil, and swaying out for six or eight inches in a slow current, but collapsing into hopelessly un-

recognizable slimy clots at a touch of the fingers.

I have found the best plan for securing card specimens to be this:—to take with me, when collecting, paper, or card, on which to mount my specimens, with cloth driers, and a book in which to place them; and to do the whole work while out in the field, using the brook or spring as my mounting bowl and its grassy sides as my draining table. Nature must, however, lend her approval to make even this plan successful, for a contrary wind will blow specimens off the paper faster than they can be supplied, and a calm day is a necessity. Granted these preliminaries to success, the specimens thus obtained may be arranged like any herbarium, or, as in the volume I exhibit, in a bound book, slipped into each page, or each alternate page, or gummed on, and protected from rubbing by tissue papers inserted. In the collection contained in the volume I exhibit I have sought to present a specimen of each of the larger algæ I have found within the District, arranged in order of a classification, from the lowest to the highest in structure, with printed labels giving date of collection and place, as well as stating the name and the feature illustrated. It will be remembered that many of the specimens here presented make no pretension to beauty, and that the credentials on which their admittance to this collection depends are strictly the credentials of a representative body, not of personal gifts or graces.

III. *Distribution.*— In answer to the question where to go to find specimens, I would say, visit every pool, spring, ditch, and brook. The pools on the Carberry meadows I have found most productive of any pools, but of their individual peculiarities I have not time at present to speak.

IV. *Species Represented.*— The next question natural after 'Where shall I go?' is, 'What shall I find?' and it is principally to answer that inquiry and to give some idea to those who have not studied our algæ, but who may be induced to pay some attention to this fascinating branch of science, that I bring my volume of the Larger Algæ of the District to exhibit card specimens, of which I will speak in detail, beginning with the highest and descending. The speaker then showed the volume referred to, consisting of card specimens of algæ, exquisitely mounted, and described each. Among the algæ shown were specimens of Batrachospermum, Draparnædia, Chætophora, Tetraspora, Spirogyra, Hydrodiction, Conferva, Didymoprium, Chara, Œdogonium, Oscillaria, Lyngbya, Vaucheria, Cladophora, Stigeoclonium, and Zygnema. Accompanying each was a microscopic specimen for the purpose of showing the intimate structure. The speaker also showed a mechanical stage, by Bausch & Lomb, which he had had ruled into divisions of $\frac{1}{100}$ inch, and by a simple system of numbering from one to ten in one direction, and ten to one hundred in the other, he was enabled to locate any object desired. He had found it more useful than the Maltwood finder.

Prof. Seaman showed a new Thoma microtome lately purchased and explained its working.

E. A. Balloch, *Rec. Secr.*

NOTICES OF BOOKS.

Cocaine in Hay Fever:—A Lecture Delivered at the Chicago Medical College. By Seth S. Bishop, M. D. Reprinted from the *Journal of the American Medical Association*, Feb. 6, 1886. Chicago, 1886. (pp. 13).

Operations on the Drum-head for Impaired Hearing; with Fourteen Cases. By Seth H. Bishop, M. D. From *Journ. Am. Med. Assoc.*, Aug. 28, 1886. Chicago, '86. (pp. 13).

Permanent Removal of Hair by Electrolysis; with Cases. By Samuel E. Woody, A. M., M. D., from *American Practitioner and News*, Jy. 24, '86. Louisville, 1886. (pp. 11).

Louis Pasteur; His Life and Labors. By his son-in-law. From the French, by Lady Claud Hamilton. New York: D. Appleton & Co., 1885. (pp. xliii, 300).

This work will be likely to interest all students of the microscopic forms of life in relation to disease, both for the sake of the scientific information conveyed, but more especially on account of the great interest in the life and experiences of Pasteur himself.

Exchanges.

[Exchanges are inserted in this column without charge. They will be strictly limited to mounted objects, and material for mounting.]

Interesting mounts in exchange for meat containing trichina.

H. M. WHELPLEY,
St. Louis, Mo.