THE AMERICAN

MONTHLY

Microscopical Journal.

VOLUME 19,

FOR

1899.

Founded in 1880 by R. Hitchcock, and published since 1887, by
Chas. W. Smiley, Washington, D. C.

forms; c is a schematic representation of a fertile branch; d is a primary sterigmata; e is a secondary one; f is a spore and g are columella.

ASPERGILLUS REPENS.—This mould grows much like the Penicillium and Mucor shown in "The Microscope" for September last. The mycelium is like that of Penicillium. The spore head is quite different (h). Primarily the fertile branch of Aspergillus is single-celled, non-septate, while those of Penicillium are septate. The apex of the fertile branch is swollen, club-like, from which swollen end called columella (12 to 36 microns in diameter) the spores, k, are borne from single, flask-shaped bodies marked d in the cut and called sterigmas. The spores are 6 to 8 microns, slightly roughened, at first yellowish, later greenish to gray. In later cultures small yellowish bodies are found scattered in the superficial mycelium. These are a second sort of fruit-bearing body and contain spores 4 to 6 microns in diameter. They are somewhat lens-shaped and have serrate margins, k. The yellow perithecium is shown at m.

This mould grows scantily upon various media. Upon blood serum it does not grow at all. Milk is made alkaline by it, does not coagulate, becomes thick and stringy and shows the presence of albumoses.

If a solution has developed in it a mould, it is not advisable to filter the solution and return it to stock for the active ingredients have probably undergone some changes. Throw it away.

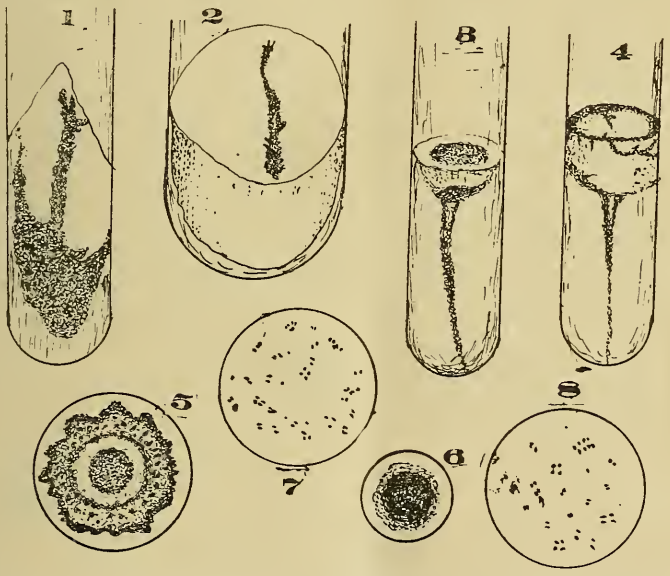
Labrador and Anticosti.—By Rev. V. A. Huard, A. M., Chicoutimi, Quebec. Paper, 8 vo. pp. 505, map and illustrations. Price $1.70 post paid.

The author of this charming narrative is president of a seminary and editor of a scientific magazine at Chicoutimi in the province of Quebec. The book is in the French language and makes delightful reading for the student.

Bacteria that Curdle Milk.

By R. R. DINWIDDIE.

Micrococcus uberis.—This bacterium is found in the milk duct of the cow. The cocci are of medium size, arranged in pairs, irregular groups, or sometimes chains of four to six. They are non-motile and readily stained by aqueous solution. They grow at 20 degrees to 37 degrees C. In agar streak culture, fig. 1, surface growth is free, white and spreading over the surface below while

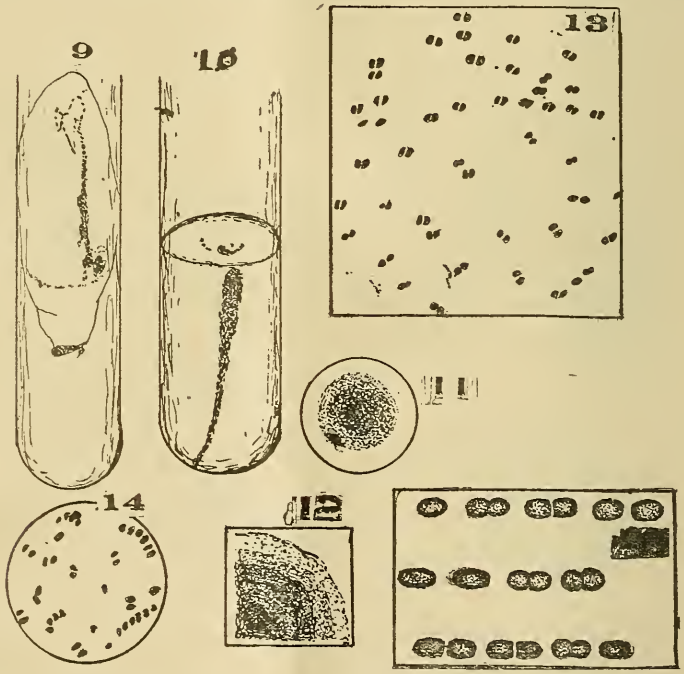


above it is limited to the wire track. Surface, smooth, moist and glistening. Potato culture, fig. 2, at 10 days, shows a free growth limited to the wire track, raised, white, granular.

Gelatin stab cultures appear in fig. 3 (4 days) and fig. 4 (14 days) 22 degrees C. There is early fluidification, a funnel-shaped depression which extends in 10 or 20 days across the tube. In five weeks, half the medium is fluidified.

Gelatin plate surface colony, fig. 5, 3 days, x7, and deep colony, fig. 6, 2 days, x60, both are 22 degrees C. In 24 hours the colonies appear as white points. If x60 they appear greenish yellow. In 5 days, they become 2 to 4 mm in size with a central area and a peripheral zone.

Figures 7 and 8 show cover-glass preparations from bouillon culture, one x600 and the other x1500, taken



with Reichert's ocular 4, objective 1–18. At 20 degrees C., the milk sours and curdles after 4-5 days; at 37 degrees, there is free growth but no curdling.

Bacterium lactarii.—This is found constantly in milk that has soured spontaneously. It is oval, single or in pairs. Chains of 4 to 6 each occur. Fig. 13 shows pairs, with the attached ends square and rounded. Segmenta-

tion occurs at length of 2½ microns. Stain by Gram's method and by the hydro-alcoholic solutions.

Fig. 9 shows agar streak culture, 2 days. It is first visible in 24-48 hours as a faint granulation along the inoculating line. Magnifying, small colonies are made out and are colorless. A yellowish white sediment appears in 24 hours. On glucose-agar the growth is larger. In lactose-litmus agar, the colonies appear all through the medium, pink color from surface to bottom.

Lactose-gelatin with chalk (fig. 10) at three weeks shows larger, opaque colonies, circular and regular in outline. Diameter half a millimeter.

Gelatin plate colonies: deep, 3 days, and surface, 4 days, are shown in figures 11 and 12 enlarged 100 dia. They are quite circular with regular and well-defined margin. Diameter, .25 mm. On potato, there is no growth.

Cover-glass preparations, x1500, are shown in figures 13 and 14, the former a 3-days milk culture and the other a 2-days glucose-bouillon culture. Figure 15 shows growth and segmentation.

The milk forms firm coherent clots in 20-30 hours ordinarily, but in incubator in 12 hours. It is strongly acid with faint sour odor.

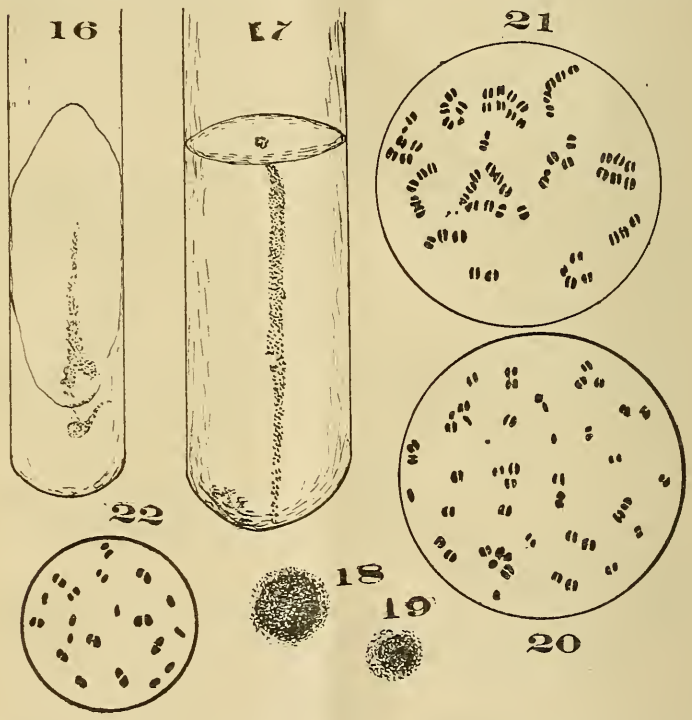
Bacterium discissum occurs in spontaneously soured milk. They are oval, in pairs, in chains or singly. Single forms are half longer than broad—dimensions 1.5 microns by 1 micron. In glucose bouillon, the chains are most abundant and larger than elsewhere. The individual elements of the chains are nearly round, segmented and vary in size as shown in figure 20.

Glucose-agar streak culture of 10 days growth shows as in figure 16. In glucose bouillon the turbidity appears later but is equally dense.

Gelatin tube stab culture of 5 days standing, fig. 17;

gelatin plate deep colony, 6 days, fig. 18, is magnified 100 dia.; gelatin plate surface colony, 5 days, figure 19 is magnified 60 diameters. Cover-glass preparations are shown in figures 20, 21, 22,—milk culture, x1500, in fig. 20; glucose bouillon culture, x1500, in fig. 21; and agar culture, x1500 in fig. 22.

The cultural characters are in nearly every way simi-



lar to those of B. lacterii, but in agar tube the growth is feebler, in gelatin plate the ringed appearance is fainter and the quantity of clear fluid separated from the curd is larger especially at temperature of 37 degrees C.

Those interested in fuller details of this milk problem should send to the Arkansas Agricultural Experiment Station for Bull. No. 45 which is distributed gratuitously.

Gates' Double Microscope.

Apparently Professor Elmer Gates of Washington has made one of the most important discoveries ever achieved by science—that a second microscope can be used to view and magnify again a small part of the image produced by a first microscope. Thus the power of the human eye is increased 3,000,000 times instead of 10,000 times, as hitherto, for though the humen eye cannot, of course, see the image directly it can see a reproduction of the image and thus microscopy is carried as far beyond the present art as it is itself beyond the power of the eye. His process is as follows :

"On the Abbe plate, consisting of fine lines ruled close together, a ½-inch objective showed four lines and three spaces. With a 1-6-inch it showed nine lines and eight spaces. Then, taking a second, with a 2-3-inch objective, or a 14 mm objective, it was focused upon the real image of the microscope by introducing the ocular of the first microscope, so that the plane of the second objective was in the plane of the real image, and then two lines and one space covered the entire field of vision.

This is only, however, the first step. When I replace the 2-3 objective of the second microscope the magnification is 400 more diameters, but the image cannot be seen by the eye. It must be photographed. With a one-twelfth objective on the first microscope and a three-inch on the second I get a magnification of 3,000,000."

He is delighted with this discovery because he wishes to study the constitutional units of the cell as modified by the mental activities of that cell. A great difficulty arises in the focusing of the projected image of the second instrument upon the sensitive plate because beyond 360,000 diameters the eye cannot see the image. A series of empirical approximations are used to find the focus. He hopes yet to be able to photograph ten times

as many diameters. He further explains his work thus :

I use the best known form of microscope and prepare the slides and slicings and stainings in the usual way ; and focus and illuminate so as to get the clearest and highest magnification of the object, when viewed through the usual ocular. Then I remove the outer lens of the ocular. It can be shown that the "virtual" image produced by the ocular and eye, although it looks much larger than the "real" image, adds no new details to the real image. This fact is known to many modern microscopists. I therefore use the "real" image as the starting point for my new microscope.

I bring down upon this "real" image or "focal plane" the objective of my second microscope, and thus magnify the "real" image so to exhibit in it details which cannot be seen when this real image is viewed through the ocular of the first microscope.

This is due not only to the special powers of the second microscope, but to an advantage which I have taken of a unique fact in photography, namely, that when two lines, markings or colors in an image are too close together, the sensitive plate will not record them as two but as one. Thus, when I ruled two lines upon a metal plate too closely together, the image of these lines thrown by a camera upon a sensitive plate would irradiate in the film and the picture would show only one line. The line of light falling on the photo-salt in the film spreads by molecular irradiation over more area than the actual width of the line of light, and there is also diffused reflection of this line of light by the semi-transparent substance of the film. To these two causes is due the fact that when the details of two structures are too close together in an image of an object, these structures will photograph as one, and thus the detail will be lost. The line of demarcation between them will, in the film of the sensitive plate, be obliterated by the irradiated and dif-

fused light. This is why all details below a certain size are lost in a photomicrograph. The space between two points that are too close together on a film is acted on by the light irradiated by these points. The "two points" are separated by magnification to such a distance that when the photograph is made the irradiation will not cover the space between the points.

The first microscope takes the light from a very small object and spreads it over an area of sensitive plate one hundred million times as great as the area of the object from which it comes, hence the light has only the 1–100,000,000 as great an intensity as when it started from the object. The light is already too weak to photograph with if best results are desired. But select some small area of this faint image and subject it to a still further magnification of six hundred additional diameters. This light becomes only the 1–360,000 as strong as it was, and the natural eye cannot see the second magnification because the light is too weak. But by remaining several hours in a completely darkened room the eye can see very faintly such magnification. But when a sensitive plate, is put in place of the eye it acts cumulatively, and the faint light rays which the eye cannot clearly see will fall hour by hour upon the plate and slowly accumulate enough effect to make a visible picture. The structural lines which in the image of the first microscope are too near together to be photographed as distinct objects, are in the image of the second microscope 600 times farther apart and do not blend by diffusion and irradiation.

It is not very difficult to distinguish on a good photomicrograph, made by best modern methods, lines which in the original object are not more than the one-ten-thousandth of a millimeter apart, but much beyond this the microscope and photo-micrography refuse to go, because the images of these lines on the sensitive plate

affects the photo-salts in the space between the two lines and this is done by diffusion and irradiation.

We are promised some criticisms of Gates' methods for February and desire others.

Amoeba in Winter.

By W. E. DEEKS, M. D.

During the summer they can be obtained by scraping the under surface of a floating weed or in the superficial ooze along the bottom of any fresh-water pond. In winter we need aquaria, and of these a certain amount of care is necessary to keep the forms in a living condition. The most suitable temperature for them is between 45 and 70 degrees F.—a sufficiently low temperature which will also prevent the bacteria of putrefaction from developing too rapidly. Along with them are usually found the Heliozoa, the stalked Ciliata and some of the Flagellata. If the temperature is raised to about 80 degrees F., they quickly disappear and in their place countless numbers of the free-swimming Ciliata make their appearance. The water also becomes putrid.

In the Autumn the superficial ooze from some fresh water pond is skimmed and placed in a dish, the mouth of which is covered almost completely to prevent too rapid evaporation. Along with the ooze get some decaying vegetable matter and also some living water plants—Anacharis, Chara and some other common forms will do. A considerable quantity is necessary to keep the water fresh. The aquarium is then placed in a place where there is plenty of light (though preferably not direct sunlight), and in a cool place, best about 60 degrees F. This then can be left any length of time, and when they are required, by squeezing a little of the decaying vegetable matter on a glass slide, I have never failed to find one or more.

PRACTICAL SUGGESTIONS.

By L. A. WILLSON,

CLEVELAND, OHIO.

Micrometry.—"While all the principles of micrometry are simple, it is very difficult to get the exact size of microscopic objects. This is due to the lack of perfection and uniformity of micrometers, and the difficulty in determining the exact limits of the object to be measured. Hence, microscopic measurements are only approximately correct, the error lessening with the increasing perfection of the apparatus and the skill of the observer. It is said that 0.2 of a micron is the limit of precision in microscopic measures, beyond which it is impossible to go with certainty."—Gage.

Ground-glass slide.—In using the dissecting microscope with a mirror there is generally too much glare. This can be obviated if we intercept the light by using a ground-glass slide on the stage. The light will then be diffused and work may be accomplished with comfort.

Podosphaera biuncinata.—This is one of the fungus species of the family Erysiphæ. The beautiful and interesting plants of this family have now ripened and the autumn leaves are full of them. They are readily gathered and easily manipulated. All that is necessary is to scrape off a few of the little dots, place them on a slide with water, cover, then see that the space under the cover is filled with water. Examine with a power of an inch, and if desirable, afterwards use a power equal to a quarter. Remove the dots carefully from the leaf and be careful not to roll the specimen up with the spider-web-like mycelium. The round dots are the perithecia which contain the asci with spores. To see the latter, press on the cover glass and gently split the asci. No reagent of any kind should be used. Podosphæra biuncinata is a striking species. The perithecæ contain but a single ascus

and have six to twelve appendages, three to five times as long as the diameter of the perithecium. Each appendage is tipped with a conspicuous fork. These tips somewhat resemble uncinula but in uncinula the tips are hooks and shepherds' crooks and in biuncinata the tips are forks which are not hooked.

AMŒBAS.—A large supply of these very interesting animals may generally be obtained from the ooze on the bottom of public fountains. When the water is allowed to escape preparatory to cleaning the fountain, an opportunity will be afforded for collecting this ooze. When collected, leave the mouth of the vessel containing the animals open, as all terrestrial life requires air.

EDITORIAL.

Subscription Price.—It will be one dollar for 1898 if paid directly to the publisher in advance or during the present month. We authorize no agents. Those who wait, or pay through self-appointed agents, bookstores, etc. should pay two dollars out of which the intermediaries may take their pay.

The X Rays.—At the inauguration of the Roentgen Society in London, the entire skeleton of a living woman was exhibited life-size.

Agar-Agar.—A nice method of preparing nutrient agar-agar for bacteriological work has been published by Dr. H. B. Sheffield in the Registered Pharmacist for November. He pronounces it "simple" but the process is at best very tiresome. We will not copy it unless requested so to do but be content with this reference.

For Sale.—A Crouch instrument with two objectives is for sale cheap by "Alpha," Wadham House, Wentworth street, London, England.

Silk Adulterations.—It is found that in London only about 28 per cent of certain silks is silk. The adultera-

tion is with tin. It is in the "weighting" of the silk. This silk stands only three months steady wear.

Effectiveness of the Microscope.—The angular aperture of objectives has been increased about all that it is likely to be. We shall hereafter look more to the utilization of shorter wave-lengths of the invisible ultra-violet rays for improvements in magnification and resolving power than to angular aperture.

Enlarging photograghs does not help us for there is nothing of detail in the enlargement that was not in the original. If new details are to appear, they must be secured by enlarging the image before it is photographed. That is what Gates claims to have succeeded in doing.

Microtome Work Outdone.—The limit of thinness cut by the microtome has been about 2-1000 of a millimeter. No one has ever thought of slicing up a blood-cell except Elmer Gates. He also sections microbes. Cement on a glass slide a single layer of cells. Then cement another glass slide to that. Cut the two apart with a very thin blade of copper the edge of which has first been sharpened to the finest degree possible. Copper being finer grained than steel takes an edge that razors are incapable of receiving. Use adamantine paper upon a glass surface as a whetstone. A still finer edge is got by polishing it with a piece of soft wood. Get the edge exactly in the middle between the two surfaces on the copper plate.

The cells having been once sliced are again cemented to glass and cut open once more. Gates has made slices 1-100th the thickness of the thinest ever made with microtomes.

Yellow-Fever Prize.—Brazil offers $200,000 for a demonstration of the bacillus of yellow fever, the surest and easiest means of its recognition, and an effective means of treatment. It purposes to build a laboratory for preparing curative serum as soon as that serum is discovered.

Bromine Sterilization.—To each litre of water add .06 gram of bromine, then in 5 minutes ammonia to neutral-

ize the bromine. Schumberg says use a solution made of 20 grams bromine with 20 grams bromide of potassium dissolved in 100 grains water. Use this solution in the proportion of 2 cc. to each litre, stir, let stand 5 minutes. Add 9 per cent ammonia water to neutralize. The taste of the water is not affected by this small amount of bromine salt.

SCIENCE-GOSSIP.

Amoeba Coli.—Amœba have been found in the human intestines associated with a special form of dysentery and with abscess of the liver. It is believed that they gain entrance to the system by means of the water drank and the uncooked vegetables eaten. In the trip from the intestines to the liver, it is supposed that they pass through the vessels that drain into the portal vein.

These Amœba have been found in people who are not suffering from dysentery. It is quite conceivable that they may enter the deeper layers of the mucosa and so into the blood streams. The analogy of the white corpuscles escaping by diapedesis through the blood-vessel wall is very interesting. That they are found in healthy intestines is no stranger than that the Klebs-Loeffler bacillus of diptheria should be found in the mouths of healthy people. A lowered vitality is necessary before these organisms can work injury.

A case of dysentery and liver-abscess is reported in "The Lancet" for Dec. 11, 1897, of a Lascar, 19 years old, in which 22 oz. of pus were aspirated from the right pleura. On microscopic examination, pus cells, red and white blood corpuscles, degenerate liver cells but no amœba were found. Later when a liver-abscess was opened they were found actively moving in the liver pus till two days after the operation. Three weeks later the patient died from exhaustion. Amœba were also found in the lining membrane of the main abscess and in the pus from the three patches of softening in the liver.

Bovine Tuberculosis.—Some of the cows at the Kansas Agricultural College were suspected of tuberculosis. At length some of the cattle tenders were taken ill. One died. Then a cow was killed and examined. Its lungs were found to be "a mass of tubercles," the pulmonary and costal pluræ were covered with tubercles and the entire entrails were diseased. The result from a tuberculin test was that the entire herd of 58 cows was believed to have become infected. "Probably the sheep and hogs also are infected" reported the investigating committee.

We should remember that one-seventh of all deaths are from tuberculosis and that cows are a prominent medium of communicating it. In Massachusetts, a report on 3000 cattle, reported 18 per cent to be tuberculous. In North Carolina 50 to 70 per cent were found infected. As many as 50 per cent have at times been found to have tuberculosis of the udder.

Slaughter Houses Breed Disease.—An official inspection of these establishments in this country shows that many bacterial diseases are propagated therein. If one hog has trichinosis, the offal from its slaughter fed to other hogs will and does surely infect the rest with trichinæ. Rats are also present. They feed on the same offal and and are infected. The dogs and cats that eat them become infected. Hog cholera, swine plague, wire-worm, staggers and other echinococcus diseases, parasites, etc., are multiplied in America faster than elsewhere because of the lack of care and cleanliness resultant upon our haste to get rich.

The Metal-gnawing Beetle.—In 1888, an individual specimen was brought to New York from Mexico and later others have been seen. They are 1 1-2 inches long and somewhat mottled. They can cut their way out of wooden or pewter receptacles if there be an exposed edge. They do not bore. Mr. F. W. Devoe of Fulton st. has reported before the N. Y. Micro. Society, the experiments made by him. His beetle by aid of its mandibles cut away the pewter between two holes and united them in one as an

avenue of escape. The bits were not swallowed but dropped in the jar and are now in evidence. The mandibles must be harder than the metal in order to cut it.

This beetle is called Zopherus Americanus. It has not been known to cut iron or steel.

Live Specimens.—Amœba, Arcella, Actinosphærium, Desmids, Diatoms, Floscularia, Hydra, Melicerta, Spirogyra, Stentor, Volvox, Vorticella and many others can be got at 25 cents per tube postpaid from Thomas Bolton, 25 Balsall Heath, Birmingham, England.

RECENT PUBLICATIONS.

Petrology for Students.—This is the title of Alfred Harker's little guide to the study of rocks in thin sections. A second edition has recently come from the Cambridge University Press. Increased attention has been given to the American igneous rocks.

Mammals, Birds, Fishes.—New book by Dr. R. W. Shufeldt, 400 pages, 130 nice illustrations, popular but scientific. $3.50. Studer Bros., New York City.

THE AMERICAN

MONTHLY

MICROSCOPICAL JOURNAL.

VOL. XIX. FEBRUARY, 1898. NO. 2.

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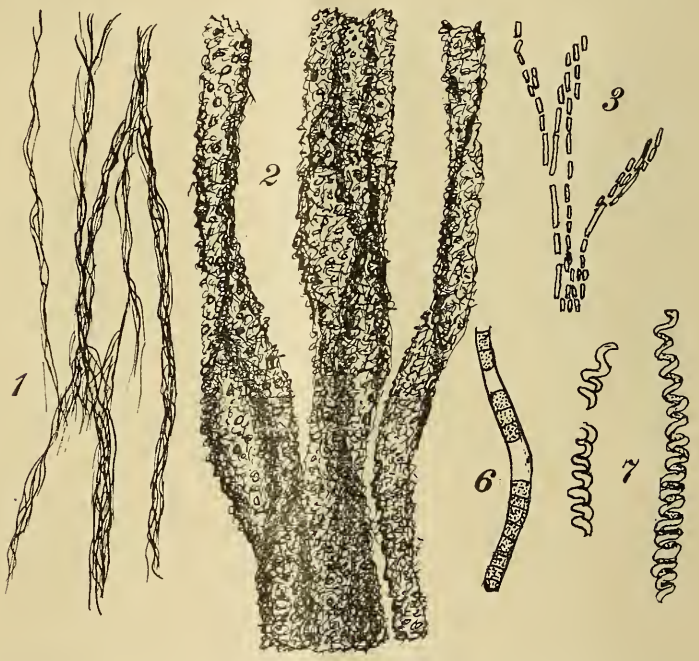
Microscopic Forms at Yellowstone Park.

THE BACTERIA OF THE HOT POOLS.—At the hottest pools may be found filamentous growth of pearly luster, white or gray scattered along the edges of the little streams or forming a delicate net work at the bottom. These tufts shown in fig. 1, may be six inches long, and the water is never below 85° C (185 F.).

BEGGIATOA.—Figure 2 shows these filaments under low powers, a quite homogeneous strand, stiff, stringy, gelatinous and coated with minute crystals. Carbon bi-sulphide dissolves them which proves the deposit to be sulpher. Stain and put under an immersion lens of 1,000 diameters. Then innumerable rod-like forms of bacteria appear imbedded in the gelatinous matrix. All these chains vary in length the larger breaking up into the

smaller (fig. 3, x 2,000 dia.). The long axes are parallel with each other and there are many hundreds of these bacterial lines placed side by side in a single filament which may be called an elongated zoogloœa coated with sulphur particles. Do they attract this coating? Such is the case with the genus Beggiatoa which leads to a belief that this is a genus of that species. Some of the

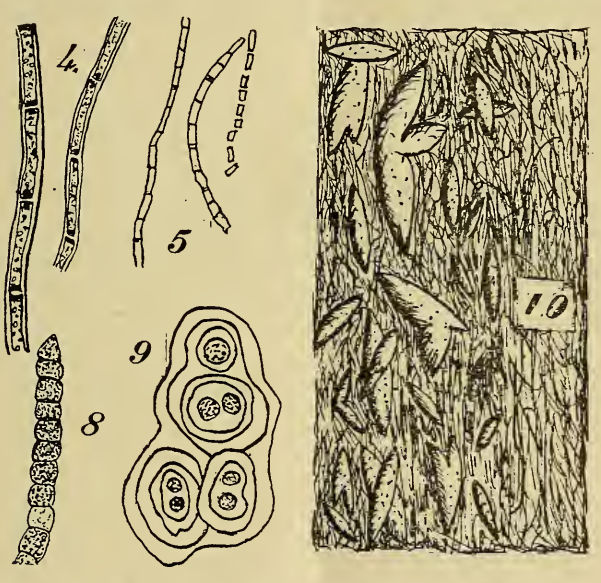


Beggiatoa even engulph grains of sulphur within their infinitesimal cell-walls. Figure 4 with magnification of 500 diameters is known to be a Beggiatoa but fig. 3 when x 2,000 does not give any such detail for the sulphur grains are plainly shown in figure 4. The rod shape proves a bacillus. The attraction for sulphur proves a Beggiatoa.

These filaments are coated so beautifully with calcium carbonate and sulphur as to appear like icicles in the

scalding water. The threads are cemented together by the lime.

PHORMIDIUM.—Another formation in the bottom and sides of these hot pools is of a leathery, felty appearance and shows many crystals of calcium carbonate (fig. 10, x 250 dia.). These filaments are less than 1–1,000th of a millimeter in diameter and are glued together. The surface is smooth and slippery but gritty because of the crystals of calcium carbonate. The cells of this organism,



magnified appear elongated and of a greenish color. It is Phormidium and akin to Oscillatoria—a very common blue-green alga of stagnant water. The several species of the Yellowstone are distinguished by the size of the cells. The smallest, fig. 5, grow in water hot as 75° C. The larger, fig. 6, are found in water not so hot. The tint is at first bright green but later is brownish. Mineral deposits produce golden yellow color and dark red. The sun will bleach them all white.

SPIRULINA.—Figure 7 shows another form, socalled

from its spiral coils. It has a power of movement. The free ends can swing from side to side. This and the previous form often mingle to make artistic rims raised above the hot water pools. They may be seen at Prismatic Spring in Middle Geyser Basin. In the margins of this spring, 300 feet wide, dark-blue at center, are beautiful shades of green to light yellow. Over the rim splashes the hot water. The wet algæ are too hot for one to hold them and one need not venture too near it.

ANABŒNA.—In the cooler places we begin to discover diatoms and a specie of Anabœna, one of the family of Chlorophyceæ.

GLŒOCAPSA.—This is a unicellular alga, figure 9, having very thick cell walls made up of an outer gelatinous layer and others concentric in arrangement. These slimy filaments are constantly damp from the condensation of steam that arises and meets them. The students of algæ find rich harvests of Schizophytes and Cyanophytes at these hot springs.

Some Photo-Micrography Experiments.

BY A. WOOLSEY BLACKLOCK, M. D.

I use a hand-camera for this purpose. Fair results can be got by adjusting the lens to its solar focus or for distant objects. Recent experiments as follows have improved the results:

I focussed an object carefully with the eye in the usual way, placed a camera with its objective close to the eye-lens of the microscope, and shifted the ground-glass until I secured a thoroughly sharp image of the object on it. I then removed the camera, without changing the relative positions of the objective and ground-glass, and having made a few fine scratches through the film of a spoiled negative, I placed this in front of the objective of the camera, and moved it about until the scratches were

sharply defined on the ground-glass. I found that this was at a distance of 8 in. from the lens, and concluded that this is the distance of the virtual image which I see when I use the microscope. I then substituted a fresh object on the stage of the microscope, carefully focussed it, replaced the camera without focussing it, inserted a sensitive plate, exposed, and developed it, getting a very much better image than hitherto, really sharp, with a power of 55 diameters. I next attempted a very difficult object, Pleurosigma angulatum, the objective being a Beck $\frac{1}{4}$ in., and the eyepiece a $\frac{1}{2}$ in. Huyghenian belonging to the telescope. This was carefully focussed, and the camera reapplied, with the result that the negative shows the diatom dotted all over the field. Those who know the difficulty of seeing the dots in this object will understand the severity of this test. The lens of the camera was a plano-convex achromatic objective from an opera-glass, $4\frac{1}{2}$in. focus, the distance of the objective from the plate being about $10\frac{1}{2}$in. Shortly afterwards I substituted a stage micrometer for the diatom slide, and found that the actual magnifying power was 1,000 diameters.

Methods in Microscopical Technique.

I. Down to recent times the microscope was utilized by means of various optical accessories and their development was a matter of physics. Methods of manipulation then in vogue have since largely fallen into disuse and their votaries have become less in number. Mr. H. B. Ward cites as an evidence of the failure of that line of development the fact that diatomists cannot agree regarding the interpretation to be put upon a direct image presented by the microscope. The followers of this school took their objects for study as they found them in nature and without preparation of any sort.

II. The next method came into vogue when the physicians, botanists and biologists began to utilize the instrument for their purposes. Mounting after killing, hardening, fixing, sectioning, and staining, led to satisfactory results. Biology made rapid progress. Every month brings refinements and additions to these operations. The optical accessories are largely replaced by these mechanical and chemical aids. Mineralogy has also resorted to sectioning. Hundreds of workers by this method have replaced the tens who "fought objectives" on optical grounds. Microscopy has thus became subservient to the sciences and is not and never will (again?) be a science of itself.

III. There are those who are not satisfied with the foregoing. Prof. H. B. Ward is one of these. He says:

"The methods in vogue today for the examination and study of living substance are but little improved over those which obtained some thirty years ago; if possibly we can see a little more it is because we have better lenses and better instruments. The cell as a living thing, as regards the changes which take place during its processes, is known by inference from the dead object rather than by observations upon its living substance. It is a chemical laboratory and should be studied that we may know the reactions which are taking place in it. If the methods of microscopical technique most generally in vogue at the present have given us, as it were, a series of instantaneous photographs of the cell and of the arrangement or rearrangement of its various parts in various conditions, there yet remains to be developed that technique which shall show us these substances in the process of synthesis and analysis, that the investigator may be able to follow the workings of the cell as a formative power and see how living matter operates." Perhaps Professor Gates has already supplied what Professor Ward calls for. We shall soon see.

Dahlia as a Stain for Bacteria in Sections Cut by the Collodion Method.

Probably the greatest difficulties have been found in the staining of the imbedding medium or in the albumen fixative. They usually obscure both the tissue elements and the bacteria. Unless the sections are cut in paraffin and not fastened to the slide by these common fixatives the bacteria are not brought out. With loose or fragile tissues there is great danger of tearing or of losing parts of them during staining and dehydrating. Although paraffin is commonly used, collodion is more often employed. The rule in normal histology is to fasten the sections to the slide. In pathological histology, they are not, for the reasons mentioned, ordinarily fastened. The need of having an absolutely perfect section from a pathological tissue, especially for diagnosis, is even greater than is the case when sections of normal tissues are being made. The loss of a very small bit from the section may cause an entirely erroneous interpretation. By the use of collodion as the imbedding medium this danger is eliminated. The method is simpler and the sections are fastened to the slide by collodion or an albumen fixative.

Collodion takes most of the aniline dyes and gives up the stain only when treated with a decolorizing agent sufficiently strong to decolorize the tissue at the same time. In the case of paraffin sections which have been fastened to the slide with collodion or albumen fixative, or both, besides the disadvantage of using a process which takes a longer time, we meet the same difficulty that we did in the collodion method. The fixative takes the stain and obscures the preparation quite as much as does the imbedding collodion.

Both the collodion and the paraffin methods have advantages. In pathological histology I prefer collodion to paraffin. The whole process of sectioning by the oil-col-

lodion method has been described heretofore. The sections are fastened to the slide by putting a few drops of ether and alcohol on the section after it is in position. Use a mixture of three parts ef xylene and one part of castor oil as a clarifier. In passing a section from water to strong alcohol, or vice versa, avoid the diffusion currents by plunging the slide directly into the desired liquid instead of carrying it through successively higher or lower percentages of alcohol.

We want a suitable dye that will stain the bacteria properly and yet one that will wash out of the imbedding material without the use of a decolorizing agent so strong that it will remove the stain from the tissue and the bacteria. Having some sections that I wanted to stain with gentian violet, but being out of it, I substituted dahlia. These sections had been cut by the paraffin method and the stain not only showed the bacteria well but brought out the histological structure of the tissue. Later, I cut some sections from material which had been imbedded in collodion and stained them for bacteria. After trying carbol fuchsin and methyl violet, I tried an aqueous solution of the dahlia. It worked perfectly. In the process of washing and dehydrating this was entirely removed from the collodion, leaving both the tissues and the bacteria well stained and sharply differentiated.

Other formulæ, using dahlia as the dye, were unsatisfactory, such as a solution containing less of the elements of a mordant nature, using 2 per cent. carbolic acid instead of 5 per cent., which did fairly well and also Koch-Ehrlich's aniline water solution which stained the collodion too deeply. The formula for the stain used is: Saturated alcoholic solution of dahlia 20 c c; distilled water 100 c c. The length of time varies, according to the condition of the tissue, from fifteen minutes to half an hour. They must be distinctly overstained. Wash thor-

oughly with 95 per cent. alcohol until the collodion around the section appears colorless, and clear with a clearing fluid, preferably clove oil. The tissue will be well defined and the bacteria will stand out deeply stained against the more lightly stained cells of the tissue.—From R. C. Reed's paper read at Toledo, 1897.

Gates' Double Microscope.

A writer in the English Mechanic claims to have seen, years ago, the effects reported by Mr. Gage and to have proved them all illusions. He says that setting up two microscopes as claimed results in enormously increasing the spherical and chromatic aberation and in the production of false images. The two objectives are never aplanatic and usually uncorrected. Then diffraction may cause apparent detail to appear in an image which is not actually in the object. It is therefore believed that Gates has been deceived by this scheme.

It is said that Gates shows ignorance of fundamental principles when he speaks of "a lens of small aperture like a 1-16th" not equaling a 1-6th for his purpose as if the amount of light utilized by any objective depended simply on the size of the opening as is the case with telescopes. That the cone of light admitted by the objective has an influence does not appear to have been considered by him.

PRACTICAL SUGGESTIONS.

By L. A. WILLSON,

CLEVELAND, OHIO.

Ptlidium ciliare.—The name of this beautiful specimen sometimes gets printed as Palladium ciliare. The spelling is peculiar and emphasizes the fact that scientific names should be plainly written. Much blame upon the

printers and annoyance to authors would thereby be avoided.

Bones.—The Luetgert trial suggests to our workers to investigate and if possible discover what, if any, histological differences exist between human and animal bones. The analogous bones should be compared. Thin sections of the bones should be examined. Bones are comparatively soft and sections may be rapidly made. A measurement of the average sizes of lacunæ, canaliculi and of the concentric lamellæ around the Haversian canals might be productive of good results.

Cartilage.—Sections of different kinds of cartilage make interesting slides. There are numerous points to be studied. For instance hyaline cartilage, costal cartilage, the capsule, the lacunæ, fibro-cartilage, yellow or elastic cartilage.

Fats.—Nearly all fats contain crystals that will polarize beautifully. Most fats are true salts composed of an organic or fat acid united to a base. To see these crystals, place a minute piece on a slide and cover, press on the cover and spread out to a thin film.

After the first examination, heat the covered slide enough to melt the enclosed fat. After it cools, the crystals will form and rearrange themselves. A knowledge of these crystals is useful in the detection of adulterations.

Subscription Price.—It will be one dollar for 1898 if paid directly to the publisher in advance or during the present month. We authorize no agents. Those who wait, or pay through self-appointed agents, bookstores, etc. should pay two dollars out of which the intermediaries and publisher may take payfor their services.

Slides.—W. White, 2 Rick street, Nottingham, England, offers cabinet of 72 slides for 21 shillings.

EDITORIAL.

American Microscopical Society.—We have been favored with a "stop my paper" from an official of this society who says it is because of the course we have pursued. Let it be distinctly stated that we have done nothing to injure the society. We have done and will do all in our power to benefit it. All of our critcisms have been addressed to those persons who by neglect or folly have injured the society. We will do anything that anyone will suggest which promises to benefit the society, even to keeping silent.

Trying to find out the causes of the Toledo dearth (only a dozen members went there), we wrote to Dr. Manton, a member of the executive committee asking his view of the cause. In his reply he says: "Shortly before the meeting, I picked up my copy of the 1896 Proceedings and noticed that my name was on the executive committee. This was the first knowledge which I had of my appointment. Neither the Secretary of the society nor the chairman of the committee took the trouble to notify me of the fact and there was no correspondence, so far as I am concerned, regarding the arrangements for the meeting."

He then explains that his duties called him elsewhere and are likely to do so. He makes the following excellent remarks: "I should say decidedly that the society should not be allowed to die. There should be a sufficient number of college professors and teachers of science interested to maintain it. It is this class of members who have the time in summer to attend and their line of work should furnish them with material for papers. If the society is properly managed, there need be no lack of interest or a paucity in attendance at the meetings."

It is now time that the place and date for the 1898 meeting were known and that pledges were secured from members to present papers, working exhibits, etc. We will report all preparations made so far as we can learn of any. We shall also continue to direct attention to the subject.

We understand from Dr. Krauss that the 1897 Proceed-

ings are all in type and we hope they will be published by February.

Moulds.—Dr. Smith Ely Jelliffe of Brooklyn has been carrying on some excellent investigations. We presented an article last month which we abbreviated from the "Druggists Circular", one of our best exchanges and in which there is often something of interest to microscopists.

Periodical Sale.—With only one insertion of the "M. J." advertisement, the owner has sold to one of our esteemed contributors the 46 bound volumes of the Monthly Microscopical Journal and the Royal Microscopical Society Journal for $46, cash on delivery. It is a bargain and another such opportunity may not occur in many months.

Catalogue.—Send 2-cent postal card to Dulau & Co., 37 Soho Square, London, for 30-page catalogue of books and papers relating to microscopy and for sale by them at net prices named in this pamphlet. Some of the prices are very high but they have a really wonderful collection of microscopical publications.

Objects.—Suter, 10 Highweek road, Tottenham, London, sends free a catalogue of 50,000 choice objects. He buys collections and sells cabinets.

Most Powerful Objective.—The best yet made is the 1-10 inch mono-bromide of napthaline immersion lens, numerical aperture of 1,60 made by Zeiss. Its work is limited to resolving a detail more than 1–8000 of a millimeter (.000,005 of an inch) in width.

Leprosy.—The International Congress on Leprosy has declared that this disease is due to a bacillus discovered by Hansen in 1871, that no other animal than man suffers from it, that it is contagious but not hereditary, and that isolation is desirable.

Vaccination.—Small granular ameboid bodies are found in the blood of vaccinated ehildren. Similar amœba have been found in blood of vaccinated monkeys. They have a diameter of one-third that of a red blood-cell.

Leuwenhoeck.—Two volumes of his works, bound in half morocco, nice and perfect for sale at $15.00.–C. W. S.

SCIENCE-GOSSIP.

Chlorosis and anæmia.—Dr. Klots having treated these diseases with nucleo-albumins and bone-marrow, photo-micrographed the blood before and after with remarkable results. In four weeks the hæmoglobin increased as shown by the following per cents: 54, 57, 64, 70, 74. The increase in weight of the body was from 117 to 119, 121, 123, 124 pounds. The number of red blood cells (in millions) was 2.7, 3.0, 3.6, 4.0, 4.1,—an increase of over 50 per cent.

Carcinoma.—Dr. Palmer Findley of Chicago, says that diagnosis of cancer of the cervix is often impossible without the aid of the microscope. To await development is hazardous. If doubt exists a microscopic examination of a piece is imperative. If pieces cannot be cut, resort to scraping. Practical knowledge of microscopy is essential. This may indicate or avert hysterectomy according as there is a malignant growth or merely an inflamatory lesion. Embed the cuttings in celloidin preparatory to mounting.

Celloidin Embedding.—Cleanse the tissues in cold water. Keep in 4 per cent formalin 12 hours, in 50 per cent alcohol 24 h., in 70 per cent alcohol 24 h., in 95 per cent 24 h., in absolute alcohol 24 h. If small, that process may be shortened, the object being merely to harden them. Then put in dilute celloidin 24 h., in thick celloidin solution 24 h., mount on cork for cutting. After exposure to open air for a few minutes, immerse in 70 per cent alcohol for a few hours, then cut. Double stain the sections with eosin and hematoxylin. For serial sections the paraffin method must be used, bnt then an oven kept at a proper temperature is a troublesome necessity.

Freezing.—Animal tissues may be cut in 50–60 minutes if frozen but such preparations are never so satisfactory as those made with celloidin or paraffin. After cutting

with freezing microtome, fix sections in 4 per cent formalin sol. 3–5 minutes, absolute alcohol 1 minute. Stain and mount.

Redondo Beach Diatoms.—In a bluff on the beach 10–25 miles south of Santa Monica, Cal., exists one of the finest deposits yet known. The foot of the cliff is accessible only at low tide, when pieces broken off by the waves can be picked up. Tidal refuse has been carried as far as Santa Monica where the diatoms were first found in 1878. This material contains a great variety of diatoms which are listed in Bull. Torrey Bot. Club, Nov. 1897, by E. A. Schultze and C.H. Kain. Can they or our California friends give us some of this earth for distribution to subscribers? We shall see.

Laboratory Dish.—An invention of Dr. Coplin of Jefferson Medical College is figured in Science, Sept. 24, 1897. In taking slides through various reagents, the section is liable to be scratched or destroyed by coming in contact with other slides. This dish is provided with grooves into which the slides can be set and so kept apart. Economy of reagents, absence of evaporation and solidity are also claimed for the invention.

Examination of Suspected Documents.—Blares, in an article on this subject, in the Journal de Pharmacie, recommends the use of two liquids with which he moistens the places on the documents at which it is suspected that a forgery has been committed. The first of these liquids consists of 1 part of castor oil dissolved in 6 parts of alcohol of 95 per cent. This is painted on with a camel's hair pencil, the effect being to make the paper partially transparent, and thus to bring out traces of erased writing. The second application consists of 2 percent aqueous solution of caustic soda. The operation of this liquid depends upon the methods of the falsificator. As a general thing, the latter removes a single figure from a number. In order to bring back the horizontal line, a portion of which he must almost necessarily remove, and to repair any damage done to the surface by the process of scraping or shaving,

he covers the spot with a coating of sandrac varnish. If the injury has been very considerable he repeats the operation on the opposite side of the paper. This varnish gives the paper back, to a large extent, restores the paper to its natural appearance, and, besides, gives it a surface upon which he can write or print without fear of the ink spreading. The figure put in the place of the one erased does not rest on the paper, however, but on the layer of varnish, and on this fact rests our ability to remove the counterfeit figure without interfering with the genuine ones that remain. An application of the second fluid effaces the printed figure. In this manner Mr. Blarez has succeeded in demonstrating some of the cleverest forgeries.

New Use for Paraffin.—Some chewing gum on sale in England and containing paraffin was labelled "for chewing only; not to be eaten". One child died of peritonitis after swallowing some of this gum.

To Cut Ring.—Through a square piece of wood pass three pins; one in the center projecting a trifle further than the other two. That one acts as a central pivot while the other two are cutters. If a handle is fixed to the wood and the long pin made to pierce the celluloid or other substance to be cut, the tool can be revolved around this central pivot and the cutting pins which are placed at a proper distance for the center will describe circles. The radius of the circle to be cut will determine the distance from the central pin to the cutters. Rings may be made in this way in large numbers without expense. If the substance being cut up is too thick, cut partly through, turn it bottom side up, insert the pivot pin in the hole already made and cut till you meet the former circular cutting which you are sure to do with exactness if care is used.

Tobacco Seeds.—Last summer an Agassiz student saved and weighed the seeds from a single pod. The weight came to 44.304 grammes. By count and weight it was found the one hundredth of a gramme contained 450 or, that one weighs .00002 of a gramme. Hence the 44 and more grammes contained 1,993,680 seeds.

To Split Selenite.—The method adopted by Professor Gates for sectioning animal cells has been applied for some time to splitting selenite plates. It consists in cementing them to glass and splitting off very thin pieces which are afterwards released from the glass by heat or other solvent of the cement. Take for example a flat piece of something less than an inch square and for practice split it down to a fortieth or a fiftieth of an inch in thinness. Glue or even mucilage will do for the cement. With a fine, thin and sharp blade detach as many layers as possible till at last you leave an extremely thin slice attached to the glass. Detach with warm water or other solvent of the cement. Cement other pieces to the glass ad libitim. The Nichols prism and crystalline objects will answer to test the proper thickness or thinness reached.

To Mount Pollen.—Digest in a warm place, in a well corked bottle 4 drams acacia, 3 drams glycerine, 3 drams pure water, thymol ⅓grain. Filter or else strain the completed solution through very fine linen or silk. Hurry it by more heat if desired. Clear the solution of all dirt residue and air-bubbles. Having this as a mounting medium use white zinc cells and finish as usual. This will do not only for pollen but for starches and other objects.

RECENT PUBLICATIONS.

Clinical Diagnosis by Means of Microscope and Chemical Methods.—Charles E. Simon, M. D., 2d ed., 133 cuts and 14 lithographic plates. Lea Bros. & Co., 1897. This is an up-to-date book on blood, urine, feces and other things where the microscope may play its part.

Essentials of Bacteriology.—By Dr. M. V. Ball, 218 pp. $1.00. The 3d Edition has just been issued by Saunders, Phila., and gives the characteristics of 275 bacteria.

Lea Brothers & Co., of Philadelphia have just published a new, fourth edition of Abbott's Bacteriology of 543 pages with 106 illustrations. Chapters are added on the bubonic plague, influenza and gonococcus. Price $2.75.

THE AMERICAN

7363

MONTHLY

MICROSCOPICAL JOURNAL.

VOL. XIX. MARCH, 1898. NO. 3.

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A Glass Stage Plate with Rectangular Movements.

BY K. N. CUNNINGHAM.

The need of rectilinear motions in transverse directions, gave rise long ago to the mechanical stage; how to make a substitute may not be inopportune. Procure a smooth, even-surfaced strip of good quality, window-glass, 8 inches long, $3\frac{3}{8}$ inches wide, and $\frac{1}{8}$ inch thick. Cut it neatly into two pieces of equal size (4 x $3\frac{3}{8}$ inches). Use one as the base plate, the other to cut into three pieces. but one a narrow strip of 1 inch in width, leaving the two other pieces of equal size, say $3\frac{3}{8}$ x $1\frac{1}{2}$. The 1 inch strip, must be shortened to $2\frac{1}{4}$ inches in length, this piece to be known as the slide carrier. After the four separate parts are prepared, their edges should be evenly ground with wet sand on a flat piece of sandstone. This gives the

plate a smooth touch and prevents the edges from getting nicked. A slantwise grinding will put a slight bevel on the harsh edges. The final grinding is done by holding the glass perpendicularly while rubbing over the stone. The edges are smoothed on a finer grained stone without sand.

The four pieces are then ready to be put together. Get a small quantity of liquid glue, to which a little chalk, clay or tripoli, has been added to make it pasty. It will dry speedily, say in a few hours, while simple glue might not harden for several days. Place a small circular spot of the glue an inch wide at each of the four corners of the larger plate, a little away from the edges. Adjust the next two larger pieces of glass accurately to the upper outer corners of the under plate. This done, the inch wide glass carrier piece is placed between them, and carefully adjusted for parallelism, and sliding contact free from latteral play. The plate is then set aside for the glue to fully set and to lose every indication of shifting under side pressure. The inch-wide sliding piece may now be removed for the addition of the slide or slip holder frame. This is made by taking a piece of stiff pasteboard a little thicker than an average glass slip, and superposing on it a 1 x 3 slip, and cutting through the cardboard so that the slip will drop into it snugly. Outside of this space the pasteboard carrier frame may be $\frac{1}{8}$ inch wide all around. This pasteboard skeleton is glued squarely across the middle of the glass carrier piece. This completes the slide carrier and the glass stage plate. With the slide carrier in use, a 1-6 objective offers an air clearance space for the slide to pass freely, to and fro.

It is useful to locate on the upper surface of the left half or side of the plate, a reference line to continuously bisect the center of the field of view of a 1–6 objective. To calibrate this line, and indicate it on the glass plate, the glass plate is laid squarely on the metal stage of the

microscope, and its inner edge held firmly in contact with the brass pillar supporting the stage and tube. Be careful that both sides of the glass plate are parallel to the middle diameter of the field of view; then lay on the glass plate, a thin glass slip whose edge must be adjusted so as to bisect the field of view longitudinally to the edge of the slip after its edge has been focussed on by a 1-6th objective. Compress, and retain the slip in position. Carefully remove the stage, and by the aid of a small diamond trace a line along the edge of the slip on the left side of the stage plate. Or, a fine splinter of flint, or carborundum will serve to scratch the line. If this is done properly the line may be shoved through the field for a full inch or more being continuously in view in a field of 2–100ths of an inch. This line once established on the plate becomes a guage or recording point for all objects on a cover glass mount of one inch area within close limits. Additional benefit is derived from tracing such a line on the rigid metal stage plate. The line traced on the metal plate must, if prolonged, pass through the center of the field of view, when limited to the field of a 1–6 objective.

The same line also becomes a guage line, enabling the field of any object to be recovered subsequently. In order to utilize this line at its full value, it is necessary to make an easily seen dot on the axis of the line at a distance of one inch from the center of the field of view, this line and its point is fixed on the left hand side of the metal plate, being the equivalent of the fine line on the glass plate when used above it. The index dot may be fixed by a few trials, while the glass plate with its guage line is in position on the metal stage. The dot should register under the line at an inch from the center of the objective.

Assuming that these two guage lines have been properly traced on the glass and the stage plate, one can then

test its registering action for particular objects in a mount of a square inch of area or less. Placing the glass stage plate in position on the metal stage, a mount of strewn diatoms is placed in the sliding carrier. A momentary examination may show some single object of interest and this is brought to the center of the field of view. Allow the object to remain there for a moment, while with a pen you put a dot of black ink exactly over the guage dot traced on the metal stage plate. Repeat this for any other objects that may be noted to the limit of five or more. If the mount is now set aside the ink dots register, on the slide, the several fields of the objects so noted and may be found at any subsequent time. This is the widest application of the combination of the two straight lines and is a means of locating the intersection of two co-ordinate lines at the point of their intersection from the fixed center of the objective in use. If one ignore the guage dot, the position of any object may be closely registered by the aid of the single line or directrix marked on the glass stage plate. Any object noted in the mount is brought to the center of the field, and allowed to rest there a moment. An ink dot is made on the slide at any point along, but immediately over the line. If after doing this the slide is run out of the field of view, on again placing the ink dot above the reference line, the whole glass plate is slid carefully through the field when the object is likely to be found by a slight oscilation of the slide while passing through the field. Since the real field under a power of 500 diameters may be 2–100ths of an inch, the shifting amplitude of the slide carrier should be very minute. In the vermicular shifting of a slide by hand in the usual way in a field of 500-600 diameters the act might consume ten minutes before the desired object could be found.

To explore slides without missing a particle of their contents, it can be used this way: Any histological or

diatom slide may be placed on the plate carrier, and the stage axis tilted 45 degrees if the stand is not rigid. Then rest the glass plate on the metal stage. The slide carrier may be slid up and down fifty times in ten seconds by the right hand, while the left hand pushes the glass stage plate across the field in an unvariable horizontal course by impulses of one thousandth of an inch or less. By this means not a speck can escape scrutiny.

Another valuable use of the glass stage plate is that by placing a slide on it, on whose surface is a liquid containing diatoms, a moving diatom once in a field of a 1-6 objective may be kept there and its movements studied for hours at a time. The movable stage being of suitable weight may be constantly shifted for long intervals without causing a jar or tremor of the slide. The slide itself is not touched after being put in position on the plate. A small hemispherical condensing lens can be easily attached to the under side of the plate by a liquid contact, and a strongly lighted field can always be had by turning the light from the concave mirror onto the lens.

On Double Color Illumination.

It is possible with substage condenser and iris diaphragm to so light a diatom as to reveal the primary structure in one color and the secondary in another. Heretofore workers have used cones of light greatly exceeding the aperture of the objective or else cones very much smaller than the aperture of the objective. The former was on the dark ground principle—the latter involving diffraction. But Mr. Rheinberg has found a plan for getting rid largely of diffraction color effects and for using any cone of illumination desired. Just as in low-power color illumination on the dark ground principle, he places in the substage condenser one of the ordinary

double color discs having a central spot of one color surrounded by a ring of a strongly contrasted or complementary color. He prefers a red centre and a green periphery. By means of the iris diaphragm, the relative proportions of the two colors are so regulated that in looking through the lenses the light appears to be of a neutral tint. This arrangement is suitable for use with high power objectives.

Recent Diatom Discoveries.

A long-shaped aperture in the nodule of Navicula rhomboides has been found by Mr. Nelson using Powell's apochromatic adjustible condenser. Pipes and a central spot in the nodule had been before seen but no aperture in so small a species of Navicula as the rhomboides.

In the diatom Biddulphia elaborata the termination of the stalk is called "the rose of the diatomic watering pot." Attached to the oval periphery of the valve is a rim only .00041 of an inch high. The general appearance of the valve can be compared to an oval tea-tray having a convex mound in the centre as high as the rim and a pipe with a watering-pot rose top rising up a little distance from the ends of its longer axis. The close-set papillæ which are small pipes analogous to the perforation in the nodule of a Navicula rise from the centre of a crater which is at the top of an elevation in the middle of the valve. The edge of the crater is level with the top of the rim round the periphery of the valve.

The ridges radiating from the center of the valve between the rows of large areolations are caused by a thickening of the silex, being located in the thinner part of the silex. On the thick ridges between the rows of areolations are intercostal dots. They are very irregular and many are missing.

This diatom has been supposed to lack a finely perforated membrane except on the conical side and convex top of the rose of the watering pot. The new Powell condenser, however, reveals it. It can only be seen by means of a direct axial cone of maximum dry aperture.

In Auliscus sculptus, Nelson has at last succeeded in resolving the rose pattern in the processes of this diatom. It was found in A. racemosus in 1891 which led to the supposition that it existed in sculptus. It is exceedingly fine but it is there. Sculptus also has very fine perforations in its beautifully fine sculptured border. All the above diatoms were mounted in balsam. Some discoveries have also been made in Actinocyclus ralfsii and in Eupodiscus argus by Mr. Nelson who recently reported them before the Quekett Club.

PRACTICAL SUGGESTIONS.

BY L. A. WILLSON.

CLEVELAND, OHIO.

MOUNTING UNCINULAS.—The quickest and best way to mount these beautiful fungi is to preserve them unstained ed in glycerine jelly. They show best when temporarily examined in a drop of water but jelly is the next best thing. Few prettier specimens can be found for a cabinet. Though generally unknown and unseen it is almost impossible to pass through the woods without trampling them under foot. They are found on the leaves of Tillia americana, grape leaves, Virginia creepers, bunches of grapes, on maple, elm, and other leaves.

EXHIBITS.—When invited to exhibit slides to a mixed company, the majority of whom are not scientists, do not take technical specimens but take the prettiest slides

you possess. A handsome slide under an inch objective will excite more than a triumph of manipulation under a one-tenth. The beak of a mosquito will produce a total eclipse of Bacillus tuberculosis. It is unwise to use high objectives at such a soiree.

Sclerogen.—This tissue is finely exhibited in the grit of a pear. With a penknife, cut as thin a section of a ripe pear as possible. Place the section on a glass slip, under a thick cover. Press out the section and examine. To press out, wrap the finger with a clean handerchief. The naked finger would grease and soil the cover. The specimen is easily prepared and is well worth examining.

EDITORIAL.

Image of an Image.—Dr. T. O. Reynolds writes that 14 years ago he experimented in the line that Gates has succeeded in. He had a B. and L. Investigator and another inferior instrument with which he tried to get an image of an image. He was discouraged because he did not get the focusing of the second instrument accurately determined. He overlooked the fact that the attenuation of light, due to the extreme magnification, rendered the image, which was really there, invisible to the human retina. He has always believed that it would be accomplished, and that the molecule and atom would be revealed as plainly as the markings of Pleurosigma. He was therefore in the opposite mood from those silly egotists who have ridiculed the matter in the petty prints of the day, and hails with entire credence the announcement that Gates has by long exposure of a sensitive photographic plate got the cumulative action of light which the eye could not gather. He looks for an unlimited expansion of our powers in this way.

Fish Commission.—*Natural Science*, of London, announces a long list of appointments to professorships and govern-

mental positions, zoological and botanical, and throws into the list—"a person named Bowers, from Martinsburg, W. Va., to be U. S. Fish Commissioner." The work of the U. S. Fish Commission is by law largely practical, statistical and economic. Of course zoologists and ichthyologists who care little for what is outside of what they call "science," would have preferred to welcome some college professor to this position. But Professor Baird, the founder of the commission, set the precedent by recommending as his own successor "a person named" Ferguson. President Cleveland appointed "a person named" Brice as commissioner, and the present appointment continues the divorce of fish hatching from embryology, classification and museum collecting. The new commissioner would do well, however, to call to his aid men of science who can work with practical ends in view. Perhaps money has been wasted in the past from too severely ignoring practical men of science and from assuming that men of science must of necessity be unpractical.

Testing Tuberculous Milk.—At Owen College, London, Prof. S. Delepine takes the milk directly from a single cow into a sterilized vessel and avoids all mixing. In the laboratory 80 c. c., of the milk are centrifugalized in two stout cylindrical test tubes holding 40 c. c. each. The tubes are sterilized by steam. A centrifugal machine giving 3,000 revolutions per minute is used for 15 minutes. The tubes are kept closed with an india rubber cap till the moment they are used. When the centrifugalization is completed the thickness of the layer of cream and the diameter of the sediment are measured, the color of the milk and sediment are told, and the reaction and specific gravity of the milk in the bottle are taken. Microscopical preparations are then made with the cream and sediment of the prepared milk. One drop of cream is taken with a sterilized platinum loop, spread on a cover glass and allowed to dry. The cream, together with the milk, is then removed by means of a wide pipetle connected with a vacuum apparatus. This is done with the tube standing vertically and without disturbing the sediment. When

only a thin layer of milk remains the tube is inclined gently so as to expose the sediment which adheres firmly to the bottom of the tube, and a small drop of it is taken and spread on the cover-glass. This is done with a platinum loop holding 2–3 milligrams. Several cover-glasses are prepared in this way. Drops of cream and sediment can then be examined at once for the detection of cells, foreign bodies and motile bacteria. The other drops spread in thin layers are allowed to dry, are then passed three times through the flame of a Bunsen burner, then left 20–24 hours in a mixture of equal parts of ether and absolute alcohol. At the end of that time the alcohol and ether are heated over a water bath to complete the extraction of the fat, the cover-glasses are taken out, washed with absolute alcohol, and are then ready for staining by one of the usual methods. If they are stained for tubercle bacilli, the Ziehl-Neelsen method is best. If the staining be with aniline dye for special purposes the film should be submitted first to the action of a dilute acid for a few seconds. Sulphuric acid, 10 per cent is good. If acid is not used, the proteid matter coagulated on the cover-glass, in the spaces between the fat glands, stains deeply, and neither micro-organisms nor cells can be seen distinctly. This permits obtaining a permanent preparation which shows clearly the number and size of the fat globules. Immediately after preparing the films two guinea-pigs are inoculated, each with the sediment of 40 c. c. of milk. The sediment contained in each tube is mixed with a little of the supernatant milk so as to make a total quantity of 2 c. c. for subcutaneous injections, and 5 c. c. for peritoneal inoculations.

Fine Meshes.—If No. 20 miller's silk, which is regarded as the best kind, be used to collect plankton, it is important to remember that not all organisms are stopped by it, and that while new silk lets many forms go through, after it has become clogged with diatoms, etc., less forms will pass its meshes. It is not at its best when new, and after reaching its best it begins to wear out. This suggests using a double bag for straining drinking water, catching

with the older and better silk what goes through the newer. Estimates of quantity taken are therefore not to be taken as infallable.

A Local Society.—The Central New York Microscopical Society has been dead for years. It never was very enthusiastic, and would not have lasted so long as it did but for the place of meeting in Syracuse having been furnished free of charge by Dr. Robert Aberdein. Some of the amateurs left microscopy and went into the Camera Club to practice photography. Has not this been the case elsewhere? How will Syracuse, without any local society, get on when its turn comes to entertain the A. M. S.?

Washington Society.—The February meeting occurred February 9th, when the vice-president, Dr. Robert Reyburn, read a paper and gave lantern slide illustrations on the life-history, and character of the principle forms of bacteria with which medicine has to deal. Some eight or ten members were present. Mr. A. A. Adee is president for 1898; Mr. H. H. Doubleday, corresponding secretary; Mr. L. M. Mooers, recording secretary, and W. H. Seaman, curator. This society has no expense for rent, light, or heat, all these being given gratuitously by Dr. Reyburn who has been one of the oldest and most faithful of its members. Its dues are, however, prohibitive to some people. It will be remembered that Dr. Reyburn was one of the physicians that attended Garfield during his long suffering in 1881.

Subscribers.—There are a few people who read our journal regularly and, we much regret to say, are unknown to us because they take the journal through some dealer who thinks it to his interest to conceal their names from us. We have a communication of interest to them if they will kindly forward their names and addresses.

One or two subscribers have made themselves heard quite loudly today because of an unintentional oversight. We beg you all to be patient, and to politely remind us of any seeming neglect. Remember that we have hundreds of people to write to while you have but a few.

Flour.—At the recent meeting of the Indiana Academy of Sciences held at Indianapolis, Ind., December 29th, 30th, C. G. Ferris read a paper on "Micro-organisms in Flour," A. W. Bitting read one on "New Apparatus for Photo-microscopy," and one on "The Number of Colonies of Bacteria and Moulds Formed by Testing Air, Milk, and Water by Different Culture Media."

Diatoms.—At the annual meeting of the Nebraska Academy of Natural Sciences, held at Lincoln, Nebr., November 26th, 27th, Dr. E. H. Barbour read a paper on "Our Beds of Diatomaceous Earth and Their Associated Fossils." J. P. Rowe spoke on certain "Peat Beds and Their Underlying Diatomaceous Deposits."

Government Position.—On February 23d an examination was to be held for the position of assistant microscopist in the Department of Agriculture. It was announced that only women would be eligible. Some of the "equal rights" women are complaining of the unfairness of limiting this to one sex, even though it be their own. They wish all kinds of differences between the occupations to be broken down and a free competition between the sexes.

The Observer.—From 1890 to August, 1897, Mr. E. F. Bigelow published this monthly containing a microscopical department, at Portland, Conn. He has some back numbers to dispose of very cheap—from 40 cents to $1 per volume, odd numbers 5 cents. In a sense back numbers are as valuable as current numbers, and are useful for reference. He also offers his "Plant Analysis" blanks, in books, in portfolio, or separately. Address him in care of this journal, or see his advertisement in *Popular Science News* into which *The Observer* was merged last August.

Duty on Slides.—A subscriber asks if there is any duty to be paid on Hornell's slides coming from England. They have been sent into this country to a good many people without paying duty, and it is not probable that duty is ever demanded. If it should be in any case, refuse to pay it and appeal to the Secretary of the Treasury explaining

that microscopical slides are specimens of natural history objects.

SCIENCE-GOSSIP.

Amplifier. — Thirty years ago Dr. Woodward, of the Army Medical Museum, was deeply interested in perfecting the art of photo-microscopy. The device of introducing into the body of the microscope an amplifier was so successfully carried out that he was enabled to obtain a greater and more accurate amplification or magnification of the object with a Wales one-sixth than was possible with the Powell and Leland one-fiftieth. A micro-photograph of a frustule of the diatom Pleurosigma angulatum had its markings so resolved by the one-sixth plus the amplifier that they were shown to be hemispherical bosses of silica rather than hexagons, as the one-fiftieth and all other lenses then known made them appear. The result was owing to the superior resolving power of the one-sixth plus the amplifier. A second microscope is infinitely superior to an eye-piece for the amplification of the "real" image. But how do we get it collected. "The line of light falling on the photo-salt in the film spreads by molecular irradiation over more area than the actual width of the line of light, and there is also diffused reflection of this line of light by the semi-transparent substance of the film. To these two causes is due the fact that when the details of two structures are too close together in an image of an object these structures will photograph as one, and thus the detail will be lost. If the new details are to appear the image must be enlarged before it is photographed."—Gage.

Epithelioma.—Dr. Hartzell reports a case in University Hospital, Philadelphia, of a sixteen-year-old boy who carried a pea-shaped ulcer above his cheek for two years. Microscopic sections were made from the border of the ulcer. They revealed a neoplastic structure consisting of fibrous stroma in which were numerous irregular-shaped branching tracts of columnar epithelium, and a round-celled

infiltrate separating the neoplasm from the healthy tissue. A forty per cent plaster of pyrogallol was applied for two weeks. Then boric acid ointment produced rapid healing. A small ulcer on the edge of the nostril was excised and microscopically proved to be much the same in structure. These ulcers are almost unknown in the young, and but for the microscope probably would have been misunderstood.

Gastric Ulcers.—In a recent case complicated with erosion, microscopical study showed that the mucous membrane of the stomach was affected with numerous necroses which could be attributed neither to anemia, bacteria nor blood infarction. They were approximately one millimeter in depth.

RECENT PUBLICATIONS.

Morbid Histology.—A text book on this subject, by Professor Boyce, of London, is published by D. Appleton & Co., New York, at $7.50; pp. 477; colored illustrations, 130.

Tariff.—The Dingley tariff law is in pamphlet form and may be had by sending five cents to W. F. Wakeman, 135 W. 23d street, New York City. Those who contemplate importing instruments, slides, books, or anything else need it.

Whist Opinions.—This is a new paper which will interest all lovers of the American game. Address, Box 761, Baltimore, Md.

Ormsby's Geo-Helio Ephemeris is an astrologer's almanac for 1898. If interested send 50c. to the Planetary Publishing Co., 169 Jackson street, Chicago. Best almanac printed.

Photomicrography. — "How to Photograph Microscopic Objects," by J. H. Jennings; for sale by the Outing Co., 239 Fifth avenue, New York. Price in cloth, 75 cents, post paid.

MISCELLANEOUS.

Wanted.—1-12 to 1-16 immersion objective, 1.30 to 1.40 N. A., adjustable. Address, Dr. Studebaker, Springfield, Ohio.

For Sale.—At London price, a Swift's Bacteriological Microscope, Crookshank pattern, with high angled lenses and Abbe Acromatic Condenser. In perfect order and nearly new. Particulars from A. H. Thomas, M. D., 611 Taylor street, San Francisco, Cal.

For Sale.—A Hartnack microscope in good condition, three oculars and five objectives, including one immersion. Price $50. Address, W. Adler, care of this Journal.

Slides.—The estate of a deceased physician offers 700 slides for sale at $10 per hundred. Also, Beck Binocular and six objectives and other accessories worth $350.—E. E. W.

Exchange.—Arthur Donnelly, Davisville, R. I., wants to exchange a new French microscope, with case, for which he paid $6, for bird skins or books on taxidermy.

Redondo Beach Diatoms.—One of our Austrian subscribers wants genuine Redondo material, 4 or 5 kilograms, and no other California earth. Will give in exchange celebrated European and Asiatic material, fossil marine, or if necessary, will pay cash. Address, J. C. Rinnbock, care of Journal.

Wood Sections.—Send to R. B. Hough, Lowville, N. Y., for sample of his sections of wood, 1-1200 inch thick, showing three distinct views of grain under each cover glass.

King's Slides.—We have just received a beautiful collection of slides from J. D. King, Ph. D., of Cottage City, Mass., and think they ought to please the most exacting. Send for his catalogue. Located on the very best part of the Atlantic coast he has unexcelled opportunities to gather marine specimens.

Leidy.—A copy of Fresh-Water Rhizopods of North

America, with its 1,190 colored figures, is offered by one of our correspondents in Albion, N. Y., for $4.25. The book is rare and now hard to get. This is the only copy we know of on sale.

Walter White's Botanical Specimens.—Now we are ready to send complete sets of the beautiful microscopical objects. Please send new orders.

General Index.—If you have not had the general index to the first sixteen volumes of this journal please write immediately for one, and state which volumes you have preserved.

In German.—We have some extra copies of *Zeitschrift fur Angewandte Mikroskopie, von G. Marpmann, Leipzig*, to send free to those who wish to see sample copies.

Books.—A subscriber asks about John Phin's publications. Send to the Industrial Publishing Company, 16 Thomas street, New York, for list of Phin's books and other microscopical publications. They are all cheap but not the latest published.

Royal M. Society.—At the meeting on January 19th, the president reviewed the progress of Microscopical Science during 1897, and gave an account of the manner in which achromatic doublets and triplets are practically calculated.

Personal.—Prof. Jeffrey Bell, one of the secretaries of the Royal Microscopical Society is to be succeeded by Dr. Hebb.

Medical Journals.—There are 275 medical journals in the United States. Combined circulation, 16,017,200 copies.

Personal.—Lyman M. Ellis, M. D., is lecturer on Histology in the Gross Medical College.

Arnold S. Taussig, M. D., is instructor in Microscopical Diagnosis in the Gross Medical College.

George N. Carpenter is editor of the *Irish Naturalist.* We shall be pleased to forward requests for sample copies if written on 2-cent postal cards and sent to us under cover with remittance for subscription due us.

THE AMERICAN

MONTHLY

MICROSCOPICAL JOURNAL.

VOL. XIX. APRIL, 1898. NO. 4.

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The Eye of Pecten Irradians or the Scallop.

BY F. A. ROGERS, M. D.

A general study of the great and important sub-kingdom of the animal creation, the Mollusk, reveals many new and strange things to the lover of nature, while some of the minute rudimentary forms of the special organs of sight, hearing, taste and touch which Mollusks possess make very interesting objects for microscopic examination. As we look at the clam, oyster, scallop, snail and the multitude of forms belonging to the Mollusca the inquiring mind often wonders how much of what is going on around them do they perceive and by what means if any is light, sound or taste, any or all of these communicated to these organisms. In some forms the special organs of sense are more highly developed than

in others and where there is no special need either from habits or surroundings for them we find very primitive organs formed and developed. It will pay to carefully inquire into the existing special conditions which are found in many of these forms and which led the writer of this article to carefully study the make-up of a very common Mollusk found abundantly on the shores of Cape Cod and which is popularly called the "scallop." A cursory observation of Pecten Irradians, or the scallop, with its scalloped edge from which this Mollusk derives its vulgar cognomen and the varied hues of the curved lines on the outside of this bivalve presents a very unique appearance.

But a view of the hidden beauty which lies within can only be observed after careful study and some painstaking research.

There are two great divisions of Mollusca, the Glossophora, (Mollusks with head region prominently developed and always provided with an odontophore or rasping tongue) and Lipocephala, or Mollusks with undeveloped head region (acephalous) and which have no cephalic eyes or rasping organs.

The Pecten belongs to the Family Ostracea which includes the edible oyster and is a division of the Order Monomya which has for its special characteristics the facts that the Anterior Adductor muscle is absent and there is no siphon as is the case with the clam. It has however a large Posterior Adductor muscle which is much prized as an article of diet and to obtain which millions of the mature organisms are yearly sacrificed.

Again the Order Monomya comes under the class of the Lamellibranchia which may be defined as a Lipocephala or acephalous Mollusk having ctenidia or gills in the form of layers disposed symetrically, two on each side of the bivalve.

In some Lamellibranchia although there are no ce-

phalic eyes yet special organs of sight are developed on the free margin of the mantle-skirt; such is the case with the scallop.

In the living state under water, just within the margin of each valve may be observed a row of minute points of great brilliancy, sparkling like diamonds, each surrounded by a dark ring of epithelial pigment. These are the eyes provided for the use of the Pecten by which its active movements are directed, for this Mollusk has the power of rapid swimming by opening and shutting the valves of the shell.

Each eye is a beautiful structure provided with a sclerotic coat, a transparent cornea, pupil, crystalline lens, retinal body, optic nerve, in fact everything that would necessarily enter into the composition of a good organ of sight.

Quite different is the make-up of this eye from some of the primitive eyes of the Cephalopods in which we should naturally expect to find highly developed sensory organs but which in numerous instances are simply a pair of hollow chambers opening to the exterior by minute orifices (pinhole cameras) and perfectly devoid of any refractive structures.

We can account for the more complete structure found in the Pecten only by studying its origin and development.

The development of the eye of some Mollusks shows that it is simply a modified area of the general epidermic layer and that the sensitiveness of its cells to the action of light and their relationship to the nerve-filiments is only a specialization or intensification of a property which might, as far as we can see, occur anywhere on the general surface of the body.

The primitive optic vesicle is said to arise as a pit or depression in the epiderm and the integument around it rises in the form of a ring-like upgrowth gradually con-

verging so as to enclose a spherical chamber, devoid of lens and cornea in some instances, but having a minute hole communicating with the outside and filled with sea-water during life.

The eyes of Pecten however originated not as pits or depressions in the exterior membrane but as tentacles and while in the cephalic eyes of Mollusks the fibers of the optic nerve join the posterior nerve-end cells; in this instance the optic nerve penetrates the capsule of the eye and passes in front of the retinal body so that its fibers are inserted into the anterior aspect of the rods as they are in vertebrates.

Again the lens in the eye of Pecten is not a product of the cuticle as is the case in most Mollusks where the closed cavity is wholly or partially filled with a refractive body, the lens being secreted from the walls, but is a cellular structure which again corresponds with the eyes of vertebrates.

Thus we note several points of agreement in the eye of this Mollusk with those of higher organizations and by carefully manipulating a portion of the mantle-skirt containing the eyes we can demonstrate these facts for ourselves.

In order to study the eye, small portions containing one or two eyes and not over two or three centimeters thick should be cut from the mantle-skirt and properly treated by fixing, hardening, embedding, cutting, staining, etc.

To show the retina the best results will be obtained by fixing in a 1 per cent solution of Osmic Acid, although excellent general results may be had after fixing in 40 per cent sol. Formaldehyd or a saturated aqueous solution of Mercuric Chloride. After fixing with Mercuric Chloride the tissue stains beautifully with Borax-Carmine, but no staining whatever is required if the tissue is fixed and hardened in Osmic Acid.

Embedding in Celloidin will give good results but not to be compared to the Paraffin method when properly manipuled, in beauty of detail, as well as mounted consecutive sections, which are needed in the study of this eye.

There is a considerable variation in the number of eyes found in this bivalve, for while in some as low as 64 have been counted, in others over 100 have been found. Perhaps the average number would be found between 84 and 96. The eyes are distributed quite evenly along

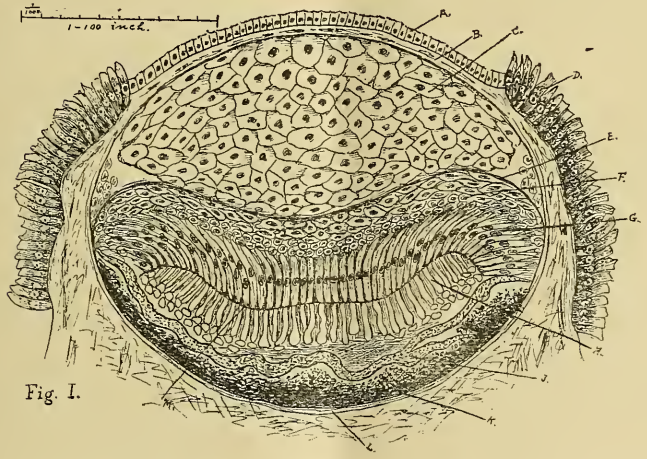


Fig. I.

the free surface of the mantle. There is also some difference in the size of the eyes in each individual scallop; those which are placed where they are of the most use in seeing being largest in size, though not more perfect in their component parts. The mantle when touched or irritated contracts taking the eyes with it so that although there are no special muscles of motion attached to the eyes yet by the contraction of the mantle they may change their relative position to the objects which surround them. The surface of the eye is everywhere surrounded by pigmented epithelial cells except the co

which has a single layer of transparent pavement epithelium on the surface.

The shape of the interior of the eye which includes the organs of vision is nearly oval. It is longer in the equatorial than in the polar diameter, measuring 1-40 by 1-50 of an inch and it is surrounded by a choroid coat which becomes continuous with the cornea. On polar section the interior of the eye is seen to be divided into two nearly equal parts by a beautifully curved line formed by the expansion of the optic nerve. Fig. I, E.

The anterior portion or chamber contains nothing but the lens which occupies nearly the whole of it. The posterior chamber contains the complex structure of the retina, tapetum and pigment and all these collectively are situated in the end of a tentacular portion of the mantle. I shall now give the details of the several parts separately as the result of my observation.

The Cornea.—The tissues of the cornea are arranged in two layers; an outer pavement epithelium and an inner or true fibrous layer of the cornea. The membrane of Descemet and the internal epithelium or endothelium are wanting. The cornea simply resting upon the lens without the intervention of aqueous humor. In shape it is circular and at the periphery or margin it is continuous with the choroid coat and tentacular portion of the eye.

It measures 1-80 inch in diameter. (These measurements are for average eyes). The external or outer layer consists of a single layer of nucleated pavement epithelial cells elongated in a direction perpendicular to the surface and situated directly upon the corneal tissue. In a stained section it appears like a row of beaded cells as a margin to the cornea. The cornea seems to be made up of a fibrous structure with very fine conmmunicating channels which may be seen upon cross-section of eyes treated with Osmic Acid also by gently scraping the epithelium from the surface and impregnating with Gold

Chloride. It does not appear to be supplied with nerves although nerve filaments may be seen running to the very edge of the cornea and communicating with the pigmented epithelial cells surrounding the eye.

THE LENS.—The lens is an oblong, oval body and occupies nearly one-half of the globe of the eye. I have never been able to make out any capsule. If one exists it must be exceedingly fine. It seems to simply occupy the space between the cornea anteriorly and the expansion of the optic nerve posteriorly. Its structure is cellular, being made up of irregular, polygonal, nucleated cells.

The cells along the front border are larger than the others and more nearly round while those around the margin and back toward the retina are oblong and spindle shaped. There is no space between the lens in front and the cornea and it appears posteriorly to lie in close opposition to the ganglion nerve cells of the inner border of the retina, or the membrana limitans interna.

The equatorial diameter of the lens is slighly greater than the corneal opening, the average measurements being 1-50 inch long, or in the equatorial direction, and 1-100 inch, thick or in the polar direction of the eye. In fresh eyes the cells of the lens are nearly regular, hexagonal in shape, united together at the edges. In the central portions the cells measure 1-1200 inch in diameter; on the outer edge from 1-1000 to 1-800 inch in diameter while the longer cells measure 1-2000 inch wide by 1-500 inch long.

THE OPTIC OR RETINAL NERVE.—Along the border of the mantle there is a nerve which runs just back of the eyes, and from this nerve are given off branches, one of which runs to each eye. Just previous to its approach to the eye it divides into two nearly equal parts one of which is the retinal or optic nerve proper. The optic nerve maintains its integrity although it pursues a tortuous

course and follows the curve of the eye, at first being wholly on the outside of the choroid but as it advances it sinks itself into and through this coating until it encroaches upon the retina. Fig. IV., B.

It continues until the equatorial diameter of the eye is reached when it turns at a right angle and passes directly across the eye just back of the lens where it expands and becomes the inner layer of the retina. The branch from the optic nerve which is known as the complementary nerve, runs a short course to the back of the eye where it divides and subdivides into numerous branches which spread out on the outside of the choroid, where in the vicinity of the equator of the eye they appear to be distributed very evenly, as seen on cross-section, in collections or bundles. The further divisions may be traced to the pigmented epithelium of the tentacular portion of the eye where they end in very small corpuscular bodies from which exceedinly fine wavy filaments extend to the individual pigmented cells. Fig. III. Branches are also given off which penetrate the choroid coat. This branch is evidently a nerve of general sensation while joined with it back of the eye is one of special sensation, or the optic nerve.

The Retina.—Of special importance and interest is the study of the retina. The ordinary methods of hardening and staining do not well show the retina for the picture is very much distorted, the rod and cone layer is destroyed or lost to view, but by hardening in Osmic Acid and taking special pains in the further manipulations I have slides which are beautifully correct in all the details.

By this process the retina is shown to be composed of three principal layers; an internal nervous layer; a middle, nucleated spindle celled layer, and an external club shaped, palisade-like layer. The internal border of the retina as seen on polar sections of the eye is limited by

the beautifully curved line which is the membrana limitans interna. Immediately back of this layer is found the ganglion layer of the retinal or optic nerve which is composed of irregular shaped nucleated cells. Some of these cells have polar prolongations but as a rule it is difficult to make these out. In the center of the eye these cells are rounded or slightly oblong while at the periphery they assume an oblong shape and are larger. Next to the spindle celled layer the ganglion cells become smaller and appear to lie close to the ends of the spindle

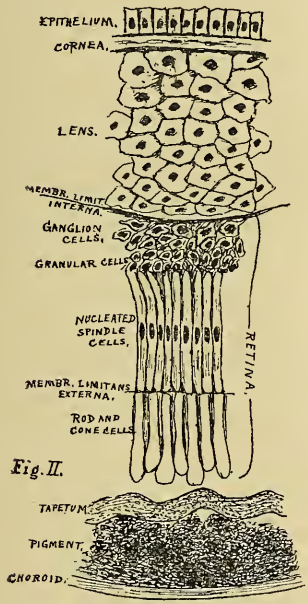


Fig. II.

Fig. III.

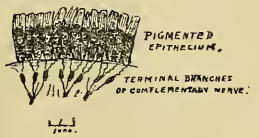
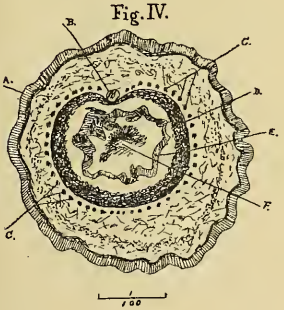


Fig. IV.



cells with which they are undoubtedly continuous. The spindle cell layer is made up of long nucleated straight and bent spindle shaped cells which lie close together. In the central portion they are shorter but straight and the ends of the cells are simply rounded; while upon either side they appear bent and the ends are pointed. The cells in the central portion of the retina are arranged parallel with the polar direction of the eye but

as the periphery is reached upon either side they gradually assume a nearly horizontal or equatorial direction. They measure about 1-600 inch long and 1-4000 to 1-2000 wide. The outer ends of these cells form a beautifully distinct, regular, unbroken line; the membrana limitans externa, (Fig. I, M.,) and external to this is found the palisade layer which corresponds to the rod and cone layer in vertebrates. This layer is composed of irregular, long, club-shaped, non-nucleated cells which are arranged with their long diameter perpendicular to the membrana limitans externa. In the central portion of the retina these cells are coarser and shorter than upon the sides. The measurements of these cells are about two-thirds that of the previous layer. The free ends of these cells are distinctly rounded and club-shaped and no external segments are to be discovered but they seem to be surrounded by a homogenous fluid or very finely granular substance that fills the space between this layer and the tapetum which we next consider.

Tapetum Lucidum.—Of peculiar interest in stuying the eye of Pecten is the tapetum lucidum. It is a bright colored and apparently light-reflecting membrane situated directly back of the rod and cone layer of the retina. In eyes hardened by the various common methods it appears upon cross-section to be thrown into various folds and masses which do not assume any certain order. The best and most striking view of this membrane may be obtained in equa-sections of the eye after hardening in Osmic Acid. It then forms a very beautiful and interesting object for the polariscope. It is not necessary however to use a polariscope to view the beautiful coloring of this object for in posterior equatorial sections of the eye may be seen the broad annular ring of pigment in the center of which the angular, iridescent mass of the tapetum appears. By using transmitted light, rich rainbow colors strongly contrast this part with the sur-

roundings, appearing as it does like some crystalline object or laminated mineral substance which has been sectioned at a slight angle with the plane of cleavage. Brilliant blue, orange, and ruby red are the colors that predominate if transmitted light is used, while with a dark ground illumination luminous colors of a light blue, golden and pearly hues appear. The surface of a section of the tapetum made in the above plain appears under higher powers to be finely granular. The granules are arranged regularly in lines which cross each other at right angles giving the appearance of the markings seen upon some diatoms with a fineness and clearness about equal to Pleurosigma when mounted in styrax.

The tapetum is circular in shape and has the edge or periphery attached to the interior of the choroid coat of the eye and on a line about one-third the distance from the posterior portion like a veil hung across.

It does not, however, extend directly across the eye but the free central portion conforms to the globe of the eye so that on cross-section it is irregularly semi-lunar in shape. At the marginal attachment it is very thin but in the central portion it is 1-2500 inch to 1-1600 inch thick. The markings and iridescence do not appear on cross section but they do appear in teased portions of fresh eyes mounted in salt solution or acid glycerine.

Pigment.—The pigment layer is situated back of the tapetum lucidium, by which on the front it is bounded and on the back by the posterior portion of the choroid. The amount in different eyes varies. In some eyes it apparantly occupies about one-fifth the distance from the posterior to the anterior part of the globe, being 1-250 inch thick at the center, while in other eyes it is not more than one-half as thick. The thickness and relative position it occupies to the other parts is best seen in polar sections of the eye, but a better idea of the composition may be had in equatorial sections. It

appears to be made up of granular pigment matter loosely put together with coarser and more dense, oval or irregularly shaped pigmented masses frequently scattered in the substance. By some methods of hardening the pigment appears not very unlike epithelial cells but such does not appear to be the case in fresh eyes or those treated with Osmic Acid.

The pigment rests posteriorly upon the choroid coat of the eye and the anterior portion is limited by the tapetum to which it adheres. In fresh eyes and those stained by the various methods the color remains the same, being a brownish red.

DESCRIPTION OF FIGURES.

Fig. 1. Polar section of eye. A, pavement epithelium; B, cornea; C, lens; D, pigmented epithelium; E, membrana limitans interna; F, ganglion cells of retinal nerve; G, spindle cells; H, rod and cone cells; J, tapetum; K, pigment; L, choroid; M, memb. lim. exter.

Fig. II. Diagramatic sketch of the arrangement of the internal parts of the eye, from one pole to the other.

Fig. III. The arrangement of the terminal branches of the complementary nerve in relation to the pigmented epithelium.

Fig. IV. Equatorial section of the eye about one-third the distance from the posterior portion of the eye. A, pig. epithel.; B, cross-section of optic nerve; CC, cross-sections of complementary nerve; D, pigment; E, tapetum; F, retina.

Figures I, II, IV, were drawn with a camera lucida and are supplied with a scale.

Microscopic Billingsgate.

The following separate phrases are all taken from a recently published article professing to be a notice of Gates' Mega-microscope :

Here's richness—it is painful nonsense—to offer such stuff is an insult—with pain tempered by uncontrolable laughter—without malice. May I presume to ask, if I do it humbly—with a loud noise—to amaze the groundlings? Does the Smithsonian know any elementary microscopy? Where outside of Washington is tomfoolery taught? It is useless. I feel pretty sure—an uncorrected Abbe condenser—has for some time been smarting—but it belongs to the public that buys it. Any scientific nonsense the more absurdly inaccurate the better—the reader will be repaid—the back settlements will be impressed with millions of diameters and all the preposterous results—the other fancy fixings will resolve—a small hole. Won't Abbe Dallinger and Van Hurk be glad to learn about that hole? It is not necessary to disturb these—ubiquitious and irresponsible—gentlemen. Is the editor equally ignorant? Is he a crazy man? It is of little importance. The beads are in the ash-box—according to his dictum. There is no more ardent lover of salutary medicine than—Pleurosigma pellucida [sic]. I propose to imitate—I am to all intents and purposes—public property open to criticism—I don't believe the Smithsonian knows that—even the American will eventually turn and—the amateur microspist—receives scant courtesy from the amateur—half-informed editors. The editors over the sea possess knowledge enough to keep from such absurdities—scientific nonsense—painful nonsense.

Extraordinary manipulative skill—with same nominal focus—would take his objectives apart and hurridily or in any other way—offer such stuff. Where is the leather-medal? It is of little importance—we shall never know. Is there no protection from such balderdash? When was the whole mass of microscopical rubbish set up? Where was the editor when that went into print? Outside of Bedlam—good fun if less sorrow—for incor-

rectly informed contributors. Why is the trusting, unsuspecting subscriber fed with—an explanation, an apology and an antidote. The editor owes him—another fatal defect. How can the same methed have another fatal defect? Amplification may be obtained by ludicrously complex means—belittled by their directors. If the stuff were inane only it might be treated with contempt but it is dangerously—microscopical facetiae—not worth the candle.

Here we have it again—he has got the focus—his improved Bardou lens must magnify—that assertion followed to its logical conclusion. It seems a shame. It is a pity. Is it not time to rebel? His blood cell covers a map 600 inches square. It is unfortunate. Could anything be worse? The editor owes him—the explanatory because. It is needed in Washington. There is none in this country. The two—dry mounts—will meet and commiserate—hardly to be wondered at. Nine or seven objects can be supplied which will not easily resolve—after he has done me the honor—too amazing to pass unnoticed. I am—I. Who are you? A crazy man?

Has he never heard of deep eye-piecing? When his —defenseless—extravagant—uproar died away nothing was left but silence—I feel—like marbles in a saucer.

PRACTICAL SUGGESTIONS.

BY L. A. WILLSON.

CLEVELAND, OHIO.

PREPARING HARD OBJECTS FOR SECTION CUTTING. — Woods and many hard objects may be easily and readily cut after boiling them. The length of time consumed in boiling depends on the hardness of the object. Some very hard substances require hours. Boiling does not

seem to injure the tissue, at least it does not when the object in view is to obtain a pretty section. For technical histological purposes it is prudent to examine the specimen in its natural state. Some of the planes used by carpenters when in skilful hands will produce elegant thin sections. The suggestion of boiling may, however, prove useful, and be capable of extensive application.

Scientific Names: —Scientific names constitute an universal language. One may read scientific works in other languages than his own and not have to translate the names of plants or animals. If there have arisen several names for the same object the rule is to select the earliest published. In the Smithsonian report of 1895, page 469, it is said: "There is nothing whatever of an ethical character inherent in a name, which should render it morally obligatory upon any one to accept one name rather than another. The rigid application of the principle involves the assumption that all persons who describe plants are equally competent to the task." Speaking of the change of Magnolia grandifolia into Magnolia fœtida, the author says: "It is difficult to see what is gained by making it, except to render systematic botany ridiculous."

Rhizoselinia eriensis. —This diatom is classed under Appendiculatæ and is described: Frustule, elongate, subcylindrical, marked with transverse or spiral lines, ends oblique or conical with one or more terminal bristles; marine. To an unscientific person it resembles a butcher's cleaver, sometimes with two handles, one on the upper and one at the lower extremity, and the markings resemble the teeth of two saws, with the teeth of one fitted into the teeth of the other. Though labeled marine it is found abundantly in the fresh waters of the great lakes. It is, never the less, a marine diatom. Its presence in the great glacial lakes is strong proof that the ocean once

beat the shores where the lakes now flow. The diatom is light and frequently floats on the surface.

CETRARIA ISLANDICA.—This is a striking lichen from the fact that the margin of the thallus is beset with pretty little spines. It is found in arctic and mountainous regions. It is commonly known as Iceland moss and the arctic plant is sold in all drug stores. It is generally found in fruit. It has been found in shady glens in Ohio and in New England, but away from its native home in a sterile condition. The fact of its presence in Ohio is a proof of the ancient glacier which once covered a large portion of Northern Ohio and brought this lichen with it to grow as a present monument of the distant past. The color of the plant is olivaceous-chestnut and the disk is dark-chestnut. The spores are simple, small, and colorless. The spinules are interesting as they contain the spermogones.

EDITORIAL.

General Index.—We can still supply copies of the general index (16 years) to this journal to those who have use for them.

Apparatus.—The micromotoscope is a combination of the microscope and the vitascope. It is an invention of Dr. R. S. Watkins, and by its aid bacilli can be unerringly discovered.

Insurance.—At length the insurance companies, which have always made medical examinations of applicants for insurance, have begun to make microscopical examinations of sputum and urine as aids to determining the health conditions of applicants. They have, however, found it difficult to get satisfactory service in this respect from ordinary medical examiners. They can perhaps waive it where the amount of money bet on one's life is small, but

in case of premiums involving $25,000 they may well employ the best experts. The urinary examination should never be omitted, and each large city can now support one or more microscopists who do this work. In St. Louis, the Paul Paquin laboratories are working up a large practice by advertising and by skillful work.

Opaque Objects.—Prof. Gates has discovered how to view, with a microscope of high power, the upper surface of an opaque object, by means of reflected light, in such a manner as to get details never before obtained by super-stage illumination. He finds by using rays of the shortest possible wave-length that he can focus down into an opaque object upon details beneath the surface. This is especially applicable to organic tissue. It is a discovery of the very greatest possible interest to pathology and biology in general. With lenses out of other substances than glass, he feels sure that he might be able to focus the ultra-violet microscope upon a living cell in the living cortex and take a photomicrograph of such a cell through scalp, skull, pia and dura, and neuroglia. He has been able already to focus upon a capillary beneath the sub-cutaneous tissues of the finger.

Angina.—Micrococeus tetragenus has been proven in cases of angina. There were usually manifestations of disease in the pleura preceding the angina. The cultures show it alone or associated with different microbes.

Mosquitoes.—Malarial disease is carried by these agents rather than by winds. It is well-known that people in houses protected by mosquito netting rarely get malaria.

Agar-agar Jelly.—Gallois uses it in skin diseases on account of cleanliness in lieu of lard or vaseline. For erysipelas take 1.5 grain corrosive sublimate, same of tartaric acid, 15 grains of agar-agar, and 3 ounces of water.

RECENT PUBLICATIONS.

Bacteria.—Two books have just been published in German on bacteria; one by Dr. W. Migula and one by Dr. Alfred Fischer, the professor of botany in Leipzig. The former is the first volume of a series, price 12 marks, and contains a general survey of the classification, morphology and development of the schizomycetes. Six plates and exhaustive bibliographies are given. Dr. Fischer's book, price 4 marks, is upon non-pathogenic bacteria, and excludes those met with in medicine. Metabolism, fermentation, nitrification, and the various physical and industrial processes get treated fully. There are chapters on morphology, classification, distribution, habitat, conditions of life, nutrition, and culture, respiration with detailed account of the relation of micro-organisms to nitrogens and carbonic acid.

SCIENCE-GOSSIP.

Faint Rays.—The ordinary leather and wooden walls of a camera allow a certain amount of light to leak through them, and the same is true of the imperfectly fitting sliding joints of the microscopes. All such light which leaks into the camera acts on the sensitive plate without helping to produce the image desired and so as to blur that image. But when the whole train of apparatus is within an actinic-proof box the exposure can be made for hours or days, so that the faint rays of the image can act cumulatively. This makes it possible to expose a plate for a long time without allowing any light to act on the sensitive plate except the light which forms the image.—Gates.

Yellow Fever.—The microbe of yellow fever is alleged to be a fact. Dr. Sanarelli, director of hygiene of Montevideo, who has demonstrated its existence and supplied a remedy for the disease, will probably be entitled to the 150,000 scudi ($150,000) offered as a reward by the Brazil-

ian Government. He claims also to have discovered a curative serum, and will shortly publish the results of his experiments.

Insoluble Glue.—To render liquid glue insoluble add to it about one-fiftieth of its weight of formalin, stir well, and then expose to strong sunlight for about ten minutes. The action of the light on glue or gelatin so treated is to render it insoluble.

Snake Poison.—In order to confer immunity against the bites of serpents in certain portions of Africa, the patient is inoculated with the poison of the alcatifa, a venomous serpent of east Africa. After the operation the person takes an oath never to kill a venomous serpent.

MISCELLANEOUS.

Wanted.—1-12 to 1-16 immersion objective, 1.30 to 1.40 N. A., adjustable. Address, Dr. Studebaker, Springfield, Ohio.

For Sale.—At London price, a Swift's Bacteriological Microscope, Crookshank pattern, with high angled lenses and Abbe Acromatic Condenser. In perfect order and nearly new. Particulars from A. H. Thomas, M. D., 611 Taylor street, San Francisco, Cal.

For Sale.—A Hartnack microscope in good condition, three oculars and five objectives, including one immersion. Price $50. Address, W. Adler, care of this Journal.

Slides.—The estate of a deceased physician offers 700 slides for sale at $10 per hundred. Also, Beck Binocular and six objectives and other accessories worth $350.—E. E. W.

Exchange.—Arthur Donnelly, Davisville, R. I., wants to exchange a new French microscope, with case, for which he paid $6, for bird skins or books on taxidermy.

Redondo Beach Diatoms.—One of our Austrian subscribers wants genuine Redondo material, 4 or 5 kilograms,

and no other California earth. Will give in exchange celebrated European and Asiatic material, fossil marine, or if necessary, will pay cash. Address, J. C. Rinnbock, care of Journal.

Wood Sections.—Send to R. B. Hough, Lowville, N. Y., for sample of his sections of wood, 1-1200 inch thick, showing three distinct views of grain under each cover glass.

King's Slides.—We have just received a beautiful collection of slides from J. D. King, Ph. D., of Cottage City, Mass., and think they ought to please the most exacting. Send for his catalogue. Located on the very best part of the Atlantic coast he has unexcelled opportunities to gather marine specimens.

Leidy.—A copy of Fresh-Water Rhizopods of North America, with its 1,190 colored figures, is offered by one of our correspondents in Albion, N. Y., for $4.25. The book is rare and now hard to get. This is the only copy we know of on sale.

Walter White's Botanical Specimens.—Now we are ready to send complete sets of the beautiful microscopical objects. Please send new orders.

General Index.—If you have not had the general index to the first sixteen volumes of this journal please write immediately for one, and state which volumes you have preserved.

In German.—We have some extra copies of *Zeitschrift fur Angewandte Mikroskopie, von G. Marpmann, Leipzig*, to send free to those who wish to see sample copies.

Books.—A subscriber asks about John Phin's publications. Send to the Industrial Publishing Company, 16 Thomas street, New York, for list of Phin's books and other microscopical publications. They are all cheap but not the latest published.

Personal.—Prof. Jeffrey Bell, one of the secretaries of the Royal Microscopical Society is to be succeeded by Dr. Hebb.

THE AMERICAN

MONTHLY

MICROSCOPICAL JOURNAL.

VOL. XIX. MAY, 1898. NO. 5.

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Making Transparent Latern-slides from Marine Specimens.

Mounting in balsam is essential so as to prevent mould, attacks by mites and because they are often too opaque. Some scale off from the glass and break to pieces unless they are mounted. It is wise to mount several, pick out the best and discard the others.

Often the animals are simply arranged on a lantern glass so as to touch it more or less completely all over their under surface, then dry and drain them. Many adhere round the drying edges before the central parts are dry; being thus fixed they do not shrink laterally on further drying but merely become thinner. If they scale off later, gum them down in one or more places lest they become loose when mounted in balsam. There are a few animals that will not adhere to the glass and yet

they shrink greatly so as to render mounting unfeasible.

Small flat fish like soles and dabs, two inches long, mount easily. Kill them in dilute alcohol, arrange on the glass as soon as dead and while limp. Carefully lay out the fins when they will dry and adhere well. Keep the side near the glass flat. As few animals adhere to a thin paper soaked in bees-wax, it can be laid over the animal and pressure applied of a fairly uniform nature upon thick and thin parts. This is best done by using a weight upon a stout glass covered with several thicknesses of fine thin flannel. Regulated so as not to distort the animal but rather to retain the shape and show the internal structures, the specimen will dry through the flannel and keep flat on the glass. Specially high parts can be pressed without flannel and with heavier weight.

Marine worms, like Sabella, and others make most excellent transparent slides, which show shape, color and internal structure. Kill them by retaining a short time in dilute alcohol and dry them before decomposition injures the small blood-vessels. In Nereis, the chief blood-vessels and the smallest branches may be shown while the even blood keeps its red color for years.

Priapulus.—This form can also be mounted without staining. Kill in fresh water. When the body begins to get limp arrange it neatly on the glass. It will adhere without lateral contraction. If mounted at once or after standing in alcohol, the body is too hard and will not adhere while on drying it contracts laterally producing distortion. To avoid this and to display the internal anatomy, cut the specimen open from end to end and stain with Beale's carmine or Kleinberg's haematoxylin. This brings out the musclar structure of the body-wall and the general internal anatomy.

Arenicola.—Cut the animal open and displace the intestine with appendages. Display them on the glass along side of the body. This partial dissection will

show the numerous blood-vessels passing to the lateral branchiæ from the main trunk along the intestine. The color of the blood may remain unchanged for years.

Eolis.—The beautiful Nudibranchs quickly lose color in alcohol. Hence transfer them after a short stay in dilute alcohol and arrange on the glass to dry. A strong solution of gum is then placed over it and the whole kept damp with dilute alcohol to enable the gum to saturate the specimen and protect the pigment from the balsam in which it is soluble. A bluish tint may disappear at once but the other color remains permanently.

Spider crabs.—These may be kept transparent with their growth of sertularians, sponges and ascidians. Being arranged on the glass, gentle and then stronger pressure is applied, using waxed paper and flannel-covered glass, till the whole is pressed flat without distortion except a slight widening of the body and legs. The leg muscles show well.

Mollusca.—Various species show their general anatomy if we first dissolve away the shell with hydrochloric acid in dilute alcohol. The organic matter of the shell retains a natural form and shows the attachment of the various parts which may be stained or not as preferred. The membranous residue with its form and color left after dissolving away the carbonate of lime makes nice slides.

Medusæ.—Dissolve out all the salt. Keep the specimen in methylic alcohol diluted with half its bulk of fresh water, for some hours. Shake to prevent adhesion to the vessel. Then digest repeatedly with fresh dilute alcohol. Specimens are so colorless and transparent as to show little of their structure but if kept many months in alcohol they turn brown-yellow and show structure quite well. But a far better way is to stain them with tincture of madder, Beale's carmine, methylene-blue, port-wine or tincture of galls. Beale's carmine stains

the canal-system but of an unnaturally bright color. Madder gives a more natural color. Methylene-blue works well with fresh specimens only. A four per cent solution of formic aldehyde is far better than alcohol if the newly caught animals are at once put into it. It will dissolve out the salt. The Medusæ retain their form well. Their delicate parts can be arranged without tearing except that the delicate fringe of Aurelia may prove too rigid to be extended. Having removed the salt and stained the specimen the lantern-slide glass should be put into a developing dish and the animal floated out and arranged under the liquid. The specimen may be half an inch thick in the centre and no attempt should be made to dry it at once since the greater part of the included liquid will diffuse out and be drained off. If the liquid comes off badly spread a solution of gum over the animal. When the edge dries cover it with a strong clear solution of gum to which a little glycerine has been added to make it less brittle. This process is continued till the whole specimen is covered with gum. Keep it then for some days to permit the gum to soak in and the bubbles to disappear by absorption which have not been removed mechanically. If kept in a developing dish over a little water covered by a close-fitting glass plate, a long growth of mould may appear in a single day but if alcohol is substituted for half the water they may remain out for weeks without mould appearing or alteration in the gum taking place which latter would occur in the use of strong alcohol. Do not dry too quickly but anneal the specimen since contraction may cause them to crack and scale off from the glass.

Coloring matter.—Dilute sulphurous acid is very useful to destroy the coloring matter, especially in the case of small fishes. If a plaice, 2½ inches long, is kept in alcohol and later in dilute sulphurous acid for a few

weeks, the earthly matter of the bones will all dissolve out and leave the cartilage. The color is reduced and the thickness diminished, but the arteries and their blood are so little altered that when mounted the aorta and branches are well seen over the whole animal.

KEEPING.—When the dried animals have been prepared and it is not desired to mount them at once in Canada balsam, they may be kept in tin boxes with flannel which has been thoroughly dried just before use. The specimens will keep for many months before mould appears.

FINAL MOUNTING.—At the four corners of the glass gum small pieces of blackened card board of such thickness that the cover glass will just clear the object. Keep the glass with the animal for a time in benzole meantime warming the cover-glass on a suitable stand over a small burner and fair quantity of liquid balsam placed in the centre. Take the glass and animal out of the benzole and carefully place over the balsam so as to catch up as few bubbles as possible. The benzole will cause the greater part to bust and disappear. If there is too little balsam, more may easily be run in between the glasses and if there were but few bubbles they will soon go. If too many, slightly incline the slide till they rise to one edge and then remove them. If kept cold for a few days the balsam will harden the edges. Then bind round with thin paper of best quality made thoroughly wet with gum. When dry, the contraction may squeeze out some superfluous balsam. This paper should then be varnished and finally strips of good black paper may be glued well round the whole. Use all possible care to enclose the balsam thoroughly so as to avoid its turning yellow and to prevent leakage when the slide has been heated by the lantern or otherwise. The slides are kept preferably in the dark to prevent possible fading.—H. C. SORBY in *Nature*.

Microscopic Inspection of Pork for Export.

The 1897 Year Book of the Department of Agriculture just published, contains a photograph taken in the room where 60 female meat inspectors are at work each with her instrument before her. Apparently an order was given for every one of them to be looking through the tube at the moment of photographing. The report on the subject is as follows:

In 1881 our pork was prohibited entrance into Germany, France, and the principal countries of the continent of Europe, on the ground that it was infested by trichinæ and was injurious to human health.

Notwithstanding the fact that it could not be shown that our pork had caused disease, and that it was manifestly more wholesome than the European pork, and notwithstanding the most vigorous protests were made by the American Government, the trade was crushed and destroyed. The year before the prohibition went into effect we sold to France 70,000,000 pounds and to Germany 43,000,000 pounds.

For ten years our pork was shut out of nearly every market of continental Europe, when in 1891 the bureau began the microscopic inspection and certification of pork destined to the markets of the prohibiting countries. This action led to the removal of the prohibitions, but the restoration of the trade was a slow and difficult process. Our brands of meat were no longer familiar to the people of those countries, commercial connections had been severed, and requirements as to cuts and cures had materially changed. It was like introducing an article into a country for the first time. Moreover, the prohibition had engendered suspicion as to the wholesomeness of our product, while the agitation had established prejudice and antipathy. There were vexations and burden-

some restrictions by both the general and municipal governments.

Notwithstanding such adverse conditions, the trade with these countries has continued to grow until now it requires more meat than the bureau is able to inspect with the available appropriation. The following table shows the pork which has been microscopically inspected and the quantity which has been sold in the prohibiting countries since this inspection was inaugurated:

Year.	To countries requiring inspection.	To countries not requiring inspection.	Total.
	Pounds.	Pounds.	Pounds.
1892	22,025,698	16,127,176	38,152,874
1893	8,059,758	12,617,652	20,677,410
1894	18,845,119	16,592,818	35,437,937
1895	39,355,230	5,739,368	45,094,598
1896	21,497,321	1,403,559	22,900,880
1897	42,570,572	1,001,783	43,572,355

The difficulties met with in the inauguration of this system of inspection were very serious. There had been no microscopic inspection on a large scale in America, and we had neither the appliances nor trained inspectors. The glass compressors for preparing the specimens of meat and the microscopes used in the German inspection were considered too clumsy and not adapted to accurate or rapid work. An American type of microscope was, therefore, selected. The stage was grooved so that an examination of every part of the specimen was insured and a special form of compressor was adopted which greatly facilitated the work.

The cost of microscopic inspection was estimated before the work was begun all the way from 15 to 50 cents per carcass. The actual cost has been reduced to less than 6 cents per carcass. The packers asserted that it would be impossible to microscopically examine any con-

siderable quantity of pork without delaying their business and damaging the meat. These fears proved to be groundless. The work of the abattoirs has neither been obstructed nor the meat injured. On the contrary, there are now from all points the most urgent appeals for more microscopical inspection.

Cholera, Typhoid and Other Bacterial Diseases Transmitted Through Oysters.

There is no longer doubt that oysters may take up from polluted water various disease germs and that the bacilli will thrive and produce disease in whoever eats these oysters unless the individual eating them is robust enough to resist the multiplication of the bacilli. It is possible for the human organism to be put in such condition that disease will not result even if its seeds are introduced therein, but extremely few are so conditioned; all others should avoid eating oysters unless they know that the the oyster beds have not been subject to contamination. This caution applies not only to raw oysters but in a less degree to stews, since the temperature of the latter is not sufficient to entirely destroy typhoid bacilli. Numerous cases of injury from polluted oysters have now been scientifically investigated.

In 1880, certain people in Scotland suffered from cholera after eating oysters that grew on the copper sheathing of a sunken ship. In this case copper poisoning was transmitted to the consumers by the oysters.

In 1893, cholera attacked two hundred and eighty-seven persons in England, of whom one hundred and thirty-five died. Forty per cent are known to have eaten shell-fish, mostly from the Grimsby and Cleethorpes beds. Cholera had been brought to Grimsby from abroad and the molluska were so located that they might

have been effected, namely, at the effluent of sewers which contained cholera discharges.

In 1894, twenty-six students, at Middletown, Conn., who had eaten raw oysters from Fair Haven, one week previously, had typhoid and several died. The Fair Haven creek received water from a sewer connected with a house where there were at that time, cases of typhoid.

In 1895, Nature cites a supper at which four friends ate oysters all of whom had typhoid before the end of the month.

In 1894 at Southend, where sewage is deposited near a pier surrounded with oyster beds, a protector of the beds gave oysters to a family August 6th, two members of which developed enteric fever on the 26th and 30th. Some months later he gave oysters to several friends, three of whom had enteric fever.

In 1895, in France, fourteen persons in a small town had eaten raw oysters from Cette and developed typhoid. No other persons than those having eaten oysters were infected and there had been no typhoid in the town for a year.

In 1843, at Marylebone, six persons ate oysters together at a restaurant; all had diarrhoea and other intestinal disturbances, and one of them developed typhoid. The oysters were from Colchester the waters of which receive sewage and other pollution. Quite recently other cases have appeared at Colchester, the evidence proving the cause to be sewage soaked oysters at Brightlingsea.

In 1891, at Harve, France, oysters were eaten from an artificial bed located at the outlet of a drain from a public water-closet which resulted in poisoning. An unusal prevalence of colic diarrhoea and cholera at Dunkirk was traced to oysters from Normandy.

In 1896, in a special report on infectious diseases communicated with shell-fish by Dr. Wood of the Royal

College, it is shown by laboratory experiments, that cholera and typhoid germs in sea water remain virulent and infectious for two months and that shell-fish may be infected.

In 1896, Dr. Klein showed that the tyhoid bacilli and colera vibrio retain vitality in sea water. He found the colon bacillus in oysters from polluted beds and absent from those in pure water. He found typhoid in the mangled bodies and liquor of oysters from a sewage laden dock at Great Grimsby.

In 1896 reports of extended researches were made at the British Association for the Advancement of Science. These showed the oyster to have great power of absorbing fecal matter; an increase from ten to seventeen thousand colonies in the bacterial contents of the pallial cavity and of the rectum when the oyster is laid down near the mouth of the drain; more bacteria in the pallial cavity than in the alimentary canal; that the typhoid bacillus does not flourish in sea water without some such nidus as the oyster; that it does not multiply in the stomach or tissues of the oysters; that the colon bacillus is present in very many oysters found on sale; that bacterial infection is largely lost if the oysters are placed in a stream of pure running water.

PRACTICAL SUGGESTIONS.

BY L. A. WILLSON.

CLEVELAND, OHIO.

PLANT HAIRS OF PEREANTH OF SHEPHERDIA CANADENSIS.—The backs of the flowers look densely tuberculate. The tubercles consist of plant hairs which readily detach on the slightest pressure and mounted in glycerine jelly make attractive slides. They are

octagonal and ribbed and each segment is bounded by an extended spinulose rib on each side. The outer part is colorless and is gradually colored until a beautiful pink center is reached.

Mounting in Glycerine Jelly.—To mount in balsam the object must be free from moisture, but not so with glycerine jelly. To mount in this medium first soak the object for twenty-four hours in a mixture of equal parts of GWA—glycerine, water and alcohol. Remove the specimen from this mixture, place it upon the center of a glass slip and remove the surplus fluid with blotting paper. Place the bottle of jelly in a pail or cup of warm water until it is entirely limpid. It will then remain limpid for a whole evening. With a small spatula take a drop of the limpid jelly from the bottle, cover the specimen and drop enough on the glass slip to fill the space between slip and cover. It is well to mount in a shallow cell and in such case, fill the cell with the jelly. If after the cover glass is placed the mount be full of bubbles discard it. Bubbles may be removed by boiling the jelly upon the slide. In boiling, use a clip and hold the slide over the flame. It will first begin to bubble from the center outward and soon a perceptible crack will be heard. At this moment, quickly withdraw the slide and place it upon a cold surface. Clean it from superfluous jelly with a soft tooth-brush under running water. Then seal with a good cement and ring to suit the taste.

Balsam Mounting.—No more balsam should be used than sufficient to reach to the edges of the cover-glass, and if this point be carefully attended to, the slip will require no clearing preparatory to finishing. Before using the glass slip, thoroughly clean with alcohol. On the center of the glass slip place a tiny drop of balsam, and with a pair of tweesers place the cover-glass over it, and hold over a spirit lamp until a sea of bubbles is seen

underneath. Remove, and with a gentle pressure hold down the cover. The bubbles will all disappear, and the balsam will become hard.

PRESERVING ALGÆ.—To preserve without shrinking use Flemming's weaker solution to kill and fix the specimen (10 c. c. of one per cent Osmic acid, 10 c. c. of one per cent acetic acid, 25 c. c. of one per cent chromic acid and 55 c. c. of distilled water). Its use for from half an hour to twenty-four hours will not injure delicate tissues. Add 10 per cent of glycerine, allowing each drop to diffuse before adding more. This will prevent the shrinking caused by diffusion currents if glycerine is added too rapidly. Add the glycerine until the specimen is well covered, when the fixing solution has evaporated from a watch glass in which they are exposed for the purpose. Red algæ retain their color almost perfectly, but green algæ loose more or less color although the chromatophores retain their shape perfectly and the cells become clearer than fresh material.

EDITORIAL.

Death of Alfred Allen.—Only 6 months ago it was necessary to announce the discontinuance of the Journal of Microscopy and Natural Science of which Mr. Allen was the editor. Following close thereupon comes the report of his death, March 24, at the age of 64. He was long Secretary of the Postal Microscopical Club of England—about 25 years. Thus "microscopists" are falling away and no new men arising to take their places as "microscopists." The users of the instrument are biologists, bacteriologists, doctors, etc.

The Souring of Canned Sweet Corn.—Since 1853 has arisen the corn-canning industry which resulted in 1895 in a pack of 72,000,000 two-pound cans—a total weight of

72,000 tons. Extensive losses by souring have led to careful bacteriological studies. By examining cans it was found that sound cans were sterile and that spoiled ones produced by pure culture twelve different species of bacteria—11 bacilli and one micrococcus. It is believed that they transform the saccharine and starchy matter into organic acids or other substances of disagreeable taste or oder. Sterile cans inocculated with these organisms promptly became sour. A vacuum is not necessary for keeping canned corn for air properly sterilized does not harm the contents. This has been indisputably proven by a long line of experiments. Moreover some bacteria can develope in a vacuum so that the latter is not a sure protection. Sterilization and not air-dissipation is the protection sought. Prescott and Underwood have spent a whole season with the best appliances in canning establishments and have practically settled these difficult questions. They found after extensive labor that heating for 10 minutes to 121 deg. C (250 deg. F) would sterilize corn in two-pound cans. The resistance of bacteria to boiling is such that some survive 5 hours boiling, others survive 8 hours boiling temperature. The ordinary water bath is thus proven useless. By culture methods and microscopical examination it was found that the bacteria were present on the kernels of corn when they came from the field and were in the new cans even after 30 minutes in boiling water and those so found were of the same species as those found in sour corn. Their rate of growth is enormous and appalling. Streak-cultures showed frequently a well-marked growth in 4 to 6 hours. Their multiplication was found to be facilitated by warm, moist weather. The new bacilli discovered require 12 pages of descriptions and the 13 photo-micrographs presented with the paper show plate cultures of the various forms of much interest. The March number of the Technological Quarterly is referred to for further particulars.

Collecting Plankton.—Dr. Dolley has devised a large centrifugal machine which may be driven by hand or by motor. It quickly separates all the suspended matter,

living plants, including bacteria, animals, and inorganic matter in such a way that the result can readily be weighed, the volume determined, the number of particles counted under a microscope, and tables constructed to show the yield of any given area of water. This method is applicable in the artificial propagation of food fishes since it collects the microscopic plants and animals which constitute the food of newly hatched fry. The suitability of water for receiving any fish is as much dependent upon the microscopic food it contains as on its temperature.

Malted Milk Lunch Tablets.—These lozengers are conveniently carried in the pocket and available on trips when one is hungry, faint or exhausted. They contain concentrated food representing the nutritive elements of milk and the cereals. Being free from starch and cane sugar they do not appeal to a disorded appetite. Otherwise they would replace all kinds of candy and ought to do so in spite of that fact. The Horlick Food Co., Rachine, Wis., send out sample packages to doctors, teachers and editors free of charge.

SCIENCE-GOSSIP.

Sewage Purification.—At Barking, England, there are biological filter-beds. The measurement of purification attained is taken (a) from the amount of oxygen absorbed; (b) from the amount of albuminoid ammonia got rid of; and (c) the increase in the quantity of nitrates. By passing the sewage intermittently through these filters and by allowing them to rest and become aerated between the charges, it was found that a purification of from 41 to 85 per cent was obtained, the whole of the organic matter was completely removed and an effluent fit to be discharged into rivers was obtained. The purification goes on at the rate of 750,000 gallons per acre of biological filter. At Sutton, England, a little different process is used, the filtrate from one bacteria tank being passed through a sec-

ond, the filtering material being finer grained and the outcome being 80 per cent of purification. The final liquids were free from all odor and remained sweet if kept in open or closed vessels. After the coarse matter was strained out and buried, the subsequent purifications were believed to be due to the work of aerobic organisms.

Micrometer Measurer.—Curtis uses the one described for the quantititive determination of silver. It is simple and can be used with any microscope which has crossed hairs in the tube or eyepiece. It consists of two metallic plates, one above the other, to which a motion parallel to one cross-hair can be given as well as across it. The two are fastened upon a third plate which is attached to the shell of the microscope.

Wood.—Phosphorescence of decaying wood proves due to minute vegetation and is not purely chemical as supposed. The mycelium of a fungus from pine has been cultivated in decoction of beech bark and Agar-agar, the result being a white, brilliantly luminous growth.

Crystals.—Tassin classifies them for microscopic examination under solution, sublimation, fusion. In the first class, they are prepared from solution in a liquid by evaporating and cooling, by reaction of soluble compounds or by chemical changes in general. To secure crystals by fusion prepare a solution in molten magma or slowly cool a homogeneous magma. Crystallization must proceed as slowly as possible and the removal be effected when the solution is at the minimum temperature. Crystals for measurement are quickly and completely dried in order to prevent corrosion or etch figures forming.

Foraminifera.—10,454 fossil forms were found in 1½ oz. of limestone from Cascina, Tuscany. They were so minute as to require 500 to weigh one grain. An ounce of sand from the Antilles was shown to contain 3,840,000 specimens.

Gold Nuggets.—The microscope shows that they have been deposited from a solution around a nucleus. Etched sections show crystallization, often large crystals with in-

clusions of quartz or other impurities but never concentric layers. Fused gold shows a similar structure. Hence native gold has not of necessity been in a melted condition.

Manchester Society.—Papers have recently been read on the slime fungi, Myxomycetes, antenna of a cranefly, on the dissection, preparation and mounting of the radulæ of Hyalinia, and on mounting in glycerine jelly.

Bacteria.—Since 1830, 560 species have become known but only 40 are harmful. Some one says that 250 million could find room on an ordinary postage stamp. We take in 30,000 germs by respiration each day. They are natures' scavengers but they also give flavor to butter, cheese, beer, game, etc.

Zeiss Objective.—His 1-10th inch mono-bromide of naphthalene immersion lens, with numerical aperture 1.60 has resolved or made visible a detail 1–200,000th of an inch in width. This is the highest limit yet reached.

Peat.—Peat originates from sphagnum moss usually, though it may come from heather, lichen or other plants. Its leaves are folded so as to give great capacity for holding water. Under the microscope is found an adaptation for taking up water in the spongy nature of the dead cells lying between the living tissues of the leaf, the internal cavities being connected by canals with the exterior. A sphagnum bog swarms with desmids, diatoms, protozoids and other low forms of life.

Protargol.—This is an antiseptic compound of silver and protein. A one-per-cent solution destroys bacteria of anthrax and enteric fever.

Steel.—With up-to-date micro-photography may be shown the conditions under which the carbon in steel exist. With 1000 diameters magnification, steel may be seen to contain minute particles of true diamond.

Sectioning Bolitic Grains.—A small glass slip is laid on a metal plate over a spirit lamp. Soften a drop of nearly dried balsam upon it with heat, lay a plate of mica on it which will become cemented to the glass. Upon the mica surface embed in balsam and arrange the small objects of

which sections are desired. When the balsam is cold and firm the glass is used as a handle by which to hold the objects while grinding. A flat surface may be given them as they lie in the balsam by rubbing with a hone. Heat the glass to release the mica by softening the lower film of balsam, lift the mica with forceps and turn it over on another glass which has been provided with balsam. The ground surface is now downwards and the other side may be ground as desired.

Protozoa.—A culture medium free from bacteria is made thus: Suspend 30 grammes hay in one litre water, add 1¼ grammes powdered calcium hydrate, shake well, heat in oven 24–36 hours, filter, precipitate the calcium with phosphoric acid. Mix the filtrate with equal parts buillon, alkalized with soda. Add 1¼ grammes agar.

Phosphorescence.—In case of the limans of Odessa which emit phosphorescenct light the phosphorescence is due to an infusorium, glenodinium, whose protoplasm emits the light.

Fish.—Most of their food being microscopical organisms, the multiplication of fish is dependent not so much on the taking and hatching of eggs as on understanding and controling the food supply; yet the Fish Commissions often hatch and plant eggs in utter ignorance of this phase of the subject.

Archaeological.—Prof. Nicholson of Lewes, England recently found on an ancient bronze implement certain small excrescences which were centres of rapid oxidisation but of recent appearance. He scraped off and examined the material under a 1-4 and 1-7 inch objective discovering that the oxidisation was due to bacteria which swarmed in it. He asks for similar observations and a method of sterilization.

Dust.—A shower of microscopic dust was reported in February off the West coast of Africa and at Leguna, Teneriffe. The dust was grey and extremely fine. It deposited upon every object and rendered the drinking waters salty and colored as by oxide of iron. The sun's

rays became so feeble as to confound the sun with the moon and reminded one of the light of a voltaic arc seen through a frosted glass.

To Stick Paper on Glass.—Make a paste out of 230 parts of muciliage, 20 parts of waters and 2 or 3 parts of aluminum sulphate, dissolving the sulphate in the water before adding the mucilage.

To Remove Tar from Glass.—Make a paste the consistency of cream of pulverized anice seed and extract of licorice. Rub it over the tar thoroughly with the hand, wash with soap and water and dry with a soft rag.

RECENT PUBLICATIONS.

New Book.—General Microbiology is the title Duclaux, of Pasteur Institute, gives to three volumes on the history of ferments, on diastases, poisonous substances, viruses, and fermentation alcoholic and other.

New Atlas.—W. B. Saunders has published an Atlas of Methods of Chemical Investigation by Dr. C. Jakob of Erlangen. It contains 182 colored illustrations (68 plates) and 64 text figures. Price $3.00.

It takes up clinical microscopy and chemic color reaction, of the blood, as it appears in health and disease, the parasites of the blood, blood spectra and blood crystals, microscopy of the mouth and nasal cavities, microscopy of contents of stomach and intestines, the most important color reactions of the gastric juice, urinary sediments, organic and inorganic, in health and disease; diseases of kidney and bladder, the most important color reactions of the urine, demonstration of some medicaments in the urine, the most important pyogenic micro-organisms, etc.

New Book.—Lehrbuch der Vergleichenden Mikroskopischen Anatomie der Wirbelthiere. Published by Gustav Fischer, Jena, 1897, pp. 681 with plates.

Erythea.—This is a monthly journal of botany, west-American in general, published monthly at Berkeley, Cal. Price $1.50. Complete sets of back volumes may be obtained.

Bulletin of Buffalo Society of Natural Sciences.—Hand book for students and amateurs in geology and palæontology descriptive of the 18 mile creek near Buffalo, has been issued. It contains 27 full page plates made from photographs of the formations found along this stream. It is by A. W. Grabau of the Massachusetts Institute of Technology and later of Harvard University. It deserves the very highest commendation.

The Society has also issued a review of the North American Delphacibae, a large group of small active insects which at times injure leaves and fruit of economic plants.

Some North American Coniferae.—Prof. E. S. Bastin and Henry Trimble have published a series of papers in the American Journal of Pharmacy and have reprinted them in a pamphlet of 124 pages on the Pinus strobus and numerous other pines. They have given especial attention to the microscopic structure and chemical composition. The microscopical structure is described and illustrated by 58 figures consisting of cross-sections of stems, leaves and bark. Their studies have led also to a description of the turpentine industries. The cross-sections have been magnified from 75 to 100 diameters and show nicely the epidermis, hypoderma, stomas, periderm, bast-layer, combium, xylem, lacuna, medullary rays, sclerotic cells, tannin cells, mesophyll cells, phloem, tracheids, transfusion tissues, resin passages, stone cells, mucilage cells, cork formation, crystal cells, and contained crystals.

This publication was intended to be the first of a series dealing with botany, histology, chemistry and economics of the cone bearer, but was interrupted and delayed by the death of Prof. Bastin. Presumably copies of this pamphlet may be obtained from Prof. Trimble of Philadelphia.

About Children.—Dr. S. W. Kelley of Cleveland gave six lectures to the nurses of a training school, upon the care of children and they proved so valuable as to be published in book form by the Cleveland Gazette Co. The book contains about everything one ought to know about children, whether in health or disease. While especially intended for trained nurses, there are many mothers who are intelligent enough to master these instructions. Price $1.25.

MISCELLANEOUS.

Glassworking.—A nice guide for amateurs has been published in London at 2 shillings. Thomas Bolas, the author, has profusely illustrated and simplified the matter.

Duckweeds.—C. H. Thompson of the Missouri Botanical Gardens has described and illustrated beautifully for identification 15 species of Lemnaceæ.

British Association.—The meeting this year will be at Bristol, Sept. 7. Many Canadians are going to it.

D. S. Kellicott.—The death of Prof. Kellicott at the Ohio State University in April removes one of the more active microscopists of America.

Lessons.—Dr. Louis Heitzmann gives instruction in microscopy, including urinary analysis, histology, pathology, and bacteriology at his laboratory mornings and afternoons. Courses may be commenced any time. Fee $25.00 for three months, three lessons weekly; or six weeks, six lessons weekly. New York City, 39 West 45th street.

Suspended.—We are sorry to hear that the Journal of the New York Microscopical Society, edited by the Rev. Dr. J. L. Zabriskie at 64 Madison avenue, New York City, has been suspended.

Natural Science News.—Oliver Hotchkiss, Twinsburg, Ohio, offers 60 numbers in general exchange.

Embryo Sissors.—Send 45c for long-shanked fine pointed curved ones to Earnest H. Short, Albion, N. Y.

THE AMERICAN

MONTHLY

MICROSCOPICAL JOURNAL.

VOL. XIX. JUNE, 1898. NO. 6.

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Tolles' Monument.

On Tuesday, May 17, 1898, at 3 o'clock p. m., 15 years after his death, friends gathered at Mount Auburn, Boston's noted cemetery, to dedicate the monument that had been recently erected over the grave of Robert B. Tolles. The pedestal is perhaps 18 inches by 36 inches, rising perhaps 9 or 10 inches from the ground. Upon this a large rectangular block of granite is placed, it having about twice the length that it has height or thickness. Upon it is carved the figure of a microscope and the words: "Erected by the New England Association of Opticians to the memory of Robert B. Tolles, 1823–1883."

The monument was paid for by opticians and not by microscopists. In the list of 62 contributors we find, however, the names of W. G. Corthell, H. M. Dunham, R. J. Nunn, M. D. and A. M. Wentworth, who are apparently the only microscopists in the list. The dedication was made by and in the name of the New England Association of Opticians whose committee had solicited the funds. Why it is that the microscopists have so held aloof from honoring the name of Tolles is as mysterious

to us as many of their other doings. We understand that a fund was once started in the American Microscopical Society but that it did not meet with expected encouragement. Why then did not the society put its funds in with those of the opticians in order to make a more creditable monument? Now that the monument is up what will the A. M. S. do with its "Tolles fund?" We have been led to believe that the fund had to be used temporarily to pay a part of the debt which the society was run into by issuing Dr. Seaman's quarterly but if so the fund will be made good presumably after the Society has cleared off its old scores.

But to return to the dedication. An address of President McKenzie was read by Secretary Donovan and an oration of W. Bohne was spoken by Edwin P. Wells. From its sentences the following are of interest: "What is the dredging of the depths of the sea for the purpose of wrenching secrets from nature, what is the scaling of the heights of mountains, what would be the discovery of the poles, what steam power, what even the circling of the globe by electricity in comparison with the journey to the stars which the genius and skill of the optician made possible by the invention of the telescope?

And what are these inventions and achievements when compared to the microscope, the golden key unlocking priceless treasures, and revealing myriads of worlds never dreamed of even fifty years ago? What was science prior to the advent of the microscope? Take the microscope away and what will science be tomorrow?

The greatest master of the microscope, the man who reached the pinnacle of perfection, whose work was never equalled in any country in the world, was Robert B. Tolles. He stood in the front rank of those whom the world should honor as the greatest of men. But world and gratitude are not synonyms and thus Tolles was suffered to moulder in an unknown grave. Is it not sad

that while the warrior, whose fame is born in the brutal roar of cannon and whose path to glory leads over thousands of mangled corpses and unspeakable sufferings inflicted by him, is honored by mouments, that the genius and toils of such a man who increased the common heritage and the welfare of humanity should be permitted to go unnoticed ?

The stake which marks the limit of Tolles' achievements in the construction of microscopes has not been advanced a single inch since Tolles' death ; indeed it has never been reached again in spite of the efforts of the opticians of the whole world."

The occasion was utilized by the orator for urging the formation of a National organization of Opticians in order to solidify their efforts and resist the aggressions of the votaries of physics who would reduce the opticians to the level of mere mechanics. It was intimated that opthalmologists are stealing much of the credit that belongs to working opticians and that the correction of this evil calls for united action in self-defence. The discoveries of astronomy are credited to the users of telescopes and not to the makers of the lenses without which no discoveries could be made. The instrument maker never has been recognized as an important factor in discovery either with the telescope or the microscope. But Tolles' best instrument has never yet found a man competent to utilize itspossibilities.

Microscopic Images and Vision.

BY LEWIS WRIGHT.

1. The discussion in the Philosophical Magazine in 1896, by Lord Rayleigh and Dr. Stoney has thrown considerable further light upon a subject which has been discussed for many years; but there seems still something to be added from the point of view of the micro-

scopist, for whom there is at issue in it a very important practical question not solved by any mere mathematical analysis, and scarcely yet, made clear to him. This question is at the bottom of the term "spectrum theory," happily applied by Lord Rayleigh to Prof. Abbe's view of the matter. Upon whatever general method of mathematical resolution the Abbe theory of microscopic vision ultimately rested, it was itself expounded to microscopists and discussed by them for many years as a matter of fact. It was thus and then confined to the statement that microscopical "resolution," or delineation of detail, was due to the union and interference (in the Fresnel manner) at the focal plane, of the direct dioptric beam and of at least one of the beams "diffracted" by minute periodic structure, in the manner of a grating illuminated by light approximating to the character of plane waves: such diffracted beams with white light becoming spectra. The Abbe theory further affirmed that the *trustworthiness* of the microscopical image solely depended upon, and was in direct proportion to, the *number* of orders of these spectra which were grasped by the aperture of the lens; and it explained all the advantages of greater aperture in greater resolution, upon this basis alone.

This was a definite, limited, and practical theory, easily grasped; and this alone was what came to be known as the Diffraction Theory or Abbe Theory. Since, therefore, that term is now applied to the wider manner of regarding microscopic vision which he has set forth, in order to keep things clear or even intelligible to any microscopist who has followed the past discussion, there is really no other course than to find a new name for the more limited and already well known Abbe theory, as Lord Rayleigh has so happily done. The truth or error of this "spectrum" theory, or the respective measure of each in it, is a matter of very great practical importance, as will appear. The wider theory is largely speculative;

but there are obvious points of contact between it and the other, which also have to be considered, and which throw much light upon it.

2. With the purely theoretical bearings of this recent presentment of the case it is not necessary to deal at length. Yet it seems desirable to mention some objections which suggest themselves, and which, if valid, have much bearing on the conclusion of Prof. Abbe, that "diffracted light [defined as "light which advances in other directions than those prescribed by geometrical optics]" is the machinery by which good definition is brough about." That is, of course, getting back to the "spectrum" theory; and this theory is only true in a conditional and limited sense, while its acceptance in a universal sense is a present cause of positive mischief.

3. There are then, some fundamental physical objections to that method of representing what takes place. Putting it most briefly: (A) All light emitted by an object may be resolved into undulations consisting of uniform plane waves. (B) we may conceive these reversed in direction (since any dynamical system may be reversed); and when they thus arrive back at the position occupied by the original object, they will there "produce an image the most perfect that the light emitted is capable of producing." This is held to follow because the plane waves there, as at each step, "reproduce exactly the same state of the ether as had prevailed at the same stations on the outward journey." Hence in general "plane waves converging inwards" are capable of producing the most perfect attainable image producible from the rays grasped by the objective. Stating objections to this with similar generality and brevity, it appears that such a presentment of the matter must break down as a full and complete explanation, however true in a limited sense, on the ground that "uniform plane waves" such as are spoken of, are not in trustworthy microscopy

the actual or veritable dynamical system; and therefore cannot, as it will be shown they do not, produce the supposed most perfect attainable image by reversal.

4. More specifically, it seems evident that we are, *ab initio*, debarred from considering the light from a microscopic object as consisting of uniform plane waves, *except on the condition of plane-wave illumination of the object.* (Here, indeed, we have the secret of Abbe's consistent enforcement of illumination by a small luminous cone or pencil, which gives approximately such illumination). For what are uniform plane waves? A wave-system is normal to the surface called the wave-surface, over which undulations from the same disturbance are in the same phase. Hence the plane wave arises from the Huygenian spherical wave, as a limiting case, in the manner pointed out by all the standard authorities. Thus Lord Rayleigh says: "So long as the radius of curvature [of the spherical wave] *is very long in comparison*, each small part of a wave-surface propagates itself just as an infinite plane wave coincident with the tangent-plane." Bassett puts it similarly—"Spherical waves concentric with the source are propagated throughout the medium; and if the effect which these waves produce at some portion of space whose greatest linear dimension is *small in comparison with its distance from the source*, be observed, the wave may be regarded as approximately plane. We are thus led to study in the first instance plane waves."

The student of physical optics knows that this is so in actual fact. To study plane-wave phenomena, or to verify plane-wave dimentional calculations, he must remove his source of light, itself relatively small, to a considerable distance from his grating or other apparatus; he must get his beams of rays approximately parallel, that the normal wave-surface may be approxi mately plane. This necessity belongs to the nature of plane waves.

5. But considering now microscopic objectives, many such have been made as short in focus as 1-50 of an inch. It is impossible to regard light emitted from an object, as consisting of uniform plane waves on arriving at the surface of such a lens, after a path of, perhaps, 1-200 of an inch; except in the case of *plane-wave illumination of the object*, as in the Abbe theory.

6. Consider next the supposed dynamical system. This is by hypothesis set up, not by the object alone, or in ordinary method: "We begin by positing repetitions of the objective field." Then it is assumed that all these replicas emit light from their similar points "the same in direction, intensity, phase, and position of transversal." This postulate seems altogether illegitimate in a theory purporting to represent actual phenomena; we know that it is *not* true in physical reality. It, too, depends for the qualified truth which it does possess, upon plane-wave illumination; then it is true, so far as that when approximately plane waves fall upon a grating the width or number of lines does not affect the image of the ruling, as ruling. But it seems to push the result of certain mathematical expressions to an extent which can hardly be justified. The ground of the immense postulate here objected to, lies in the fact that resolution into plane waves of ether-disturbances set up by an object, is represented by expressions which equally represent replicas of the disturbances; the nature of circular functions involving this necessity. Mathematical expressions are but tools, and often have the usual defects of tools; in particular that of not being sharp enough. Ask these functions to express a given disturbance and many surrounding replicas, and they will do it. But ask them next to express an actual limited disturbance resolved in this manner, and no more, and they fail; their edge at present is not sharp enough to do that. Such failure, however, is in this case an imperfection;

and surely to ground such a physical postulate upon the very imperfection of an imperfect tool, is rather arguing in a circle. It seems to be a case of what was described only the other day in a review of a mathematical work, as "the special philosophical vice of the mathematicians, the tendency, namely, to mistake the sign for the thing signified."

7. This seems further to appear, when we consider the *reversal* of the supposed dynamical system. This, it is supposed, produces the "best attainable image which the light emitted by the object [and grasped by the objective] is capable of producing." Unquestionably the light-waves emitted may truly be regarded as a dynamical system; and may be conceived as reversed; and the reversal of the whole actual system would produce such an image as described. But it does not seem to follow that mere "coalescence and interference of *uniform plane waves*" involves such a result. Besides what has already been said as to the absence of plane-wave character in rays from any self-luminous object, at the very minute focal distance of a high-power objective, questions as to the longitudinal components in the disturbances, and their disposal and influence, and several other questions, would seem to need further solution than is known at present, before this could be assumed.

In any case, what the reversal of the supposed dynamical system must really reproduce as an image at the place of its origin, must be the postulated operative cause of the system. That, by the hypothesis, is not an actual object and it alone, emitting luminous waves, but *the object surrounded by an indefinite number of identical replicas, emitting identically similar plane waves.* This does not represent any object in reality: and that fact seems to dispose of such a presentment as a full and complete representation of microscopic vision.

The same conclusion follows from directions "how to see the rulings." We first illuminate the object by a near approximation to plane waves; and then behind the lens further exclude everything but the narrowest pencils of almost exclusively plane waves. Thus we produce a "ruling" extending far beyond the limits of a true image, and which in other respects is as far as possible from being any such. We are really producing, and do produce, easily calculable results of interesting experiments in the interferences of plane waves; and though these results are physically and directly related to the *periodic* structure of the object, considered as an interference-grating, they are no trustworthy representation of it. This truth has always been recognized and insisted upon by Prof. Abbe and his school, resulting in a sort of "counsel of despair" as to any truth or certainty in such microscopical images.

8. This brings us back to the more concrete Abbe "spectrum" theory, as already described. But Prof. Abbe throughout, considers the object to be illuminated by plane waves. In this limited case, what Dr. Stoney advances is more or less true; but Abbe differs from the latter in constantly recognizing that condition and its consequences. Thus, while Dr. Stoney states that a cone of rays from the condenser, as wide as possible, may be used (as in practice it may, for reasons to be seen), Abbe again and again insists that such is not the case, and this at great length. "Strictly similar images," he says, "cannot be expected except with a central illumination with a narrow incident pencil." This is the condition for securing an approximation to plane-wave illumination, with its diffraction phenomena.

9. We may now consider how far the Abbe theory, which possesses more or less undoubted truth, is an adequate representation of microscopic vision; and the most satisfactory feature about the lengthy discussion from

which these remarks originate, is that in several ways additional light is thrown upon that question. The general conclusion at which I have arrived stated briefly as before, is that *the trustworthiness of a microscopic image is in proportion as the object approximates to a self-luminous condition, and diminishes in proportion as it is or has to be* (for it may have to be) *examined by plane-wave illumination.* This view is of most fundamental and practical importance to microscopy and microscopic optics.

10. Supposing the "spectrum" theory to be true, as a full representation, it was demonstrated that "microscopic vision is *sui generis.*

11. Another fundamental objection to the competence of the theory as a general one, is found in the fact that the character of a grating may be such, that its spectra cannot give a proper image.

12. The object may conceivably be self-luminous; in which case there will be no spectra, and the waves emitted from different points of the object will be quite heterogeneous, and in no permanent phase-relations. Yet an image must be possible, and can in that case be only analysed according to the Airy method. We can only employ a really self-luminous object in experiments with low powers of the microscope—perhaps up to an inch. But even the results with such a power are decisive of the real question; and with high powers we can more or less approximate to this kind of luminosity in several ways.

Thus, even a wide cone from the condenser approximates to it. Lord Rayleigh has shown how and why this kind of illumination must introduce a large amount of heterogeneity into the rays proceeding from the object, and concludes "that the function of the condenser in microscopic practice is to cause the object to behave, at any rate in some degree, as if it were self-luminous, and thus

to obviate the sharply-marked interference-bands which arise when permanent and definite phase-relations are permitted to exist between the radiations which issue from various points of the object." Since Dr. Stoney, however, seems rather to regard the function of the condenser as being that of providing illumination by plane waves, we had better resort to other methods, which may help us to decide what is a very important practical question. For while the ideal is to get absolutely aplanatic systems of plane waves transmitted through the object, and all conditions short of this (caused by imperfections in the slide or various other details) impair the image (as in one special sense they do impair it, with some objects); according to the view expressed, irregularities of phase thus produced may add to the *trustworthiness* of the image, though it may impair it in some other features.

Take therefore as an object on the stage, a grating of 3,000 or 6,000 lines to an inch, illuminated by a narrow cone from the condenser, focussing the flat of a rather distant lamp-flame. Place immediately in front of this flame a coarse grating, 50 to 100 lines per inch, either photographed or of wire. The several points of these luminous lines emit light-waves chiefly in the self-luminous manner, indiscriminate in phases and transversals at the points of the flame itself. Arranging the stage grating so as to cover only half the objective field, a condenser can be selected of such a focal length, and other matters so adjusted, that the focal image of the coarse grating formed by the condenser, corresponds both in intervals and focal plane with the object-grating on the stage, and using the same illuminating cone. Remove now the coarse grating and place the stage grating centrally: then removing the eyepiece and looking down the tube, the dioptric beam and its flanking spectra as so often described will be seen; they are the images of the

source of light. They interfere and form the image seen by the eye-piece, in the Fresnel and Abbe manner. Removing the stage grating, and replacing the coarse one over the flame, its focal image is now the object. Owing to the heterogeneity of the rays, this ærial image emits no spectra—there neither are nor can be any such. But it is perfectly resolved. Here we have a resolution of 3,000 or 6,000 lines per inch that has no place at all in the "spectrum" theory; which therefore can be no *complete* theory of microscopic vision, though it has an important place in it.

Using reduced photographs of perforated zinc, I have similarly used their ærial images in comparison with *P. angulatum* on the stage. Only approximately in one respect, because the difficulty of getting sufficiently reduced photographs prevented use of the same illuminating cone in the two cases. But there is no doubt about the results in all important respects.

As another expedient, we may place beneath the slide a sheet of finely-ground glass. This ground surface refracts and reflects the light in countless phases and directions through the object, the waves issuing therefrom with similar heterogeneity of character. Here also we must have at least a very considerable degree of approximation to the nature of self-luminosity; nor can we get from such illumination any of the well-marked "spectra" or out-of-focus interference-fringes, familiar to us with the Abbe method. The difference in character of illumination by such methods, is so great, that if the "spectrum" theory be completely true, there should at least be a uniform and vast deterioration in the image of an object thus illuminated. On the contrary, with all good lenses of moderate aperture, and slides with any fair amount of opacity in details, such an image is about *the very best we can get.* The excellence of this method of illuminating was first shown many years ago. By its

means really good moderate powers can be used up to their full aperture, rendering the very finest hairs as tapering to a *perfect point*, with entire absence of the diffraction-fringes shown round such details with a narrow pencil. Where and why "resolution" often fails with high powers as regards some objects so illuminated, belongs to the question before us, and is dealt with presently; but the method can be carried much farther than many would suppose. The diatom *P. angulatum* (45,000 to the inch) is resolved by it beautifully with a dry lens; and this self-luminous resolution has the cardinal superiority over Abbe's with a narrow pencil, that by no possibility can any images be produced by it other than the small white disks on dark ground, or black spots on white ground, at different foci, which can be produced in the same way from a sheet of perforated zinc. By grinding the back of the slide itself, even an immersion-lens can be more or less filled with direct rays, and in this way all the spots can be seen (*as* spots, and not falsely as spherules) in *A. Lindheimerii* (69,000 to the inch). With a first-rate apochromatic and one of the slides mounted in sulphate of arsenic, I have seen the striæ in *A. pellucida;* though with such objects as these the method comparatively fails.

13. We may also compare the results of mathematical analysis with those of experiment. We have two kinds of possible image, for the Abbe or "spectrum" image is a real fact enough under the necessary conditions; our inquiry here is simply what *proportion and value* must be assigned to it in ordinary research. Lord Rayleigh's articles here and elsewhere seem to supply useful *criteria* as regards that question. He shows that according to the "spectrum" theory a square and circular aperture of the same width give the same resolution for points or short lines. On the other hand, respecting the resolution of self-luminous lines of sensible length, another

analysis led to the conclusion that a circular aperture must exceed a square aperture by say 10 per cent to give equal resolution. Airy in a slightly different manner calculated that the circular aperture must exceed by about 20 per cent. Experimental test was made using a 50-to-the-inch wire grating in front of a sodium flame, and two different rectangular apertures (with sides parallel to the wires) on the object-glass of a telescope, measuring the distance at which the object-glass (with aperture) resolved the grating. Of circular apertures, four were employed in the same way. The two observers differed very slightly, and the mean for the four circular apertures worked out in the proportions of 1·13, 1·09, 1·09, and 1·09 to 1·0 of rectangular aperture. Here the grating in front of the flame is regarded as self-luminous, just as in the experiment with the microscope above described.

Thus far experiment confirms the analysis; but Dr. Stoney considers (in the previous dicussion with me which Lord Rayleigh alludes to) that the same methods cannot be applied to microscopical resolution, on account of the wider angle of the cones of rays concerned, and the physical consequences of that difference. At all events, the agreement of experiment with analysis as regards both kinds of image, in the microscope also, is remarkable.

Calculating by the E line for white light, the ultimate limit of resolution for a dry objective of utmost aperture (N. A. 1·0) is 96,410 lines per inch, which we suppose to be attainable according to the "spectrum" theory, although the aperture is circular. In 1888 Mr. E. M. Nelson, whose microscopic vision is phenomenally keen, just "glimsed" the striæ of *A. pellucida*, mounted in the arsenic medium. Including the double system, or all across the valve, these striæ are about 1-2500 of an inch in length. He used an oil-immersion condenser of

much greater aperture than 1·0, with a single-notched stop, through which sun rays were sent by a hiliostat. The beam through the notch being first so oblique as to be outside or excluded by the 1·0 dry aperture of the objective, a strong green spectrum alone appeared at one side of that aperture, at back of the lens. The notch was then gradually deepened until a very small direct or dioptric pencil was just seen on the opposite side of the aperture—replacing the eye-piece. The striæ were just seen. The diatom was probably something less than 95,000 per inch, and any dry lens must be some little less than 1·0 in N. A. Here then, with *very intense* plane-wave illumination—in fact nearly "uniform plane waves"—we have also as nearly as possible the theoretical limit attained, or closely approached, with a circular aperture.

Turning now to the more average kind of microscopic image, the extreme closeness with which Lord Rayleigh's 10 per cent reduction of efficiency in circular apertures represents the facts of observation as found by the most competent observers, will forcibly strike everyone who has studied microscopy for any length of time. But Dr. Mercer, has recently tested the question photographically. It is comparatively easy to prepare circular and square apertures of equal dimensions. He also ruled upon the same glass plate six sets of lines at intervals of 0·42, 0·46, and 0.5 mm. and their doubled intervals of 0·84, 0·92, and 1·0 mm. apart. The apertures were 5·0, 5·5, and 6·0 mm. diameter. It will be seen that both lines and apertures give excesses of about 10 and 20 per cent, representing those calculated by Lord Rayleigh and Airy respectively. An ærial image of these lines focussed by the condenser, was used as the object, and successive photographs taken with all the square and circular apertures. Then only *similarity of resolution* had to be compared, which can be done within very small limits of

observational error. The results agreed with Lord Rayleigh's calculation and experiments, not with the Abbe calculation or with Airy's.

14. Dr. Stoney recognizes essentially what is here maintained. "The standard image is the outcome, partly of the features upon the object, and partly of the state of the light by which the object is illuminated. *It may be improved by increasing the degree in which the first of these factors, and by decreasing the degree in which the second, contributes to produce, to modify, or to efface detail in the image.*" So closely does this practically coincide with my proposition, that had it stood alone or as the final conclusion of his exposition, nothing more would have been necessary; and it has the further merit of recognizing the fact (which constitutes the real place and proportion of the "spectrum" theory in microscopy, and the *nexus* between it and the Airy theory) that we have *two distinct elements* to deal with in an image, whose respective preponderance or proportion are highly variable. The present attempt at further treatment is made chiefly because he does not seem to recognize the true relative proportions, either in maintaining with Abbe in such a universal sense that "diffracted light is the machinery by which good definition is brought about;" or "the great assistance which is rendered to the practical microscopist by Abbe's theory."

(To be Continued.)

Woods.—L. W. Hahn, Silver Creek, N. Y., offers 110 varieties of foreign and native woods for $3.00.

Personal.—Prof. W. A. Rogers died at Waterville, Maine, March 1, 1898, aged 61 years. He had been professor of physics and astronomy in Colby University since 1886 but expected to remove to Alfred University the present spring.

PRACTICAL SUGGESTIONS.

BY L. A. WILLSON.

CLEVELAND, OHIO.

TRICHIA.—On a piece of bark, from the woods, a golden yellow dust was found. Examination with the microscope developed that this dust was entirely composed of the threads and spores of trichia. By placing a very small portion of the yellow dust in water on a glass slip, then teasing with needles and mounting in glycerine jelly a very acceptable iustructive slide was produced. A good picture of these threads and spores is given on page 32 of "Fungi" by M. C. Cooke in volume XX of the International Scientific Series. The plant, however, is not a fungus but a Myxomycete belonging to the lowest order of plants the Protophyta. It is described in Bessy's Botany on page 211 where trichia is placed in Order VII, Calonemeæ.

A LITTLE LEARNING IS A DANGEROUS THING.—So is a tyro in microscopy who poses, in court, as an expert. So is a microscopical expert in one department who poses as an expert in another department. So is an expert who for a fee under the guise of being an expert acts as an attorney for one of the parties to a suit. The disagreements and contradictions of microscopists in court is disgraceful. A fixed set of stupid questions are permitted and the scientifically stupid attorney on the other side is generally too obtuse to cross examine so as to elicit the whole truth.

THE EXAMINATION OF WATER.—Fail not in examining water to examine the specimens on the surface, in the sediment and those suspended. In each stratum a different fauna and flora will usually be found. To see bacteria and very minute specimens resort must be had to other means.

MICROSCOPICAL AQUARIA.—For study and the enter-

tainment of one's friends two simple aquaria will be found convenient. First, for vinegar eels, pour into a wide-mouthed bottle some pure cider vinegar already infested with the anguilullæ; to this add a spoonful of boiled starch; watch the bottle from time to time and add vinegar to supply evaporation. Fungus may form on the top. Touch this to a glass slip, remove the fungus, cover the slide and examine. A great sight of hundreds of writhing eels will be displayed.

Filterings of the Water Supply.—Pour the filterings into a conical glass or beaker. Re-enforce the supply with new filterings, at least once a week. One may thus keep a supply on hand for years. The glass or beaker will have a deep sediment of diatoms and desmids which will furnish food and oxygen to the animals in the super-natant water. Here one may study the survival of the fittest as one set of prevailing infusoria disappear and will be superseded by another. The starch diet will fatten the vinegar eels and render them easy for manipulation. An inch objective with a C or D eye-piece will exhibit the anguillulæ to good advantage.

SCIENCE-GOSSIP.

Medical Microscopy.—The chief medical officer of the U. S. army says: While scientific medicine could not exist independently of the fundamental branches, they simply constitute the basis upon which the superstructure has been reared, to a large extent during the last half of the present century. The histological changes which occur as a result of various disease processes, were unknown and unknowable in advance of the invention of the compound microscope, and the same is true as regards the ætiology of infectious diseases. The discovery of the anthrax bacillus (1850) and the demonstration of its ætiolog-

ical relation to the disease with which it is associated, by Davaine, Pasteur, Koch, and others (1863-1875); the discovery of the tubercle bacillus by Koch (1882) and the discovery of the malarial parasite by Laveran (1879)—these discoveries, so essential to the progress of scientific medicine, would evidently have been impossible without the aid of the compound microscope. While we owe much to the methods of research devised by Pasteur, Koch, and other pioneers in this line of investigation in the application of these methods, the compound microscope is absolutely indispensable, and, as medicine could not profess to be scientific so long as we were ignorant as to the ætiology of disease and of the histologic changes resulting from disease processes, we must recognize the perfection of the compound microscope as the most important event of the century from our present point of view. The principle involved in the construction of the compound microscope was invented as long ago as in the sixteenth century, but it is only within the present century, and principally during the last half of the century, that those improvements have been made which have made it available for ætiological and histological studies. There is, however, a growing disposition to suspect that our microscopes, notwithstanding the great degree of perfection attained in their construction, are still inadequate to the task of revealing to us the specific infectious agents of certain diseases, because of their minute size.

Gates' Double Microscope.—This has been repeatedly done before, and as often condemned. A second microscope forms a most inefficient eye-piece. With regard to deep eye-piecing, a 20-power eye-piece will easily render visible, even to one possessed of ordinary vision, everything that a ¼ inch objective of N. A. 1·0 (oil immersion if you like) is capable of resolving. EDWARD M. NELSON.

War.—On September 18, 1870, mail communication from Paris was interrupted by the German investment of the city. Balloons were at once resorted to and on Sept. 23, 25,000 letters were carried out by the "Neptune." Later

1,200 went out on the "Washington." While letters could be carried out they could not be brought in by balloon. Carrier pigeons were therefore sent out with the balloons and permitted to bring back dispatches. These had to be light enough in weight for the pigeons to carry. Photo-micrography was therefore resorted to. Messages were copied on a single sheet of paper and then reduced to the most minute proportions. On their arrival in Paris the characters were enlarged by the microscope. Each message was then copied on a card and forwarded to the person addressed. Each word cost ten cents and each message was limited to twenty words. Later the messages were printed from type and reduced still farther. They were put on pieces of paper 1¼ by 1½ inches. The collodion films were rolled and enclosed in small quills which were sewed to the tail feathers of the pigeons. The collodion films were ten times thinner and lighter than paper. On arrival, in Paris, the quills were split open and the films rapidly unrolled in water containing a few drops of ammonia. The films were then dried and enclosed within two plates of glass. They were then ready to be deciphered by the microscope. This mode of reading was later supplanted by a projecting lantern and electric light. When thrown upon a large screen four trans scribers could work at once on each sheet contained 1,600 messages. At a later time, the films were photograghed back to the scale of the original printed matter so that each section was enlarged from the most minute dimentions to a form that could be read with perfect ease. Then the telegrams were separated by scissors and each person received a dispatch in fac-simile to the original printed matter. Many of these dispatches are today exhibited as specimens of photomicrography.

Milk.—In Dr. Julius Nelson's investigation it was found that milk in a cow's udder may have as high as 10,000 bacteria per drop, that first drawn being most infected.

Wanted:—Petrological microscope with accessories for petrological work, instrument to be of superior grade and in good condition. Send description and price.

THE AMERICAN

MONTHLY

MICROSCOPICAL JOURNAL.

VOL. XIX. JULY, 1898. NO. 7.

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Microscopic Images and Vision.

BY LEWIS WRIGHT.

(Concluded from Page 104.)

15. We therefore next consider that illustration. To begin with, the resolution of *A. pellucida* is no real problem at all: it is not even of the same nature as the problems which do confront the scientific worker. Supposing it were, the latter would regard with consternation the elaborate apparatus described for producing monochromatic light. This diatom, however, has been studied for many years; the dimensions of its structure are known and familiar; and the powers of annular illumination have long since been ascertained. It is no problem, or one in which help is needed, to take what is really a "grating" of this *known* fineness, and already *known* to have this definite periodicity of structure, and arrange matters so as to get the most conspicuous "resolution" of it. The problems in which assistance is really wanted, the microscopic worker's really "difficult" objects, are such as Dr. Dallinger confronted

in detecting the spores of a monad, itself only 1-6000 of an inch in diameter and themselves only 1-240000 of an inch; or more especially (because here was involved real "resolution" of fine detail) the *process of division* in the nucleus of a cell, itself only 1-20000 of an inch long. In such cases what will be found and is to be observed is *unknown*; accurate periodicity of structure is probably absent; and mere artificial force of clearness in "resolution," even if obtainable (which it seldom is) is worthless in comparison with known trustworthiness in the image so far as it goes. Taking any such case as this for our test-object, and comparing it with the treatment of the *A. pellucida* as described, we shall be able to appreciate the proportion of both truth and error—for there is truth as well as error—in the "spectrum" theory.

16. We cannot help, in the first place, seeing much error. While the minuteness of structure to be detected by Dr. Dallinger (in an unknown object) was as great, the method of proceeding described for the *A. pellucida* is impracticable, and would be useless even if practicable, real work has to be done by far different means. The finest lenses, used with a wide and solid aplanatic cone of light, could alone do such work; and moreover, earlier lenses of 1·48 N. A. were surpassed in results by apochromatic lenses of 1·40 N. A., better corrected for spherical aberration—the meaning of which we shall see. Supposing the microscopist, however, to know or suppose the measure of minuteness in the divisions of the cell-nucleus, he would have to employ (with doubtless some modification in detail) arrangements for *plane-wave illumination* generically similar to those he describes for the diatom. But he would be wrong, and the results would be *nil*.

Narrow pencils and annuli have of course been tried, for the contrast they give. The probable reason of failure is want of sufficiently regular *periodicity* in the detail. Only such periodic detail is shown better by

such methods; all else is "blurred." Dr. Dallinger had to do such work with a high degree of heterogeneous illumination—as close an approach as is possible with the lens used, to a self-luminous condition of the object.

The image even of the diatom is a false image. It is admittedly so in regard to the "spherules," and competent judges are very doubtful whether even the breaking up of the striæ so shown, is not due to false diffraction-fringes from the midrib of the valve, the spherules being thus arranged in longitudinal rows far more straight than is really the case. Looking at the matter theoretically, it will be observed that after having laid down how the excellence of the image is in inverse proportion to "the degree in which [the state of the light by which the object is illuminated] contributes to produce, to modify, or to efface detail," he proceeds to obtain this image by almost the greatest specialization of the light which is possible. The effect of this is to replace the actual detail, by other apparent detail which is visually intense, and geometrically symmetrical, to an utterly false degree.

Similar results are traceable in other diatom work by the Abbe school, as may be shown by the most familiar test-valve of all, a much coarser one, the *P. angulatum*. Dr. Van Heurck has photographed this with the celebrated Abbe-Zeiss lens of 1·63 aperture and dense immersion-fluid and medium, by Abbe methods, with an uncorrected condenser; the result is a series of hexagons resembling a honey-comb. Dry objectives can only image details "correctly so far as regards their number and position, but any further detail is not correctly represented." Immersions embracing most of the first spectra, "we now see some detail: the dots appear hexagonal, and are separated from one another by walls which are thin, and which look like a honey-comb;" and "this is the first and only step we can take towards

learning what the actual detail is," because no objective will embrace the other orders. Examining these several statements, there is every reason to believe that a dry objective with a wide cone of light gives a perfectly truthful image, while it will give the hexagons quite easily if that figure is preferred; Zeiss's well-known large-scale photograph is of a value so coarse that it is beyond dispute that a portion of the second-order spectra *were* included by the lens used, with the result of introducing a false *doubled* resolution impossible with first orders alone; and an immense further step can be taken by using a first-rate immersion-lens of 1·40 aperture, with a wide cone. The Zeiss photograph ×4900, and the Van Heurck photograph, are confessedly the highest triumphs of photography by the Abbe method: one has only to compare both with the beautiful photograph ×4900 taken in this other way by Mr. E. M. Nelson, and other similar ones up to a scale of ×6400, to *see* once for all, which is the truest image, and the all-importance of a sufficiency of heterogeneous light.

The minute detail in some of these photographs could not possibly be shown by that method, because, minute as they are, they are *unsymetrical* and not *periodic*. In regard to the *P. angulatum*, both circular disks and hexagons can be seen, depending upon the precise focus; the sharpest portions show the circles, which, disposed in quincunx arrangement, most diatomists who have worked with English appliances believe to be the true figure. Besides the sharpest image, we have the phenomena of "postage-stamp fracture," and the shape of far coarser markings in other diatoms to guide us. Mr. C. Haughton Gill has demonstrated that the spots are either apertures or depressions, by depositing pigment in them; and the various images can be imitated with perforated zinc. It is the distinct outlines of the *fractures*, and broken-through apertures, which are so

magnificently shown in Mr. Nelson's photograph with a wide cone.

17. We can also, however, see the large amount of *truth* in the Abbe theory, and its important, though not *all*-important, place in microscopic vision, especially for certain classes of objects. Wherever we have a known periodic structure in transparent objects, plane-wave illumination and the consequent interference-lines formed by the beams diffracted by that structure, have an extraordinary effect in *intensifying* into black and white a more or less accurate representation of the periodic detail. How this occurs can be easily seen from two examples, macroscopic and microscopic.

Take first quite a coarse striation of 50 to the inch, visible to the naked eye, represented by a grating of platinum wire and by a piece of platinum foil corrugated to the same gauge. Make the wire incandescent, and (checking irradiation by a smoked glass) the striation is easily seen. Make the corrugated foil incandescent (these observations are supposed to be in the dark) and probably the detail will be quite invisible. The eye was quite competent to see structure of this fineness by the Airy self-luminous method, if the detail was in contrast; but there is now no *contrast*, and the detail is more or less invisible. Then let the corrugated foil be cold and illuminated by extraneous light, and the detail is seen again. There is both *shadow* to assist the contrasts, and also there are phase-relations between the tops and bottoms of the striations which come into play.

Let us further imagine a perfectly transparent structure with uniform periodic detail, but the elements of that detail differing in thickness only; and let it be mounted in a medium of nearly the same refractive index. A diatom in balsam nearly represents such a case. It is quite evident that by heterogeneous illumination at all approaching the self-luminous character, it

will be difficult to find anything *sufficiently contrasted* in detail to see at all, though the very same illumination of a *black-and-white* photograph of small scale, or of the same diatom in a medium of 2·4 index, might show it easily. But plane-wave illumination might very easily bring about phase relations more or less approximating to *half-wave discordance*, which we know well would be more effective than black-and-white itself by direct light; in any case these phase-relations will produce conspicuous effect in a Fresnel-fringe image. Thus the Abbe method has a most important function in enabling us to see *contrast* in the details of a large class of objects—especially hyaline or transparent objects—which do not present contrast or opacity sufficient to be seen in any other way. The error has been in giving to it the sole or all-important place, not recognizing that there is quite another kind of image also available, depending upon Airy's theory; and that this latter, while in the the case of transparent details often giving images insufficient, or at least far inferior, in black-and-white contrast (what microscopists call "resolution"), is free from the *contour* errors of the Abbe image, and must be used to correct it so far as is possible in the individual cases.

The errors of the "spectrum" image are well known: Prof. Abbe himself has sufficiently insisted upon them. Its very contrast, or "resolution," is in most cases a glaring departure from *truth*, to which (when we can get resolution at all) the more indistinct self-luminous image is in reality a far nearer approach. It tends to make details which should be only geometrically symmetrical to a limited extent, perfectly so. In extreme forms it makes rows of spots into lines, and these lines straight when not really so.. It is always liable to false resolutions of double fineness. It fails to give even a tolerable image of the larger features of the object, thereby showing its failure to be a real "image" at all. All

that can really be learnt from it, is that there is probably (for this is subject to possible delusion from the false intercostals above mentioned) *some* periodic difference of structure in the object *similar in dimentional intervals* to "lines" shown: in regard to "spots" this is more uncertain, since these are often produced by false diffraction-fringes from any long line which may cross the true ones. That the lines are lines, or that the "pattern" is so geometrical as appears, is in the highest degree improbable. That the "spectrum" theory and method so long retained exclusive predominance, is because attention has been so concentrated upon either gratings or diatoms of *known periodicity* in structure, but which only represent to a very small extent indeed any serious kind of investigation.

18. It appears that in microscopy we have to deal with two characteristics of an image, which often are only to a limited extent compatible; that we have at command two methods of illumination which respectively promote more especially each of such characteristics; and that in most cases our problem is so to combine and balance these two methods as to produce the best result. *Fidelity of contour* will be secured in proportion as we are able to obtain our image by heterogeneous illumination, approximating the object to a self-luminous condition. But this method may prove utterly unable to give us *contrast*, which we may therefore be compelled to increase by using to a greater or less (even to a very large) extent plane-wave illumination, at the expense, however, of some greater or less degree of infidelity in contour. Thus an opaque subject, even of much minuteness, may be best shown by ground-glass illumination, or a very wide cone; while a diatom, unless in a very dense medium, or dry in air, may require narrow pencils of approximately plane waves. It is interesting to observe that there is thus a great degree of practical truth in

Prof. Abbe's early contention as to "different origins" of different parts of the image. Many of us have written of this as an "error," now "recanted," which strictly is true; but there is this broad practical sense in which it also is true.

And we are unable to use either kind of image or of illumination absolutely pure, if we desired to do so. The narrowest pencil we can practically use will not give us absolutely plane waves alone; there will be some amount of heterogeneity in the pencil, which in some little degree serves to *correct* our image. And the widest cones we can use, or even ground glass, do not prevent greater or less approach to the character of plane-waves, as the rays travel farther from the lamp; and these by their interference tend to *intensify* the image. We have to play off and adjust one against the other. In so far as we may regard every elementary or excessively small cone or pencil of rays from the condenser as an individual beam of plane waves (which no doubt is the case in some degree), in passing through the object it originates two or more pencils from the same point. These being necessarily in the same phase or phase-relation, so far as they exist must interfere at the focus, and thus *intensify* the image. On the other hand, the numerous such elementary pencils comsrising a wide cone, are in many discordant phases and transversals, and this very heterogeneity tends to correct the *contours* in the image, as above. We thus understand why, in really critical work, a large cone from a good condenser usually gives us the best results; but why it may be impossible, even with a perfect objective, to use a cone of light which will fill its aperture completely. It may be necessary, to intensify the image, while using as much heterogeneous light as we can, to use only pencils each of which throws out another diffracted pencil grasped by the aperture, so as to intensify, or correct it. But this

necessity depends on the nature of the object, and does not exist in all cases.

19. There is a very obvious and simple, yet decisive test as to the correctness of this view. According to the Abbe or spectrum theory, the amount of cone or heterogeneous light which can be used will depend upon the *minuteness* of the structure alone. According to the view here maintained (which recognizes the Airy theory as also concerned in the image) the *density or contrast* of the structure is the chief factor in this question. All experience proves that the latter is the case.

It only remains to show how directly the questions here discussed affect practical microscopy and the work of the microscope optician, and also determine the prospect of further advances in our powers of microscopical research.

20. The Abbe or "spectrum" theory has in its time, confessedly, led to enormous improvements in objectives. Owing to that specialization and ignorance of what physicists had done, there was amongst microscopists no understanding of the direct function of aperture in resolution; and so the Abbe theory was for years written about, and advanced as "the first explanation ever given." It thus produced a vivid consciousness of that function which was entirely new, to which we owe our present immersion and other high aperture lenses. But it is as easy to show that, this work being done, its undue preponderence and acceptance as the *only* theory, especially on the Continent, is now causing distinct prejudical results, owing chiefly to its connexion in practice with a narrow pencil or cone. Abbe himself throughout insisted upon the narrow pencil. Dr. Van Heurck does the same; Dr. Peragallo writes that a cone of more than 0·50 N A. is of no use; and Dr. Dallinger, and authorities like him, who in a general way accept the Abbe theory as *the* "theory," but know from their own exper-

ience the vital necessity in difficult research of a wide cone, write expressly of "theory and practice being thus at variance," in some way or other which had to be explained.

It is difficult to estimate the prejudicial effect of this upon microscopy on the Continent. As a quite uncorrected condenser will give a fair cone up to 0·50 N. A., amd also by immersion extremely oblique rays from its margin (equivalent to annular marginal illumination), for years no better Continental condenser was made. Prof. Abbe at last was driven to compute an achromatic, but this last production of Continental microscopy only gives an aplanatic cone of 0·65. Except those few who know of English condensers, with their *aplanatic* cones of 1·10 for immersion and 0·90 for dry conbinations Continental workers have thus been condemned to the errors and weaknesses of narrow pencils, which have thence been propagated through our own medical schools and the results are sufficiently striking. Dr. Koch at last found out, empirically, that wide cones gave much sharper and "finer" images of bacteria, in fact the only images worth having. Prof. Abbe accounted for this observational fact, in an article expressly contradicting any advantage whatever to the image (as an image) from a wide cone, on the ground that the wide cone, owing to its more sharply defined focal plane (want of "penetration"), makes invisible the transparent tissues in which the bacteria are situate. But he fails to account for the fact that it is just the same with bacteria in invisible culture-media or sputum; and that the advantage really consists in the much greater sharpness or *thinness* of the images of the bacteria themselves; in truth of contour, so that square ends are shown square and not rounded; and in the fact that there are no blurred edges or diffraction-fringes around them, as appear with a narrow cone. In fact, many allied bacteria cannot be distinguished at all

by the microscopic methods still too current in our schools, which have taken their methods from Germany.

At the Jena workshop in 1895, Prof. Zimmermann, one of the scientific staff (who has himself published a work on microscopy), said that in photographing they found no difference in results obtained by the chromatic and achromatic condensers; which is equivalent to the statement that they knew of no better results than those from a 0·50 cone. Our results are quite different. Mr. A. Pringle, whose splendid photographic work on bacteria is well known, often uses the largest aplanatic cones; and, Dallinger: "Photo-micrography with a small cone is quite easy, as great contrast can be secured [the reason has been shown in foregoing paragraphs]. With a large cone difficulties begin—difficulties of adjustment, difficulties of lens correction, difficulties of exposure, and difficulties of development. If, so far as our experience goes, a good photo-micrograph is required, these difficulties must be mastered."

21. This quotation leads us to the prejudicial effect of the theory (or rather of its undue preponderance) upon microscopic objectives. The mode of illumination directly influences the quality of the objective; because the all-important point of correction for spherical aberration has commanding influence upon the cone of heterogeneous rays which can be used with it. This does not appear under the Abbe method; and Strahl maintains that "the influenceof spherical aberration has been considerably over-rated in objectives!" The most eminent firm of Continental opticians states that its lenses, owing to the system of calculation and manufacture, are uniformly free from spherical aberration, so much so that there is no need for any "empirical tests," viz., testing upon the microscope itself. That is not the case when tested by the more perfect English appliances. The condenser itself is an English appliance. Ten years ago only one house,

I think, made one with wide aplanatic cone. Today every English house of any standing constructs achromatic combinations with 0·90 of aplanatic cone, and two construct apochromatics. Not long ago, having the opportunity of testing and comparing three similar objectives together, I was enabled to see the difference. With the Abbe condenser there was no very obvious distinction; but tested by English condensers it was quite otherwise. The great firm had no cause to blush for any one of them; all were good lenses; but they now revealed as distinct characteristic features as one sees in individual faces. On a graduated series of *Poduras*, one of them now gave most unusually good definition with rather a small cone under the highest (×27) eyepiece; while a second, scarcely equal in this point, excelled the others in the *wide* cone it was able to use on this object. Another operator more skillful than myself, and certainly of keener vision quite independently reached identical conclusions. Slight variations of pressure in the final polishing of the glasses are quite sufficient to produce such differences as these, in such small lenses as are here in question.

Whether this latter be the cause, or some other, nearly all high-power objectives even of the present day, and of the very best makers, show a very sensible amount of aberration. Drawing a circle to represent the whole aperture, and smaller concentric circles to define zones of its surface, many of the zones have *slightly different foci.* This fact plays all sorts of insidious hanky-panky-tricks with small-cone interference images of the Abbe kind; giving more force to such of the spectra as are correctly focussed than to the others. But in other respects, with small cones, these zonal differences are not obvious, and often escape detection, many portions of the aperture not being utilized at all. There are refined tests familiar to opticians, and some

others employed by highly skilled microscopists; but not only are these too seldom employed by even the best makers before the lens is sent forth, but we have seen that even their necessity is disputed, and the importance of spherical aberration itself actually challenged, by adherents of the "spectrum" theory as heretofore understood.

When, however, we do employ adequate tests, and at the same time make careful comparisons between one objective and another, we find that the perfect correction of spherical aberrations is just *all-important* in determining how far we can go in using with that lens the heterogeneous illuminating cone which is so important for depicting true contours in our image, still preserving sufficient resolution of minute structure. (We are here postulating sufficient opacity in the details, to dispense with much of the aid we have seen to be often necessary in hyaline subjects.) High-class moderate powers now easily utilize their full aperture, with ground-glass illumination. With high powers, the amount of this, or of aplanatic cone possible, is in almost direct proportion to the perfection of spherical correction. Few lenses over 0·60 N.A. will, however, even yet bear more than three-fourths of their aperture as direct light; many very good ones only two-thirds. And objectives differ strangely. In Zeiss's apochromatic series, the half-inch of 0·65 N.A. and the $\frac{1}{8}$ immersion of 1·40 stand out from the rest: some rare specimens of the former will bear their full cone, and occasionally an $\frac{1}{8}$ of 1·40 has been used in photography with a cone of 1·10. Very recently there was sent me for examination by Messrs Swift, a new English 1-12 apochromatic of 1·40, which was remarkably well corrected spherically. A rough but very fair idea of the spherical correction may be obtained almost immediately by focussing a *Podura* test-scale with small cone and then ascertaining how far the iris can be opened without

altering the image of the exclamation-marks. Using successively larger *annuli* of light, this test becomes far more efficient and severe. It was accordingly tested upon *A. pellucida* mounted in arsenic by Dr. Van Heurck. All the transverse striæ in the diatom were most easily resolved with a central, solid, unstopped full aplanatic cone of over 0·90 from a dry condenser. The larger features were of course also quite correctly and sharply imaged.

But this is not nearly the limit. Owing to some astigmatism and other defects, my vision is very coarse and imperfect in these matters, and for me to see the striæ means much more for many other observers. The first valve Mr. E. M. Nelson showed me in balsam as "strongly" resolved, was to my sight quite unresolvable, and he had to search for another, which I was able to see. This diatom is one of the most variable in resolvability of the whole list, quite apart from the mere coarseness of striation. *That* is no difficulty at all. Since that experiment Mr. E. M. Nelson has shown *A. pellucida* clearly resolved into striæ *mounted in balsam*, as well as "dry," with a similar cone of over 0·90 from Powell's apochromatic condenser, and a Zeiss $\frac{1}{8}$ apochromatic of 1·40. This latter lens was probably one of the finest ever made, and the mere striæ were not all it had to tell us, using no arrangements beyond the 0·90 full cone, and Giffard's green light-filter. On a dry valve, it clearly displayed where bits of coarser upper membrane with their blacker lines were overlying the lower, as is more often seen in *A. Lindheimerii*. And on a strong valve in quinidine, carefully adjusting for what may be termed the "white" focus, each of the striæ could be seen outlined at both edges, the outlines being a series of small convex curves, scalloping out the stria into partly-defined oval beads. The divisions or narrower necks between these partly-defined ovals did not lie in longitudinal rows, but occurred with a considerable degree of irregularity. Such

resolution, which most closely parallels the coarser *Lindheimerii* valve, may be the truest resolution yet attained.

No doubt the above lens was an almost phenomenal one. Every practical microscopist knows that the "similar" objectives, by even the very best makers, are not "all alike," whatever the makers may affirm. They differ in features as in a case above mentioned; most of all in the cone they can employ in critical work, and in what such a cone will reveal. Everyone engaged in difficult research has some favorite objective, treasured and spared in work as much as possible; because he knows full well that if parted with or injured, though he can buy a "similar" one at the list price, it may be long ere he finds such another.

22. The question of how far we may still expect advances in our optical powers of reseach is important; and it is answered very differently according to the "spectrum" theory, or the qualified views here maintained. It not only follows from the foregoing, but has been over and over again stated expressly by the Abbe school, that we have no hope of further advance, except through increase of aperture; and on that ground was constructed the lens of 1·63 N.A. to be used with flint-glass mounts and dense fluid media—conditions under which it is practically useless. So little are other conditions recognized, that Dr. Van Heurck has only used the chromatic condenser in his skillful published diatom photographs; and those results are simply *nil*, not one of them surpassing, or in some respects even equalling, what has been done in England with 1·40 lenses.

It is far different if the Abbe theory be relegated to its proper place and proportion. Then such "lucky" objectives as the above assume a very marked significance, and hold out a world of promise: in them and in what they tell us lies the future of microscopy. Not the best even of them is probably *perfectly* corrected for all its

zones; but the best of them reveal a marvellous standard of approach to this; and with that we find ever associated an increase of that practicable cone of heterogeneous light which we have found so all-important to true contours. *And with this we get further revelation.* More *minuteness* we do not indeed get; for that we can look only to the 1·63 lens. But we have a world of structure to learn yet, *within the resolution* of our present lenses; and for that we are only waiting better condensers and better correction. It was only recently that the protoplasm so long written about as "structureless jelly," yielded up some at least of its marvellous and minute structure, which can only be seen by English wide-cone methods, with one of the exceptionally-perfect objectives here referred to; whose significance, however, as we have seen, is not yet recognized on the Continent as it is in England, and even here only by the few. It may be beyond us to-day to discover the minute departures from type which cause the superiority of the few phenomenal lenses: it is no easy thing to ascertain precisely what it is, in a lens one of whose components may not exceed a hemisphere 1-16 of an inch in diameter. But the superiority is there; it has been attained; and we may cherish reasonable hopes of such discovery. We may anticipate that the present rarest excellence may be reached yet as a standard, more generally procurable by the scientific investigator; that the very best of all may even be further improved in correction in some degree. If it be so, such advances will not be barren of results in research. The microscopist may yet hope and take courage.

PERSONAL.—Prof. W. A. Rogers died at Waterville, Maine, March 1, 1898, aged 61 years. He had been professor of physics and astronomy in Colby University since 1886 but expected to remove to Alfred University the lresent spring.

PRACTICAL SUGGESTIONS.

BY L. A. WILLSON,

CLEVELAND, OHIO.

CICADA TREDECEM.—This insect is now visiting the Mississippi Valley. It is a well marked variety of Cicada septendecem, or so-called Seventeen Year Locust or Periodical Cicada. The insect now seen is a thirteen year Cicada. It lives thirteen years underground in the larval and pupal stage and then as a perfect insect emerges into sunlight. Entomologists recognize several well-defined broods of this strange insect, the present brood being called No. VII. This brood last appeared in 1885. The brood in question ranges from Southern Mississippi and Northern Louisiana up along the river through Tennesee, Southern Kentucky into Southern Illinois, with quite a patch in Missouri. A fine treatise on this insect with illustrations is contained in the U. S. Agricultural Report for 1885 on page 233 et. seq., and illustrated page 347 et. seq.

A WHITE-FISH'S STOMACH.—The contents will be found to be almost exclusively composed of crushed remains of microscopic crustaceans, principally of Cyclops and Lychnis. What the cyclops lacks in size and weight it makes up in numbers. Should one female lay ten eggs at a time in three months she will lay eight times, so that at the end of a year her descendants would equal 4,442,189,120. If we calculate that one cubic inch will contain ten millions, then the progeny of a single female from January to December will amount to 444 cubic inches of solid food, as much as a single fish could consume.

BAZZANIA.—This is a genius of liver or scale mosses. The genus has two species in this country—trilobata and deflexa. The first species is found in wet woods and the second on rocks. They are pretty and easy to exam-

ine. Remove all dirt and examine, covered in a drop of water. Examine the slide with the cover up and also reverse the slide. Along the stems will be found the amphigastria or under leaves. It makes a beautiful show under a one inch objective. It may be mounted and well preserved in glycerine jelly.

EDITORIAL.

Postal Microscopical Club.—A 16 page pamphlet, issued by the President, R. H. Ward, M. D., and the Secretary, Dr. Shanks, contains the twenty-second and twenty-third annual reports. The club has been in continuous operation since 1885. Its membership remains about the same, and about thirteen boxes of slides pass from member to member each year through the mails. The Club reports having had some of its boxes crushed and absolutely destroyed by the rough treatment of the postal cars grabbing up mail bags on too swiftly moving trains or throwing the bags off from such trains. This only occurs at small stations, suggesting that no member should be permitted to send or receive the boxes at suburban stations. If the members are restricted to using post-offices in cities and large towns, this difficulty would be largely obviated. Another difficulty which has always annoyed the officers is the holding of boxes too long before forwarding them to the next station. As a remedy for this each member should be compelled to deposit $5 or $10 to the Treasurer so that fines may be rigorously assessed for each violation of the rules. The annual dues $1 cover the officer's expenses for slides, boxes, postage, expressage, stationary and printing.

A new special series of boxes have been in service for several months. Half of these are six-slide boxes devoted to special subjects and contributed by members who have made special studies in certain fields. The other half which are circulated alternately with the first are two-slide boxes and a few with three-slides accompanied with

elaborate notes for the benefit of those persons who wish to make a serious study of the objects or to gain experience and efficiency in somewhat advanced fields of research. These boxes each contain one botanical and one zoological specimen. Most of the notes have been made by Dr. Ward, Dr. Shanks and C. M. Vorce. Others are invited to contribute for next year. Some of the members have testified their high appreciation of the boxes and the notes as being superior to any of past years.

The membership is divided into circuits. While a box is passing through a circuit, including six or eight addresses, it is out of sight of the Secretary. If the box fails to complete its circuit on time, the Secretary is put to great trouble in tracing it. This is where "one sinner destroyeth much good." Last year a circuit was necessarily dropped because no boxes could be got through it or could even by any amount of special effort be got back from it except after months of delay which was simply ruinous to the plans of the officers. It would give us pleasure to publish the names of the members of that circuit if the officers would kindly furuish them to us. If, however, they neglect the system of fines, suggested above, they will loose a part of our sympathy. There are some vacancies in the well behaved circuits and co-operation is desired in finding suitable persons to be made new members.

SCIENCE-GOSSIP.

Preserving Media for Biological Preparations.—The following fluids are recommended by Amann for preserving biological specimens: *Lactophenol*: Carbolic acid, 20; lactic acid, 20; glycerin, 40; distilled water, 20 parts. Recommended for fronds of mosses, hepaticæ, fungi, and algæ. *Lactophenol copper solution*: Crystallized chloride of copper, 0·2 part; crystalised acetate of copper 0·2 part; distilled water, 95·0 parts; lactophenol, 5·0 parts. For preserving chlorophyll, recommended for Demidiaceæ, Palmadaceæ, Confervæ, etc. *Concentrated lactophenol copper*

solution: Crystalized copper chloride, 2·0 parts; crystallised copper acetate, 2·0 parts; lactophenol, 95·0 parts; water containing algæ is mixed with 10 per cent of the above solution. The whole material is preserved thereby for a long time. *Lactophenol glycerin jelly*: White gelatin, 85; distilled water, 44; glycerin, 30; dissolve by heating on the water bath, filter and mix with 10 parts of lactophenol. *Lactophenol copper glycerin jelly*: Prepared as above with the substitution of 10 parts of lactophenol copper for lactophenol. Phyocyanin and chlorophyll retain their color excellently in this medium. *Lactophenol gum*: A strong solution of gum arabic in water 1, glucose 2, and lactophenol. For preparing mosses for the herbarium. *Potassium mercuric iodide glycerin*: The author states that the salt dissolved in concentrated anhydrous glycerin gives a mounting medium of 1·78 to 1·80 refraction index. He recommends the mixture for Diatomaceæ. The preparations are ringed on with amber or dammar varnish mixed with two per cent of boiled linseed oil.—*Pharm. Centr.*, xxxviii., 544.

Astronomy.—The microscope is useful in astronomy—(1) As applied to the graduated arcs of measuring circles in astronomical instruments of precision, and to the fine divisions on the measuring rods used in determining a base-line,—the fundamental measurement in astronomy. The microscope micrometer, which contains the microscope as an essential part, is used extensively; (2) In the measurement of the position of stars on the Astro-Photographic Chartsand plates obtained by the International Congress for their catalogue of all stars of the first eleven magnitudes; (3) In the determination of differential stellar parallax from photographic plates; (4) In the study and observation of the heavenly bodies as advances in astronomical photography make it possible to produce slides of sufficient fineness for the purpose.

Woods.—L. W. Hahn, Silver Creek, N. Y., offers 110 varieties of foreign and native woods for $3.00.

THE AMERICAN

MONTHLY

MICROSCOPICAL JOURNAL.

VOL. XIX. AUGUST, 1898. NO. 8.

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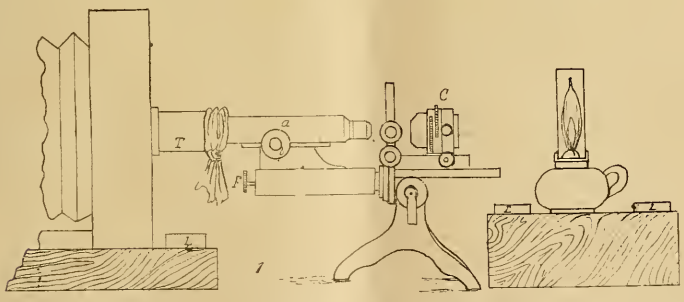
Photo-Micrography.

The essentials are a light source, a microscope, a camera, and objects. Better results with less trouble can be obtained by using artificial light, which may be



either limelight or lamplight. Lamplight should take the form of the ordinary microscope lamp, although, any flat-flame lamp with wick slit, of preferably one inch in length may be used.

See that your wick is quite dry, and that you have the best paraffin; dissolve one ounce of camphor in every pint, fill your lamp about three parts full, light the wick, and turn it till the flame is about three-quarters of an inch high; allow it to burn for fifteen minutes, and then turn it up as far as it will go without flaring or smoking, let it burn for another five minutes, and if there is no sign of smoking all will go well. The lamp should always be turned with the edge of the flame to the microscope, the flat of the flame should never be used except with a bull's eye.

The camera need not be elaborate, if one is in use for ordinary photography, no matter what size it is, it can be used. But to those who do not possess a camera, it is by no means difficult to rig up an apparatus, which though costing but a little will serve as well as a special outfit. When a camera has to be made, make it of small size, and it will be found that a quarter plate, 4¼ by 3¼ inch, will be quite large enough. The length of camera is important, for upon the extension of the camera depends the amplification of the image. It is advisable, therefore, to have a camera which will extend to at least 4 feet 6 inches. It can be used either with or without an eye piece.

In making a camera, the first thing to do is to purchase your dark slide. Cheap dark slides with a focussing screen frame may be obtained, and it is advisable to purchase the two because one of the main difficulties in making a camera at home is to obtain perfect register between the focussing screen and sensitive plate. The camera should be made in three sections, sliding one within the other, and that portion nearest the microscope should be the larger. A very stout varnished millboard can be bought; this is nearly a quarter of an inch thick. Measure the exact size of your focussing screen frame, which we will suppose to be 5½ by 4½ inches. We shall

then want a piece 19 inches by 20 inches; this must then be cut into strips 19 inches long, two measuring 5½ inches in width, and two 4½ inches in width. These when joined up at the edges will form a box 19 inches long by 5½ by 4½ inches. To form the corners it is advisable to get a carpenter or joiner to make angle pieces of oak or beech, the section of which will be somewhat like an L, with equal width of the vertical and horizontal arms. On to these angle pieces, which which must be about 1 inch wide and 19 inches long, the millboard may be fastened by fish glue and short brass brads; the angle pieces must be inside. Having made this box, fasten the focussing frame on to one end with fish glue and brads. Measure the exact external size of this box and procure some more millboard, and fix up in exactly the same way, so that it will just slide outside the other box. You will then have a camera with a sliding body, which will extend to 36 inches and close up to 18 inches. If thought desirable a third section may be added, but this will hardly be required. In place of millboard it is possible to use black twill, lined with ruby fabric. What is wanted is a sleeve of black cloth with elastic run into the four edges so as to make it contract and enable it to be pulled out.

If cloth is used, the focussing frame must be screwed to a stout wooden frame, which is provided at both sides with brass tongues and screws to screw into a stout wooden plank, so as to keep it upright. The millboard is preferable.

To make the camera front it is merely necessary to procure a piece of wood of the same size as the back and to this fasten the millboard or cloth sleeve. A hole must be cut exactly in the centre, of such a diameter as to take the tube of the microscope easily, with about a quarter of an inch to spare. Now procure a piece of cardboard postal tube about 4 inches long, and glue this into

the hole in the front of the camera. The base board should be 8 inches wide, 8 feet long, and 1 inch thick—2 inches in thickness is better. It should be well planed on one surface. Beech, mahogany, or oak are the best woods, pine should not be used. Draw a straight line down the middle of the planed surface, the use of which will be seen afterwards.

The microscope may be of any pattern provided the body may be turned absolutely horizontal. Most modern microscopes can be placed in this position, but frequently they are unsteady when so placed. In such a case have two iron shoes screwed to the long base-board, and under these shoes slip two of the legs of the microscope; for the third foot have a hinged shoe with screw so that it can be placed over the foot and screwed up tight so as to hold it steadily. Some modern microscopes have a horseshoe foot, in which case procure about four pounds of lead in a block and place this over the foot.

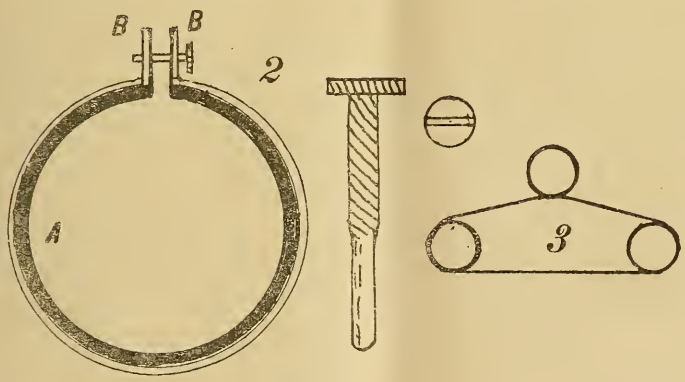
The microscope should have a substage condenser, but if this does not form part of the outfit, then a low power objective should be placed below the stage.

The objective will, of course, be already part of the outfit, but for those who wish to purchase new ones, there are few which can beat the new hard semi-apochromats of Mr. Reichert, of Vienna, a 3 mm. of this type of quite new construction having passed most successfully through some very severe tests. Still, good work can be done with an inch, half-inch, or quarter-inch, though better work can of course be done with fine diatom markings, etc., with a one-sixth or one-eighth.

In ordering new objectives it is essential to insure their being corrected for the chemical rays, though with anything higher than a one-sixth inch this can be ignored. For objectives of lower power it is advisable to use a strong tincture of litmus in a flat-sided cell or tank of

about half an inch internal measurement. Such tanks may be bought from any photographic dealer, as they are designed for use with the optical lantern. The action of the litmus solution is to cut out or absorb all the yellow rays, by which in the ordinary way focussing is effected, and leave only the blue and violet, to which the plate is most sensitive. Any old objectives can, however, be corrected by an optician.

It is essential that the microscope should have a fine adjustment and one that works steadily, so that when in use the image of the object will not shift from side to side. If this is underneath, as shown in Fig. 1, and, as is usually the case, it has a groove in the milled head, a



piece of fine silk twist or catgut should be passed over it and then carried round two ordinary cotton reels with grooves cut in them, as shown exaggerated in Fig. 3. One of these reels should be provided with a cross saw cut, as in Fig. 2, into which can be fitted a square-sided rod of brass fastened to a long handle, which is supported on wooden pillars, to the back of the camera. At this point it ends in a milled head, which enables the operator whilst examining the focussing screen to manipulate the fine adjustment. If the fine adjustment has no groove, then a small collar of brass lined with a couple

of thichnesses of box cloth, and a screw working through two eyelet holes, as shown in Fig. BB, may be used; this slipped round the fine-adjustment and tightened up and connected with the long brass handle will enable fine focussing to be perfected. A is the box-cloth and BB the tongues with screw.

The question as to whether an eye-piece should be used or not depends to a great extent upon individual taste, but it has this great advantage, that when an eye-piece is used, the extension of the camera is considerably less for any given magnification, in comparison with that required when no eye-piece is used. The eye-pieces in general use are the Huyghens, Ramsden, orthoscopic, compensating and projection oculars. For those who intend to do really good work in photo-micrography, the projection oculars should be obtained. They are made by several firms, Reichert, Zeiss, Swift, Powell and Lealand, and Beck, and usually they are made in four sizes, 2 and 4 for Continental tube length, and 3 and 6 for English tube length.

Ordinary ground glass as supplied by camera makers is utterly useless for focussing upon. It should be replaced by a dry plate treated as follows:—Place the dry plate without exposure to light in a clean solution of hypo.(1 : 4), allow it to remain for fifteen minutes, then wash thoroughly for an hour in running water, allow it to drain, and immerse for ten minutes in 5 per cent. solution of sulphuric acid. Finally rinse and immerse for the same time in $2\frac{1}{2}$ per cent. solution of barium chloride, and wash well and dry. This treatment precipitates a very fine deposit of barium sulphate in the gelatin which is easy to focus on. Instead of this, a sheet of plate glass about $\frac{1}{8}$th inch thick may be used, on one surface of which, (that nearer to the microscope), fine lines crossing each other at right angles in about half inch squares have been ruled with a diamond. When an eye-piece is

used on this so that the ruled lines are sharp, one can readily detect when the image is sharp.

The extension of camera determines the linear magnification of an object, and as half the value of a photo-micrograph for educational purposes is dependent upon the degree of magnification being known, it is just as well either to work always with a given extension for each power or to calculate out each time the amplification. "The linear amplification of a projected image is the distance between the image and the posterior focus of the lens system, divided by the focal lengths of the system. The posterior focus of the lens system corresponds in the microscope exactly to the upper side of the ocular. It follows from the preceding data that the amount of amplification of an image for any distance between ocular and screen is found by dividing this distance, expressed in millimetres, by the focal length of the objective used, and multiplying the quotient obtained by the number of the ocular" (Van Heurck).

The initial power of a lens is found by dividing 10 (the nearest average distance of distinct vision in inches) by the focus of the objective, thus 10 divided by $\frac{1}{8}=80$, the initial power of $\frac{1}{8}$ inch. If this be multiplied by the power of the eye-piece, it gives the magnifying power of the combination; thus with an eye-piece magnifying 3 times we have $80\times3=240$ diameters. To apply this to a camera a proportional sum is used :—As 10 : the camera length : : microscope amplification: camera amplification. Example: Using a $\frac{1}{8}$ inch objective, eye-piece magnifying three times, and camera extension of 24 inches, required the magnification—

As 10 : 24 : : 240 : x=576 diameters.

If the objective alone is used, then the length of the tube must be added. A $\frac{1}{8}$th inch on a 10 inch tube and camera extension of 24 inches will give us :—

As 10 : 24 plus 10 : : 80 : x = 272 diameters. This shows clearly the advantage to be gained by using an eye-piece.

These are but rough and ready rules; for very exact work it is essential that a stage micrometer should be used, and the enlarged image divided by the real measure gives the magnification.

Modern Methods and Their Achievements in Bacteriology.

In order to convey some concrete idea of the extreme minuteness of bacteria, it has been mentioned that if a postage stamp $\frac{7}{8}$ inch long and $\frac{3}{4}$ inch wide (22·2 mm. by 19·05 mm.) were covered by a single layer of the typhoid bacteria, placed end to end and side by side, 500,000,000 bacteria would be required; and further, that the same area, covered to the depth of one-tenth of an inch (2·54 mm.) would accommodate no less than 2,000,000 million of these microscopic creatures. If beef-broth be sterilized, and to the limpid liquid be added bacteria known as *Staphylococcus aureus*, in the proportion of 246 per cubic centimetre of broth, and the whole maintained at the temperature of the animal body (about 98 deg. F.) for twenty-four hours, it will be found that the liquid has become quite turbid, and calculation will reveal the presence of 20,000,000 bacteria in every cubic centimetre of the solution. In other words, each original bacterium has become 80,000. The bacterium which causes fowl cholera, an epidemic disease which quickly decimates a large fowl yard, is so abundant that the blood of an infected fowl teems with them to the extent of 15,000,000 to each cubic centimetre. Indeed, if one-fiftieth of a drop of this blood be injected into a healthy rabbit the animal sickens and dies in twenty-four hours, and the blood in its body contains about 12,000,000,000 bacteria.

The lecturer then described the methods now in use of cultivating bacteria in solid media, and which were first introduced in 1881-82 by Robert Koch. It was mentioned in passing how great were the benefits conferred upon humanity by the rapid increase in our knowledge of bacteria, due mainly to these methods, especially in the departments of medicine, chemistry, and botany. A series of slides was then shown, illustrating the cultivation of bacteria by the use of solid media, their identification by appropriate methods of culture and various modern methods of artificial staining. It was shown how bacteria may thus be sifted out and determined specifically by accurately noting their morphological and biological characters. One slide showed a culture of some bacteria collected in Oxford Street at mid-day, by exposing a bottle containing beef-broth to the air for a few minutes. A portion of the broth was mixed with gelatin, spread on a glass plate 3½ inches (88·9 mm.) in diameter, and placed for a few hours in an incubator. The result of this treatment was that the isolated bacteria multiplied enormously and founded colonies, which could be transferred to other portions of the nutritive medium and sub-cultures so obtained. A sample of sewage was diluted to a known extent, mixed with a definite quantity of medium, and similarly treated. In this way it is possible not only to identify and sift the multitudinous forms of bacteria, but also to estimate their number and roughly compute their weight. Thus the sewage was found to contain about 2,000,000 typhoid bacteria per cubic centimetre, and it is estimated that about 40,000 million *Staphylococcus aureus* weigh 1 gramme.

The lecturer showed conclusively the absolute futility of chemical analysis, of water, unless it is supplemented by a careful bacteriological examination. It has been stated by the most eminent authorities on water analysis

that the presence of 0·05 of organic matter per 100,000 parts is a negligible quantity. Some time ago a water was described as containing 1 grain (0·0648 gramme) of organic matter in 5000 tumblers, *i. e.*, one 5-000th of a grain (·00001296 gramme) per tumbler. Now, granting that this organic matter represented bacteria, and in weight they resembled the *Staphylococcus aureus*, it follows that each tumbler contained the alarming proportion of over 518 thousand typhoid bacteria. If we go a step farther and consider the alarming rate at which the cholera bacteria multiply in the blood of a healthy rabbit, we cannot fail to grasp the shockingly fatal results that may accrue from an imperfect examination of a sample of water infected with the typhoid bacterium. The fact was emphasized that infinitesimal weights of bacteria cannot possibly be detected by the aid of purely chemical methods, and that no examination of water is complete unless it has passed through the hands of an expert bacteriologist. One-sixtieth part of crude sewage in 100 c. c. of distilled water gives a proportion of about 1·7 of sewage per 10,000 of water. Chemical analysis detects this small amount of organic impurity, but the chemist looks upon this sample of water as one of exceptional organic purity, and passes it as a first-class potable water. But the bacteriologist has methods at command which enables him to detect far smaller proportions of organic matter, and he sees great danger when water is contaminated with sewage to the numerically small extent of one part in 500,000.

The lecturer passed on to consider the conditions that affect the growth and vitality of bacteria. All bacteria may not be present in a given area in the same proportion, and if a culture be made in a nutritive medium that favors the growth of all alike, it is possible to miss specific bacteria that may be of great importance.

It is customary, therefore, to add to the media certain substances that are known to retard the multiplication of the rabble, whilst they favor the growth of the few. The addition of 1-500th per cent of carbolic acid acts in this way, and is largely used in the case where, *e. g.*, it is required to find *bacillus coli*. By adding sewage to phenolated broth a pure culture of *B. coli* may be obtained. This medium is favorable also to the typhoid bacillus, and both multiply well in a medium prepared from a sterilized infusion of potato mixed with gelatin and iodine. The incubation period for these two varieties of bacillus varies from twenty-two to forty-eight hours. It was noticed that whereas the *B. coli* develops carbon dioxide the typhoid bacillus does not. The cholera vibrio grows and multiplies best in a medium containing 1 per cent of salt and 1 per cent of peptone. By such devices the specific bacteria may be isolated from other varieties, and in the form of a sub-culture spread upon glass, dried, stained, and examined. In 1893 the value of this selective method was proved in a striking manner. A man died from an unknown cause, an inquest was held on the body, and as a result the death attributed to pnuemonia. Another doctor, somewhat sceptical about this conclusion, took a portion of the dead man's bowels, mixed it with gelatin and placed it in an incubator for ten days. Then a portion of the putrid, evil-smelling substance was transferred to a peptone solution, a plate culture of the same prepared, and the presence of the cholera bacillus proved beyond the shadow of a doubt. Dr. Klein described another method of sifting, depending on the principle that whilst some bacteria thrive in air, others are killed thereby. These two classes are described respectively as ærobic and anærobic bacteria. The cholera bacillus and *B. coli* are examples of the former class. Anærobic conditions are attained by a variety of methods, including the absorp-

tion of oxygen by alkaline pyrogallol and its removal by the use of an air-pump. If milk, boiled and sterilized, be mixed with sewage, placed under anærobic conditions, and examined after twenty-four hours' incubation, it will be found clear in one part, while the top and bottom portions of the vessel will be occupied by a coagulum. The liquid literally teems with anærobic bacteria.

Bacteria which cause phosphorescence on old, rotton wood, and the bones of dead fish next received attention. In such cases the bacteria either themselves become luminous or else produce a luminous secretion. A medium composed of broth with small proportions of sodium chloride and asparagin favors the multiplication of these luminous bacteria in the course of 48 hours incubation. An exquisite photograph was shown of a flask filled with a fluid charged with such bacteria; the plate and flask were left in the dark for several hours and a strikingly beautiful picture was produced. Slides were then placed in the lantern, showing many specific forms of bacteria, including those of anthrax, tuberculosis, influenza, as well as those which convert urea into ammonium carbonate, nitrites into nitrates, and give rise to other well-known and important changes in nature. It was shown how useful are the bacteria which invade the roots of leguminous plants in enabling a plant to absorb its supply of nitrogen direct from the atmosphere. The question of the choice of suitable dyes was then discussed, and the various aniline dyes, *e. g.*, methyl blue and gentian violet passed in review. A slide was exhibted of the bacteria cultivated from the expectoration of a person suffering from tuberculosis. The culture had been stained with fuchsin and then treated with nitric acid, which discharges the color from all bacteria except the tubercular bacillus. The discovery of a method of isolating this dreadful scourge was made in 1882 by Koch, and enabled him to prove conclusively that tabes

mesenterica in children, lupus, scrofula and many other loathsome and unmentionable diseases are but different forms of one and the same complaint, viz., tuberculosis. In conclusion Dr. Klein said that though he would place high in the list of famous achievements Simpson's discovery of the use of chloroform, Jenner's method of vaccination with calf-lymph, and Lister's antiseptic surgical methods, yet he reserved the highest place of honor for Koch's discovery of a method of isolating the bacillus of that fell destroyer, tuberculosis.—Dr. Klein at the Royal Institution, London, reported in the Phar. Jour., June, 1898.

Practical Suggestions.

BY L. A. WILLSON,

CLEVELAND, OHIO.

Textile Fibres.—In the Agricultural Report referred to in the last article on page 90 is a fine essay on the testing and discrimination of textile fibres. Cold nitric acid will destroy silk and leave cotton untouched. The action of muriatic acid is the same. On a cotton fibre place a drop of sulphuric acid and follow quickly with a drop of the transparent solution of the tincture of iodine. The fibre will form into disks or beads of a beautiful blue color. Flax is affected in the same way but more conspicuously. Wool treated with commercial sulphuric acid or strong diluted sulphuric acid will liberate the surface scales at one end and they will then appear under a low power as hairs proceeding from the body of the fibre. The fibres of dyed black silk are interesting under the microscope when prepared as follows: A few threads of the warp are placed on a glass slip in one or two drops of concentrated nitric acid, the black color changes to green, then to blue. A life-like motion is observed in all the fibres, and they appear marked cross-wise like the rings

of an earth worm. The acid will finally dissolve the fibre.

Polarized Light.—The following rather unreliable but curious rapsody is copied from an old school chemistry :—"Fancy yourself in a region solely illuminated by Aurora borealis, imagine a country where every passing cloud throws a diverse colored shadow of gorgeous hues across your path, where the air breeds rainbows without the aid of a shower, and where the summer breeze breaks these rainbows into irregular lengths, fragments and glittering dust, scattering them broad-cast over the land, like autumnal leaves swept by a gale from the forest and you have an approximate, and by no means exaggerated idea of the effect of polarized light on substances capable of being affected by it. For it is light endowed with extra delicacy, sublety and versitility. it renders visible minute details of structure in the most glaring colors; it gauges crystalline forms of infinitesimal thinness; it betrays to the student's search otherwise in appreciable differences of density or elasticity in the various parts of tissues. Indeed, as a detector, polarized light is invaluable, acting the part of a spy under the most unexpected circumstances. It denounces as cotton what you believed to be silk; it demonstrates disease where you supposed health. It adorns objects that are vile and mean, whose destiny is only to be cast out—such as paring of nails, shavings of animal hoofs, cuticle rubbed or peeled from the stems of plants, offscourings of our kitchens and store rooms, sugar, acids and salts—with the most magnificent, the most resplendent tints such as are seen when the sun streams through the stained glass windows of a Norman cathedral.

Unrestrained Imagination.—It is always wise in science, to be calm and to avoid exaggeration. Many young microscopists are apt to permit the uninitiated to deceive themselves as to the magnifying power of

the objective used. Far better is it to always advance the exact truth. Our instrument is wonderful, needs no exaggeration, but speaks for itself.

Analyzing Flowers.—For this purpose, a good dissecting microscope will answer nearly every requirement. This should be supplemented by a case of dissecting instruments, such as knives and mounted needles.

Analyzing Mosses.—For this purpose a first rate compound microscope is indispensable. Here every part of the plant is often diagnostic. The protonema, the costa of the leaves with guides and stereids, the antherids, archegones, the perichetal leaves, the seta, the stem leaves, the branch leaves, the capsule, the calyptra, the operculum, the peristone, the spores and in fact nearly every part is frequently brought into requisition. Few studies will require more attention or develope more microscopic acuteness than the analysis of mosses.

EDITORIAL.

The Nerves.—Some very extended microscopic studies of the nerves have been made by foreigners and Prof. Barker has compiled the results in the N. Y. Medical Journal. The illustrations largely photomicrographs have already reached one-hundred and two in number.

Necrology.—Dr. D. P. Frame died at Kansas City, Mo., Feb. 25, 1898, having been a veterinary surgeon for twenty-five years but, for two weeks prior to his death he was a government meat inspector at Kansas City, having just moved there from Colorado Springs. He was a good microscopical student, a subscriber to periodicals, and a member of the Postal Microscopical Club.

Diatoms.—The flora of the Pacific coast excels that of the Atlantic in elegance and abundance of forms, though not in number of species. Algæ may be found covered to the depth of a quarter of an inch with deposits of the

characteristic forms of the region—Arachnoidiscus ehrenbergii, Isthmia nervosa, Hyalodiscus subtilis and Rhabdonema crozieri. C. S. Boyer is studying them.

Irridescence of Water-proof Cloth.—An American manufacturer anxious to imitate the English goods spent much money to discover the secret preparation. George E. Fell dissected a piece under the microscope and discovered starch granules with polarized light. Comparing with various kinds of starch, he found it to be potato starch. This information could probably have been sold for $500 or $1,000 if Mr. Fell had demanded it.

Larva of Dermestes.—In drug stores, they burrow into all kinds of roots and even sticks of extract of liquorice. Their appetite for paint brushes results in their eating up the bristles. Druggists fumigate with benzine or with bisulphide of carbon. An ounce bottle half filled and set in their way uncorked, will kill all that are near. They make pretty microscopic objects.

The Hermit Crab's Cutting-hairs.—F. S. Morton kept several hermit crabs in an aquarium and observed their habits. When a bit of food touched their antennæ, they grabbed it and rolled it about with their foot-jaws by a sawing and crushing motion before crowding the food into the mouth. A microscopic study revealed the cause of the motion. The crab was simply cutting up his food preparatory to swallowing it. With a one-fifth inch objective can be seen double rows of very sharp teeth on each hair. When jammed rapidly into a bit of soft food, they quickly reduce it to pulp. The crab lives on decayed matter which these cutting hairs readily prepare, but more solid food would undoubtedly break them.

Bed Bug Hairs.—A careful examination of the body of Cimex with a good ⅛th objective will show it supplied with hairs which are trifid at the ends. The shaft is covered with delicate spines, long, pointing from base to tip, and lying at a very low angle in relation to the axis of the shaft. He has been flattened dorso-ventrally by crawling

under clothing during which the hairs conveniently act as anchors.

The Skin.—Nikola Tesla says that from 4,000 to 7,000 microbes light on every square foot of the human body every 24 hours. Examined under the microscope the skin would swarm with millions of microbes which feed upon the skin and destroy its freshness producing yellowness and wrinkles. He directs thorough washing daily and rubbing with alcohol. He has also invented a battery to drive them away into space with great violence.

The Microscope Inadequate.—As in small-pox, rabies, scarlet fever, typhus fever, and certain other infectious diseases, the efforts heretofore made to demonstrate the specific ætiological agent in foot-and-mouth disease have bee unsuccessful. The carefully conducted investigations of Loffler and Frosch also failed to demonstrate the presence of any specific micro-organism in the lymph drawn with proper precautions from the vesicles about the mouth or udder of infected cows. Cultures in various media inoculated with this lymph remained sterile and the micro-organisms could be demonstrated by the use of the microscope, in stained preparations. Nevertheless, experiments showed that this lymph was infectious material and that calves inoculated with a very small amount of it invariably developed the diseasein two or three days. From which we are sure that there exist organisms too small to be recognized by the microscope as at present developed.

Training Needed.—For the untrained eye the microscope is little better than a toy, and it may even be regarded as a dangerous instrument, because of the inevitable mistakes which the novice will make if he undertakes to decide questions of diagnosis by the use of high-power oil-immersion objectives without having had the necessary training for such delicate work. In blood examinations, especially, considerable experience is necessary in order to give value to the evidence afforded by a microscopical investigation. It is a very easy thing for the non-expert to overlook the malarial parasite, and still easier to mistake

vacuoles in the corpuscles, deformed red corpuscles, etc., for parasitic elements.

SCIENCE-GOSSIP.

Reagents for the Microscopical Examination of Food.—Van Bastellar finds the following reagents useful for the microscopic examination of foods:—[1] Chloral hydrate, 5; distilled water, 3. This is an excellent clearing medium, and shows the structure of various cells, such as beet in chicory, and chicory in coffee, also renders detection of inorganic matter mixed with starches more rapid. [2] Aniline, 1; acetic acid, 10. Gives a bright yellow tint with schlerenchyma and woody tissue, detects powdered nut shells, olive stones, etc., in pepper. [3] Acetic acid, 1; water 2. Gives a violet tint with fragments of tissues of *Melampyrum* seeds in flour. [4] Potassium iodide, 1; iodine, 1; water 50. Renders starch distinct by coloring the granules blue and therefore making the size and shape more evident for their identification. [6] Potash, 1; water, 100. Causes certain grains of starch to swell, and thus distinguishes them from others which are more resistant. Also gives a reddish tint with tumeric and a violet color to ergoted particles in flour. [6] Methyl violet. 1; water, 300. Stains starch granules. [7] Tincture of logwood [1 in 15], 4; sodium chloride, 1. Detects presence of alum in bread, flour, etc. [8] Sulphuric acid, 1; water, 20. Gives effervesence in presence of carbonates or bicarbonates, thus detects such mixtures as chalk in flour. Also gives a blood-red tint to ergoted flour. [9] Eosine, 1; solution of ammonia, 10. Stains altered yeast cells and bacilli. [10] Hæmatoxylin, 1; water, 25; alcohol, 25; sodium chloride, 5. Resembles No. 7 in action. [11] Solution of ferric chloride, 1; water, 5; blackens acron tissues, also those of leguminous seeds. Gives a greenish tint to powdered date stones and other adulterants in pepper. [12] Copper sulphate, 1; water, 20; ammonia *q. s.* to give a clear blue solution. Gives a dirty greenish blue with some foreign admixtures with

rice. [13] Ferrocyanide of potassium, 1 ; water, 100. Gives a redish tint with flour or other substances contaminated with copper salts. [14] Fuchsin, 1 ; alcohol, 100 ; stains various tissues, notably those of pepper. [15] Chlor-iodide of zinc, 1 ; water, 50. Reacts like potassium iodide. [16] Solution of ammonia, 1 ; water, 20. Acts like No. 5, and gives blue tint with copper.—*Journ. de Pharm.* [6], vi., 228.

In Botany.—Prof. Pierce in an article on the scope of botany says : The microscopic study of plants leads us to the most fundamental questions of biology. By microscopic study a botanist discovered that all organisms are composed of cells and that these cells are minute masses of a viscid substance called protoplasm. So much alike are the microscopic processes in the animal and vegetable kingdoms that much light is thrown upon the great questions of the influence of parents on offspring, of heredity, of descent, of development, by the microscopic study of the phenomena of fertilization and development among plants. The microscopic study of the purely vegetative as distinguished from the reproductive parts of plants reveals certain mechanical principles of structure which engineers are now just beginning to follow in their buildings, especially those constructed of materials which in large masses resemble in physical qualities those microscopic elements of which plant structures are composed. The study of structure whether macroscopic or microscopic leads us to investigate the functions of the parts. This study of functions is physiology. The first knowledge of bacteria came through the botanists. The methods employed in studying and combatting them were first suggested by botanists. Precision in the manufacture and the uniform quality of the product of bread, cheese, vinegar and beer have come only in recent decades when microscopic organisms upon which these processes depend have become known and have become regularly raised like wheat or cattle. Similar methods will be obtained shortly in the production of wine and in the curing of tobacco.

Stem of Dodder.—When the haustorium has been developed the root dies and connection with the soil ceases. The stem above the haustorium twins around its host and throws out new suckers as it grows. It thus establishes itself firmly upon the victim, which it at length destroys. It climbs all indifferently—the clover, the thistle, the nettle or rag-weed, the day-flower and even the poison-ivy. It feeds upon the juice of the latter without acquiring its properties. The stem makes an interesting mount.

RECENT PUBLICATIONS.

Hemorrhoids.—E. R. Pelton, 19 E. 16th street, New York publishes at 75 cents three lectures by Dr. C. B. Kelsey advocating the humane treatment of this evil by the avoidance of surgery and deserves every praise for so doing—a very nice little book of 68 pages.

Vibration the Law of Life.—This is the title of a new book ($1.25) by W. H. Williams of Denver upon breathing. It is based upon experiences and successes of his own and seeks to give a scientific exposition thereof. All knowledge and all happiness await him who learns and practices the proper breathings. They induce clairvoyance, clairaudience, the healing of all disease physical and mental. Though there is absolutely no mention of the phrase "Holy Spirit" in this book, all the results which the early Christians are said to have derived from the Sanctus spiritus, are independently shown by Dr. Williams to be obtainable by a special breathing. He does not however state the fact that the Greek word "pneuma" and the Latin "spiritus" always meant breath or breathing until later Christians undertook to make them mean Spirit in the sense of Ghost or invisible personality. If "pneuma" which in all other writings means breath were translated literally in the N.T. a wonderful mine of scientific knowledge would be unfolded thereby for those who know how to and do persistently practice this special (holy) breathing which this book describes to a certain extent and of which more is learned from other writers.

THE AMERICAN

MONTHLY

MICROSCOPICAL JOURNAL.

VOL. XIX. SEPTEMBER, 1898. NO. 9.

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Locating Objects by the Points of a Compass-Dial or of a Clock-Face.

BY R. H WARD, M. D., TROY, N. Y.

This obvious expedient is of course known to many; but according to the writer's observation it is adequately used by few if any. It is certainly capable of greatly increased usefulness. Anyone who has seen, as the writer has witnessed many times, an experienced and competent microscopist search two or three hours for some special object known to be somewhere amidst the confusing abundance on a large mount, and then go off to bed (toward morning) without finding it, will realize the convenience and importance of having some ever-present means of knowing where to look.

For locating a certain small object among a large number strewn over a slide or a structural point in a

large section, for instance, for the sake of being able to find it again or to tell some one else where to find it, the Maltwood finder leaves little to be desired in accuracy; as the object can be directly located in one of the squares of 1-50th inch, and by recording the position in the square by tenths, readily estimated by the eye, its location can be almost infallibly determined and recorded to 1-500 inch. But this method, though on the whole the best for fine work, requires a special piece of apparatus which is not incapable of being broken in careless hands, and therefore falls far short of being universally applicable.

The rough expedient of drawing a circle on the cover-glass, around the object, is also useful in some cases; though much more troublesome and less precise, and wholly inapplicable when many objects are to be designated on the same slide.

By imagining a compass dial to be centered upon the cover-glass with North at the top, the location of any object can be stated off-hand and instantaneously, and with definiteness enough for all low and medium powers. Everything in the general direction from the center to the top would be North (recorded as "N."); and by beginning at the center and surveying to the top any object tolerably easy to recognize can be promptly found under any power up to ⅔rds, and with little difficulty up to 1-5th. In cases of special difficulty, and often with higher objectives, a medium power should be used as a finder, as in other methods. By designating the distance from the center by tenths (estimated) of the radius, further definiteness is and should be attained with no appreciable trouble. Thus an object stated to be at "N. 5" would be half way from center to top, at "E. 9" would be at the right and near the circumference, and at "N. E. 3" would be on a radius midway between the two former and about one-third of the way out. Either

one could be almost instantly found with a one-fifth objective. This locates the radius near which the object lies, to about one-eight of the circumference, or 45 deg. Of course these angles can be subdivived by combining the letters to make 16 points of 22½ deg. as "W. N. W." for example, but few persons could do this without some possibility of confusion.

The clock-face, a somewhat more familiar object, gives greater precision by dividing the circumference into 12 segments of 30 deg. each. The principle is the same, the directions being given by the hour figures, and the distance of radius by decimals; a system successfully used in designating instantly the location of the bullet holes made in target shooting, except that the radial distances are given by ruled circles. Here the top becomes 12, the bottom six, and intermediate points by the familiar directions of the clock-face. Thus the "3, 9" location would be at 3 o'clock, to the direct right and 9-10ths out, or identical with the "E 9" of the compass method. By the clock method the hour spaces can be readily halved by the eye, giving 24 segments of only 15 deg. each. It might be seen that an object was at the right of 12, but not as far as 1 giving 12½; while the pointer would, with the aid of the figures, be recognized as midway between 12 and 3 o'clock, corresponding with N. E. of the compass; so that "1½, 3" here would be identical with "N. E. 3" of the other. With a very little practice one will recognize the 4 and 5 o'clock direction almost as accurately as the 3 or 6; and the location of dozens of small shells, scales, or other objects can be recorded almost as fast as the numbers can be written.

If instrumental precision be desired, it can be secured by centering the cover-glass around the optical axis of the microscope, and then, with the goniometer ocular or with the graduations of the concentric revolving stage,

measuring from this center the angular distance of the object above or below the longitudinal axis of the slide; and then measuring with the ocular micrometer the linear distance from the center of revolution. Thus an object at the right and 60 deg. below the axis would be 5 o'clock, one at the left and 30 deg. above the axis would be a 10 o'clock. By this means the object can be easily located within a single degree; but that is seldom, if ever, necessary, as sufficient accuracy for the cases to which this method is applicable can be gained, almost automatically after a little practice, by comparison with the picture of the dial "in the mind's eye."

A Description of Cells Proper.

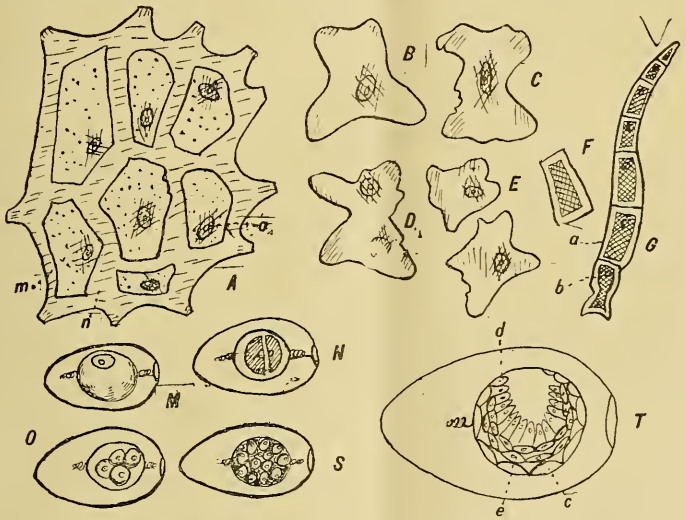
The cell is the unit of structure in all animal and vegetable life. The lowest plants and animals consist of single cells and are called unicellular. Most cells are so small as to be seen only by the microscope for they measure from 1-10,000th to 1-125th of an inch in diameter. They have to be dissected and stained for examination. Some cells consist of protoplasm with a cell-wall and others without a cell-wall. It is a viscid, nitrogenous substance, often granular, but usually undistinguishable from albumen or the uncoagulated white of an egg.

THE ONION.—A plant is made of cells differentiated into parts such as roots, stems, leaves, and flowers. The cell of an onion (figure A.) consists of a cell-wall, M, protoplasm, N, and nucleus with nucleolus, O. This is one of the best examples of a typical cell.

THE AMŒBA.—Cells reproduce and multiply by self-division and this may be best studied in the amœba. Nearly every stagnant pool contains water which examined under a rather high power will reveal a small, moving, jelly-like speck (fig. B). It is composed of granular protoplasm containing nucleus and nucleolus which

must be distinguished from vacuoles. When about to reproduce the cell becomes dumb-bell shaped (fig. C) after which two nuclei form at opposite ends (fig. D) and finally the two parts are separated (fig. E).

A Simple Plant.—Take a single thread of the green scum from a pool of water. Under the microscope, find it to consist of a string of single cells (fig. F and G). The single cell, F, is afterward divided into two, and the second produces a third, a fourth and fifth and so on



until seven are shown in G, the lower cell of which is commencing to divide to form a new one. The outer wall being continuous makes a thread-like object which differs from the amœba, wherein the outer wall separating, many separate individuals are produced. Why the cells of algæ string together like a thread, when reproducing, and those of the amœba, in like circumstances, break apart, the microscope does not reveal, neither does it show why a cell made in nature is alive and one synthetically like it, made by a chemist, does not possess life.

THE EGG.—An egg (fig. M) is a primordial cell set aside for reproduction. While developing, the nucleus in the yolk separates just as in the case of the amœba, (fig. N). The two cells then form four (fig. O) and the four form eight (fig. S) and so on until the entire yolk is occupied and there arise three distinct layers called epiblast (fig. T, c.) hypoblast, d, and the mesoblast, e. Upon these, as fundamental principles, all animal and vegetable structure is built.

Micro-Studies in Marine Zoology.

BY JAMES HORNELL, JERSEY, ENG.

A new series will be at once begun and considerably improved. The slides will be increased in number to 20, an increase of six, each of the four members of the magazine will range from 28 to 32 pages or more. The plates will number three or four in each number. A new feature will be the introduction of numerous figures in the text. The radical feature of improvement will be however, that all the text will relate to the slides and the plates. There will be no miscellaneous articles. Each instalment of slides and its corresponding number will be confined to a single class or phylum as the case may be, and hence the issue will be on systematic lines.

The Third Series will treat of the Protozoa, Sponges, Hydrozoa, and Actinozoa—one instalment to each. There will be no danger of duplication of slides already in Subscribers' cabinets, as the author will issue with each number a list of slides proposed to be sent, together with an alternative list from which substitutes may be selected for such as may not be desired in the other list.

The number to be issued first will deal with the Sponges, and will comprise some unique preparations. Special attention will be taken in the ringing of the slides to secure permanency.

All the slides we guarantee, any that may go wrong will be willingly repaired free of charge. Subscription will be inclusive of 20 slides, and 4 instalments of text and plates, $6.75 sent post free by mail.

The completion of Series 2, was greatly delayed by reason of prolonged and serious illness combined with unusual press of business in other branches of work. For the future, arrangements have been made such as will result in a punctual issue of the Series.

The "Journal of Marine Zoology" will in future be a separate publication, and will be the organ of the Jersey Biological Station. It will be issued half-yearly.

Practical Suggestions.

By L. A. WILLSON,
CLEVELAND, OHIO.

Manipulation of Soft Tissues.—It is very easy to obtain thin sections of soft tissues such as the tissues of fruits, trichinous pork, flesh and similar structures. Cut a very small piece as thin as possible with a thin knife. A microscopic dissecting knife is just the thing. Then place the small piece on a glass slip under a number two or number three cover and press down until the section is flattened out thin. Success may nearly always be attained by taking a very small piece. Failure will usually follow by taking too large a particle. In this way the cells and grit in a pear and the trichina in pork may be quickly and elegantly seen.

Blood Manipulation.—An old Doctor once called upon the wife of a microscopist, during the latter's absence, and requested the wife to get out the microscope to enable the doctor to examine his own blood. The Doctor lanced himself, drew nearly a teaspoonful of blood, daubed a nice, clean slide therewith, covered, examined with the microscope and saw nothing but darkness

visible. When the doctor reluctantly admitted his failure, the wife took a small particle of the blood, placed it a short distance from the center of the slip then tightly drew a smooth edged slip with a firm motion over the slip containing the small particle of blood, covered and examined when a beautiful picture of red corpuscles and white corpuscles was presented to view.

The Use of a Blue Glass Between the Source of Illumination and the Objective.—In artificial colors, white light is composed of three primary colors, blue, red and yellow. This is not true of sunlight the primary or fundamental colors of which are composed of red, green and violet. Our lamps generally emit a more or less reddish, yellow light. To correct this, use a piece of the proper blue glass obtained for the purpose from a microscopic dealer. The blue adds the other primary and makes the light practically white. After becoming accustomed to the blue glass it will be very uncomfortable to use the microscope without its aid.

Flower Crystallizations of Sugar.—By the following method one will never fail in producing these crystalls. Take any white sugar and in one test-tube make a saturated solution in water and in one tube a saturated solution in alcohol. Mix the two in a third test tube, when thoroughly mixed place a drop of the mixture on the center of a glass slip. The sugar will harden into an amorphous mass. When the mass has hardened, place the slip on the shade of a student's lamp. The crystals will soon begin to form. Leave the slip on the shade until they have formed throughout the mass and then remove and mount in balsam. Piso's Cough Cure placed upon a slip, hardened and set upon the lamp shade will produce the crystals. The hardened mass on the slip, placed in a damp cellar or cupboard will produce the crystalization in the course of twenty-four hours.

Can Amoeba be Formed from Bacillaria?

By Arthur M. Edwards, M. D.,

On the tenth of last July I collected in a two ounce bottle some algæ in the salt waters of the harbor of New York. The water was ordinary salt water of the ocean. The bottle was about full, holding nearly two ounces. I took it home, examined it and found it to be Melosira nummuloides, a common species. I could not find any other species of Bacillaria and was about to throw it out. I hesitated for a while. I therefore took it out of the bottle leaving a very small quantity behind and thought I would grow it in the water and see what it came to. I put the bottle aside, a two ounce salt mouthed bottle it must be remembered, on my desk where I could examine it from time to time with a microscope, using a quarter inch objective and a one inch occular. I had a power of about 400. My desk was at the east side of the house so that I had sunlight for a short time in the morning. The bottle was not exposed to the sun's rays so that it did not get very warm. We had hot weather nevertheless and although my window was always open the thermometer went up to nearly 100° and as there was no cork in the bottle the water rapidly evaporated. Perhaps if I had not had several years experience in growing Bacillaria and other things in bottles I would expect the water to become rank but it did not. There was not very much vegetable or other matter in it, and water alone cannot decay. It evaporated and evaporated. The level gradually became less until it had evaporated nearly to one quarter and was very salty. The quantity was so very small that I could not test it chemically, but it was brine. I wanted to again see if Melosira nummuloides would change into Melosira borreri as I had seen it do many years before (Published in Grevillia). I took some out on

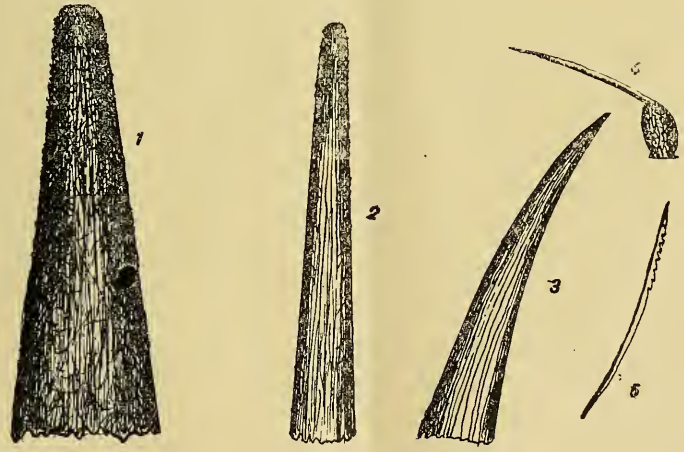
the first of August and saw that it was changing into Melosira borreri and that there was in many times to quantitativcly appeared a form that I was not prepared for. The genus Cyclostella was present but no species that I could identify. Itwas nearly transparent but looked at very closely it had fine rays or dots near the periphery of the disc. They were all alive and had rays diverging from them several times as long as the diameter of the frustule. These rays were of some substance which was not cellulose for it was too hard for that, and seemed to contain a certain amount of silica in its composition. For when the gathering was dried on the cover and ignited over a spirit lamp, it did not entirely burn away. This was an old discovery, for I had seen the same thing happen in a gathering I made ten years ago on the marshes of Elizabeth, N. J.

What was new was the presence of an amœba. It was nearest to Amœba radiosa, at least it looked like Leidy's figure 4, Plate IV, Fresh-water Rhizopods. I say it does not agree with Amœba radiosa entirely for Leidy says it is "comparatively small, colorless, transparent, inactive." This was colored, light brown color and active. But what is most strange is this. It seemed to come from and be evolved from a Cyclotella. I saw a Cyclotella with its rays which I have described. I saw another Cyclotella with the rays more short, only just beyond the siliceous frustule. I saw another in which the surrounding cellulose was growing more and more until it assumed the form of an amœba, and this was not an amœba eating a cyclotella, as I have seen hundreds of times in years gone by. Soon the amœba grew in dimensions, and by and by put forth a portion which separated from the parent and became a separate amœba, moving slowly away. After a time it slowly stopped and then assumed the form which Leidy has figured in his figure

4, Plate IV. Then it became transparent and moved about quickly just like Amœba radiosa. After a time it assumed a figure like A. verrucosa (Leidy, Plate III, fig. 29). At this point I lost the thread of my observation. But looking at the gathering next day the amœba were all gone and empty shells of the cyclotella were left.

Some Fine Points.

The point of a pin (fig.1) can hardly be called a fine point. It is very coarse when seen under a 1-5 objective. That of a needle (fig.2) shows a very much better workmanship. Passing from man's handiwork to that of Nature, that is to say from diluted to purer essence, we get a very sharp point beautifully tapered in the rose



thorn (fig.3). Much more delicate and minutely drawn out is the nettle sting (fig.4) while the serrate and sharp point of a wasp's sting exceeds all the rest in workmanship (fig.5). Figs 1 and 2 represent mineral, 3 and 4 vegetable, and fig.5 animal life,—the three great kingdoms of Nature in the first of which intelligence sleeps, in the second it dreams, and in the third it wakes.

EDITORIAL.

The Zoological Bulletin.—Under the editorial direction of Professors C. O. Whitman and W. M. Wheeler, is published as a companion serial to the *Journal of Morphology*, and is designed for shorter contributions in animal morphology and general biology, with no illustrations beyond text-figures.

Slides.—We have received two very interesting slides from W. A. Terry, Bristol, Conn. They represent the artificial culture of diatoms; one a two-year culture and the other a 2½-year culture. He says he has nearly succeeded in convincing Prof. H. L. Smith that they are produced from spores.

Spiders.—Many spiders use their rope-making power in seizing their prey. They not only stab and poison their victim, but tie it, wing and leg, rapidly throwing over it coil after coil of sticky ligament, which soon not only render it helpless, but convert it into mummy, thoroughly wrapped, and not only easy to carry, but put up for preservation, should the spider not desire an immediate meal.

The Gape Worm.—Dr. H. D. Walker, of Franklinville, N. Y., has for many years given attention to that disease which carries off so many fowls and has demonstrated that the earth worm is the intermediate host through which the parasite is communicated to hens and chickens. The obvious remedy is not to allow them to eat earthworms. His first paper was read before the Buffalo Microscopical Society, Nov. 11, 1884. Further study has resulted in an illustrated pamphlet of 30 pages, published Nov. 1897. Dr. Walker has had the cooperation of Dr. Joseph Leidy and of Lord Wolsingham of England, to whom he sent slides. Those who are interested in the details of his twenty-two experiments would write to him at Franklinville, N. Y.

Laboratory Work.—From July 5 to August 27, 1898, there was opportunity at Cold Spring Harbor, Long Island, to study biology practically. There was apparatus

for microscopic photography and a limited number of microscopes for students. But each was requested to bring his own dissecting and compound microscope. The fee was $20 for the basic course of instruction. Students not provided with compound microscopes were charged $5 for the use of one. Board and rooms cost about $1 per day. Mrs. Gertrude Crotty Davenport was instructor in microscopic methods.

Shameful.—One of our best friends who lives at Elgin, Ill., says that there are about forty physicians there and that not one of them knows enough about a microscope to be able to resolve a diatom. It would be a dangerous proceeding to let anyone of them manipulate a first-class homogeneous objective.

SCIENCE-GOSSIP.

The Smallest Watch.—The diameter of this is less than half an inch. The exact measurement is 10½ millimetres, or .4137 inch. Its thickness is 3 millimetres, or .1182 inch, being but little more than a tenth of an inch. The length of the minute hand is 2 4-10 millemetres, or .09456 inch. That of the hour hand is 1 3-10 millimetres, or .05122 inch. The entire works of the tiny watch comprise ninety-five individual pieces, and its exact weight is 14.3499 grains, or, according to the metric system, 93 centigrammes-less than a single gram! After having been wound up with the diminutive key the watch will run for twenty-eight hours. The mainspring when run down has a circumference of .13396 inch. Its weight is 38 milligrammes, or .5902 grain. The weight of the four main wheels, with their springs, is 42 milligrammes, or .6468 grain. There are thirteen cogs on the little cylinder wheel, which has a circumference of 2 millimetres, or .0788 inch, and weighs .75 milligramme, or .01155 grain. The balance has a circumference of 3.57 millimetres, or .140658 inch. In one hour it completes 18,152 revolutions, travelling a distance of 9,842 feet 6 inches. The most

delicate tools and measuring instruments were made specially for the construction of this watch. The preliminary work in the making of the timepiece was very expensive, and the selling price is $1,250.

A Flying Bullet.—Accompanying is a diagram of a photographed projectil showing the light interference produced by the sound waves which it created in its forward rush. Prof. Mach, of Vienna, was the first to photograph flying bullets and has described his work in the Open Court. The path of a flying bullet resembles the course

of a ship in water. It has its head wave, or bow-wave, and it has its "wake" of eddies. The head-wave, is a sound wave, and when the velocity of a bullet is greater than that of sound, the head sound-wave of a bullet reaches the ear before the sound of explosion, and so, in such cases, a discharging cannon gives two reports.

Whooping Cough Bacillus.—It has hitherto eluded the grasp of the bacteriologist, but has finally been captured by Dr. Henry Koplik, of New York, whose discovery has been confirmed by Dr. Ozapelewski, a German expert—there being only one other bacillus—that of influenza—which is as small. The whooping cough bacillus can only be seen under a very high power. It is usually in the shape of a club. Dr. Koplik, who is connected with the Good Samaritan Dispensary, has a laboratory adjoining

his clinic. For five years he has labored there trying to discover in the sputum of whooping cough patients the elusive bacillus. Though it was found in each case, its cultivation until recently was a failure. Finally, the desired result was obtained by planting the sputum on human blood serum. A tiny particle of the sputum, under the proper treatment will reveal bacilli by the thousand.

The Fresh-water Hydra.—My friends, it is true, laugh at me, and I laugh at them. They wonder why I am so devoted to "a glass globe full of water, with a few plants and snails," and I tell them that while they see much to admire in horticulture, agriculture, and a host of other "cultures," I am an enthusiast about hydra-culture. Indeed, in this small and insignificant aquarium I have a flock of fresh-water polyps, called "hydras," full of interest, full of wonder. I envy Trembley, who in 1744 published A Memoir on the Fresh-water Polyp, the intense pleasure he felt in unraveling the life history of these creatures. He was investigating the unknown when he studied the strange phenomena connected with them, and was transported with astonishment. I know, from the labors of others, what to expect, and yet I am lost in wonder.

We may be thankful that these animals are so small as they are; for, if they were only a few feet in length, we should have in our water world many a repetition of the devastation said to have been caused by the Lernæan Hydra, whose destruction was one of the gigantic labors of the hero Hercules. As it is, the longest you can find is only an inch in length. They can, however, be easily seen with the unaided eye, and with the help of a pocket lens can to some extent be studied. In fact, Trembley, the famous observer of them, had nothing better. It is only when we wish to examine minute details that the use of the elaborate microscope is called for. A group of them attached to the rootlets of duckweed or the under side of the leaves or on the stems of plants is a curious sight.

A nearer view may often be obtaided, for they will attach themselves to the side of the glass to enjoy the light, which they seem to love.—R. Blight in Pop. Sci. Mo.

Mucilage Cells.—Methylene blue has the advantage of being a decisive reagent for mucilage in plants; only some lignified cell-walls otherwise take up the color, and the stain may be applied by proper manipulation to dry as well as to fresh plant material. Fresh specimens of leaves, etc., are left for several hours in a solution of methylene blue, 0.4 gm. in 95 per cent alcohol, 100 c. c.; afterwards cut sections and transfer each to a slide with a few drops of a similar solution, in which four-fifths of the alcohol is replaced by an equal volume of nearly anhydrous glycerin. The mucilage cells are stained blue in a short time, and after covering the specimens they may be kept indefinitely, the contrast between the stained and unstained portions becoming more marked as time passes. Dried material should first be softened in water, then transferred to strong alcohol prior to cutting sections.—Am. Journ. Phar., lxx., 285.

London Air.—Its dust particles, in a suburb, number 20,000 per cubic centimeter in the open air, and 44,000 in a quiet room; while in the city the totals per cubic centimeter were 500,000 when taken from a roof, 300,000 in a court, and about 400,000 in a room. In other words, the air of the square mile is 900 per cent thicker than in the suburbs; which is in accord with the general experience that fogs are both more dense and more frequent over the center than in the outskirts. But what is especially interesting is to learn that although dust is the great carrier of microorganisms, there is only one of these articles per 38,000,000 atoms of dust. Thus it is calculated that a man could live in the metropolis for seventy years and only absorb 25,000,000 microbes into his system from the air, or about the same number as he drinks in a half-pint of unboiled milk. Of course there are other serious objections to dust; but it is something to know that there is only one microbe to many millions of motes.—London Telegraph.

Test for Semen.—Professor Florence, of Lyons, has made a discovery which he thinks may prove to be of considerable medico-legal importance, namely, that the addition of a strong aqueous solution of iodine (1.65 parts of iodine, 2.54 parts of potassium iodide, and enough distilled water to make 30 parts) to human semen gives rise to the immediate formation of dusky-brown microscopic crystals, partly long rhombic tables, and partly fine needles C. Posner has succeeded not only in eliciting this reaction, but in determining that it is due to the combination of iodine with spermine. Hence it results that the reaction may be produced with any fluid containing spermine, and therefore is not absolutely a test for semen, although it is a valuable import as a corroborative test. Inasmuch as suspected seminal stains are practically never due to ovarian juice or other non-seminal fluids containing spermine, the Florence test will be very valuable.

Albuminuria.—The common reagents for its detection are nitric acid, Robert's formula, Millard's formula, potassium ferrocyanide, and heat. All five methods have been applied by Dr. Garratt to fifty separate lots of urine each containing a sediment whose character had been determined by microscopic examination and which indicated abumin. The experiments were for the purpose of determining the relative value of these five different methods and resulted in showing Millard's formula to be the best and almost perfect. His formula is as follows: Potassium hydrate, five-per-cent solution, twenty-two parts; acetic acid, glacial, seven parts; carbolic acid, two parts.

Cleaning Cover Glasses.—Braun recommends the following process for cleaning microscopical covers. Collect the cover glasses to which cedar oil adheres, in a glass containing methylated alcohol. Pour off the alcohol, wash with benzine, boil for about half an hour with soda solution, stirring with a platinum needle. When rinsing, rub the glasses with the hands to remove any adhering matter. Then place them for twenty-four hours into acetic acid,

and finally into 96 per cent spirit. Rub dry with a piece of soft leather, and pass through a flame.—*Ph. Ztg.*, xlii., 762.

Royal Microscopical Society.—At the last meeting the president referred to the loss the society had experienced in the death of Dr. Henry Perigal, who died at the advanced age of 98. He then exhibited and described two old microscopes, one of which, made by Benjamin Martin, probably dated from about 1770. It had two concave mirrors, one of 4in. and the other of 9in. focus. The optical part was curious, having a fixed black lens in the tube, which was common to all the objectives, each of which was fitted with lieberkuhn. The other was an antique instrument, with simple lenses fitting into one another to increase the power. It seemed to be a copy of one made by Mann and Ashcroft, somewhere about 1740, and was made by Cary. He next called attention to an excellent lithographic portrait of Prof. John Queckett, the work of Wm. Lens Aldous, whose son had presented it to the society. Mr. Fredk. Ives exhibited a camera lucida which he had devised. It was one he had obtained from Messrs. Swift, and he had slightly modified it by depositing on one of the inside faces of the compound prism a very thin specular film of silver, through which it was possible to see the pencil without having to centre the eye, as was the case where the film was opaque with a small hole in it to look through.

After some remarks by Mr. Beck, Mr. Swift said there was a difficulty in centering the eye in the old form which did not exist in the one before them, the pencil being seen with ease while delineating the object under observation. The president thought the device a valuable one, and preferable to that of a thick film of silver with a hole in it. Mr. Ives also exhibited a monocromatic green screen, consisting of dyed films between two plates of glass, which he thought possessed advantages over liquid screens. The one now shown would cut off all beyond the F line on the blue side, including the ultra-

violet, and also the red and yellow. In reply to inquiry, Mr. Ives said that, of course, the light was not strictly monochromatic: it was a mixture of pure green in the spectrum at the E line, with some yellow-green on one side and blue-green on the other.

Mr. B. W. Priest exhibited a large number of slides of sponges. He said he had brough a selection which would be found to be characteristic of the order Calcarea and the three sub-orders of Silicea—viz., the Monaxonidæ, Tetractinellidæ, and Hexactinellidæ, to the last of which he directed attention, on account of their great beauty. There were also some slides of freshwater sponges.

Quekett Microscopical Club.—The 361st ordinary meeting was held June 17th, President, Dr. J. Tatham. Mr. Vezey referred to the death of Mr. Henry Perigal, a member since 1881. Mr. A. Earland read a "Note on Orbiculina adunca F. and M., and its Varieties," based on the material sent him by Mr. Bryce-Scott, of the Intercolonial Railway of Canada; but the precise locality where found was not stated. It certainly contained an astonishing number of varieties of this species, of which specimens were exhibited, and a type slide was presented by the author to the club. Mr. Rousselet read a paper "On Micro. Cements for Fluid Mounts," which gave rise to an interesting discussion, in which Messrs. Morland, Measures, Nelson, the president, and others took part. Mr. Rousselet said after a lengthened experienced he was obliged to retract part of his former eulogium of Clark's cement, which, while retaining unimpaired spirit mounts, had failed to keep intact watery solutions, such as formaline, and he had been compelled to remount some hundreds of slides. The general opinion of members seemed to be that it was best to use two, or even three, cements having different solvents, one over another.

Cheap Books.—Allan Wheeler, Denver, Colo., offers Carpenter's Microscope and its Revelations ($6 book) for $2.00. This is second-hand but good. He also has medical books in great variety.

MISCELLANEOUS.

For Sale.—A $45 microscope stand for $25. Address: W. A. Murrill, Ithaca, N. Y.

Books.—How to Photograph Microscopic Objects by Jennings, 75 cents; Photography applied to the Microscope, by F. W. Mills, $1.00. Sent postpaid, by Outing Co., Ltd. 241 Fifth avenue, New York City.

Indiana Academy of Science.—Officers for 1898: Prest. C. A. Waldo, Purdue Univ.; Vice-Prest. C. H. Eigenmann, Indiana Univ.; Secy. J. S. Wright, Indianapolis; Asst-Secys., A. J. Bigney, Moore's Hill College, G. W. Benton, Indianapolis; Treas. G. W. Benton, Indianapolis.

Mirror Loup.—A new mirror loup has been made by E. M. Nelson which is serviceable either in day-light or by the light of a paraffin lamp.

New Binocular.—Beck has produced a portable binocular of same general character as his National but made so as to remove the stage entirely from the stand for convenience in packing. The stand is large, fitted with a centering apparatus and suitable for pond work.

A New Station.—A biological station containing aquaria, laboratories, rooms for collections and library is in course of erection near Sebastopol, on the Black Sea. It is expected that the building will be opened for scientific work during the present year.

Mountains.—At an altitude of 2,000 feet a search for microbes proved fruitless in Switzerland and presumably would elsewhere.

Wolmer Forest.—The Guilford Natural History and Microscopical Society has succeeded in securing the protection of birds, foxes, etc. in this forest.

Carbondioxide Crystals.—When solid carbondioxide is examined under the microscope, wire-like crystals may be seen along its edges. Branching filaments issue from them apparently at right angles and somewhat resemble the groups of minute crystals seen in crystallised iron, gold and ammonium cloride.

THE AMERICAN

MONTHLY

MICROSCOPICAL JOURNAL.

VOL. XIX. OCTOBER, 1898. NO. 10.

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To the Memory of Robert B. Tolles.

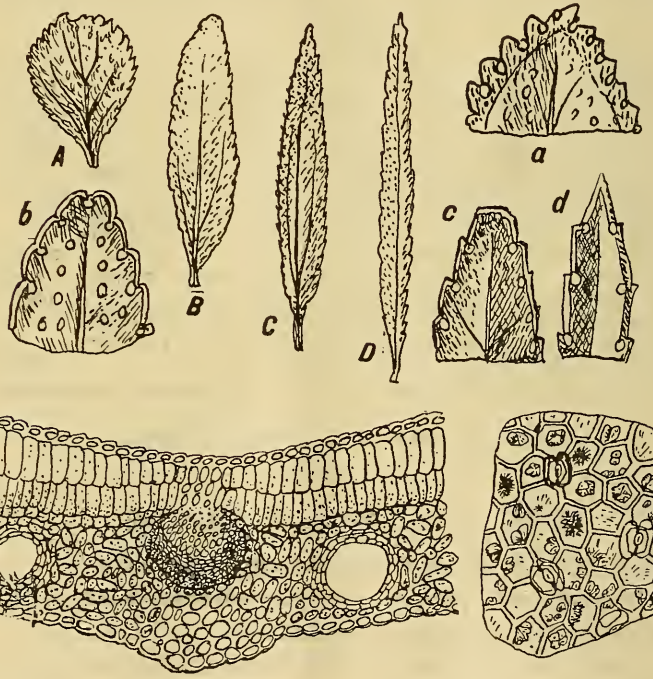
BY DR. J. W. DINSDALE, CHICAGO.

Of cypress shall ye now your garlands make,
And drowsy poppies for your sorrow's sake.
With words that halt for breath—
And through the sadness of succeeding years,
Lo ! ye that live shall water them with tears
In memory of his death.

Laurels and roses shall ye also twine—
With notes of dulcimer and song divine
Shall all the air be rife—
And hearts be glad o'er all the land and sea
Joined fast in bonds of close fraternity—
In memory of his life.

The Structure of Buchu Leaves.

B. BETULINA.—The leaves vary from 1-2 to 3-4 inch in length, and from I-3 to 1-2 inch in width, in the upper part. In shape they are obovate, cuneate below, somewhat undulate, and recurved at the apex (fig. A and a) glabrous and minutely wrinkled, with a polished surface,



denticulate at the margin, furnished with scattered oil cells, one occurring also at the base of each tooth and in the obtuse apex. The odor is characteristic, recalling a mixture of peppermint and black currant.

B. CRENULATA.—The leaves are oblong-oval or elliptical (fig. B and b) obtuse or somewhat rhomboidal, varying from ½ to 1¼ inch in length and from ¼ to ½ inch broad in in the middle. The surface is glabrous, polished and

minutely wrinkled, and the margin crenulate. The leaf is furnished with oil cells in exactly the same way as *B. betulina*. The odor recalls that of horsemint (*Mentha aquatica*), and the flavor that of peppermint, with a trace of carraway.

B. SERRATIFOLIA.—The leaves are linear-lanceolate, varying from 1 to 1¼ inch in length, and from ⅛-¼ inch in width in the middle (fig. C and c). They are obtuse at the apex and serrulate at the margins, glabrous, polished, and minutely wrinkled, and are furnished with oil-cells in the same manner as the two preceeding species. The odor and flavor resemble those of *B. crenulata*, but the taste is more distinctly bitter. Buchu apparently owes its properties to an essential oil. In the case of *B. betulina* the oil affords a crystalline deposit of diosphenol which has been ascertained by Dr. Cash to possess antiseptic properties. It has an odor like menthol. The leaves also yield a ketone resembling menthone, and a hydrocarbon. The leaves in addition yield mucilage and contain hesperidin.

The epidermis consists of tabular polyhedral cells (five to six sided), without stomata on the upper surface of the leaf. These cells contain amorphous masses or sphærocrystals of hesperidin (see figure). Between the epidermal layer and the palisade cells there is a layer of colorless cells, thin and with irregular walls, as seen in alcohol or almond oil, but in water swelling up and forming mucilage by the dissolution of the walls (see figure). The mesophyll consists of a single layer of palisade cells and a spongy parenchyma beneath, sphæraphides occuring in some of the cells. The oil cavities are lined with two or three layers of flattened cells. Those at the base of the marginal teeth occupy nearly the whole thickness of the leaf. The lower epidermis is furnished with stomata. The midrib is not prominent on the upper surface, and very slightly so below. It consists of a woody

bundle with soft fiber and a pericyclic arch of lignified cells on its under surface, separated from the upper and lower epidermis by layers of polygonal thick-walled cells, which do not contain chlorophyll (fig. 1). Several species of the allied genera or of the same genus are occasionally offered in commerce, but only one occurs with sufficient frequency to demand notice. This is *Empleurum serrulatum* (fig. D and d), known in commerce as "Fine Long Buchu." The leaves resemble those of *B. serratifolia* but are narrower and longer, $1\frac{1}{4}$ to $1\frac{1}{2}$ inch long, and about $\frac{1}{8}$ to $\frac{1}{6}$ inch broad. The apex is sharply pointed, and does not contain an oil cell, although these are present at the base of every tooth. The lateral veins, which are only slightly visible in the official species of buchu, are practically not visible in *Empleurum*. The odor is very different, slightly recalling that of baked apples, and the faint flavor is rather like that of lemons and carraways mixed, but there is a distinct bitterness. Umney has pointed out that the infusion of these leaves has an odor like trimethylamine, and that ferric chloride does not produce in it the green coloration which it gives with the leaves of *B. betulina*. The leaves have a similar structure to those of buchu as regards the mucilage cells. The fruit of *Empleurum serrulatum* is often found mixed with the leaves. It consists of a single carpel, linear-oblong and compressed, with a sword-shaped beak, the whole being about $\frac{3}{4}$ inch long, of which the beak forms half. The fruit of *Barosma* consists of five carpels, opening by the ventral suture, and adhering by their margins when dehisced.—*Phar. Journal*

Some Observations on Brain Anatomy and Brain Tumors.

Dr. William C. Krauss, of Buffalo, read a paper at the 92nd annual meeting of the Medical Society of the State of New York, Albany, Jan. 25, 1898, with the above title.

He called attention to the difficulty in remembering the gross anatomy of the brain, and to the almost universal presence of optic neuritis in cases of brain tumor. He attempted to overcome the difficulty in regard to the anatomy of the brain by formulating the following rules, which are somewhat unique and original, and at the same time easily remembered.

The nerve centres are divided into two great divisions encephalon, and myelon. The encephalon is divided into two subdivisions, cerebrum, and cerebellum. The cerebrum, cerebellum and myelon are divided into two hemispheres each, right, and left. The encephalon is indented by two great fissures, longitudinal and transverse. Into these two great fissures there dip two folds of the dura, falx cerebri and tentorium cerebelli. There are two varieties of brain matter, white and gray.

There are three layers of membranes surrounding the brain, dura, arachnoid, pia. Each hemisphere is indented by three major fissures, sylvian, rolandic or central, parieto-occipital. Three lobes, frontal, temporal and occipital, on their convex surface are divided into three convolutions each,—superior, middle and inferior. There are three pairs of basal ganglia, striata, thalami, quadrigemina. The hemispheres of the brain are connected by three commissures, anterior, medi, post-commissure. The cerebellum consists of three portions, right, and left hemisphere, vermes. There are three pairs of cerebellar peduncles, superior, middle, inferior. The number of pairs of cranial nerves, in the classifications of Willis and Sommering, can be determined by adding 3 to the

number of letters in each name; that of Willis making 9, and that of Sommering making 12,) or the name containing the more letters has the larger number of pairs of nerves, and vice versa). The cortex of the cerebellum is divided into three layers of cells, granular, Purkinje's cells, a molecular layer.

Each hemisphere is divided externally into five lobes of which four are visible, frontal, parietal, temporal, occipital and one invisible, insula (Isle of Reil). Roughly speaking, the visible lobes correspond to the bones of the cranium; that is, the frontal lobe is underneath the frontal bone, the parietal lobe beneath the parietal bone, etc. The brain contains five ventricles, of which four are visible—the right and left, (1st and 2nd,) the 3d and the 4th; and one invisible, the 5th or pseudo-ventricle. The cortex of the brain contains 5 distinct layers of ganglion cells.

Studying carefully 100 cases of brain tumor in which an ophthalmoscopic examination had been made for the presence or absence of choked disc (optic neuritis), Dr. Krauss announced the following conclusions:

Optic neuritis is present in about 90 per cent of all cases of brain tumor. It is more often present in cerebral than in cerebellar cases. The location of the tumor exerts little influence over the appearance of the papillitis. The size and nature of the tumor exerts but little influence over the production of the papillitis. Tumors of slow growth are less inclined to be accompanied with optic neuritis than those of rapid growth. It is probable that unilateral choked disc is indicative of disease in the hemisphere corresponding to the eye involved. It is doubtful whether increased intracranial pressure is solely and alone responsible for the production of an optic neuritis in cases of brain tumor.

Fungi.

BY J. G. WALLER, PREST., QUEKETT CLUB.

Having obtained samples of sand from the lightships in the German Ocean, immediately off the English Coast, I was led into one of the most interesting subjects that ever I was engaged with the microscope. It opened up an entirely new field.

The Fungi comprise a very large family. In many cases they are what Linnæus called "Servi," going before to prepare the way or coming after to clear the way as in the case of mould. These apparently simple forms produce the potato disease, the vine pest, fungus foot of India. Yet we could scarcely expect to find Fungi excavating as they do small particles of calcareous sand and at two fathoms depth. But Prof. P. M. Duncan, found a similar deposit as far back as the Siberian age—myriad's of ages ago. Still operating in our own seas is the same eternal law.

There is however some uncertainty as to whether these organisms are algæ or fungi. Long ago Fries, a Swede, regarded them as interchangeable, and that what in water were Algæ became Fungi or Lichens in air. Kollicker called them Fungi but Dr. M. C. Cooke, moulds. But if we entertain evolution or devolution in these classes we shall not too readily make species in lower organisms. This practice has too often taken place. "Mere mycelia have been described as perfect plants, mistakes have been made in important points of structure, and productions of an undoubted fungoid nature have been referred to algæ though agreeing with them neither in habit nor physiology, while the commonest mould's have received new names, and several conditions of the same species have been registered as autonomous productions."—Berkeley.

The Fungus foot is a terrible disease which attacks the bones of the lower extremities and the victim dies of exhaustion. It has been classed as a mould by Dr. H. J. Carter. In the Intellectual Observer (II), is a good account of it. I was particularly struck with the close resemblance between his illustration and an illustration of mine in one of the objects from the Varne sand which I called Saprolegnia varniensis. In the mycelia the analogy is striking as also in the development of sporangia, The large family of Mucor may be set down as potent destroyers closely allied to each other.

Hog Cholera.

Two diseases, closely resembling each other, yet caused by distinct germs, and frequently both affecting an animal at the same time, have been recognized. The question of formulating practical measures for controlling these diseases has been as difficult as it is important. While most prevalent in the great corn-producing States, the diseases have been carried to all parts of the country, and therefore, any regulations to be effective must be enforced over a wide extent of territory, and would be correspondingly expensive. The losses have, however, been tremendous, being placed by some as high as $100,000,000 a year; an estimate which does not appear exaggerated in the light of the careful inquiries in the State of Iowa, from which it was concluded that this one State lost from $12,000,000 to $15,000,000 worth of swine in a single year.

There are but two methods of control which, from our present knowledge of the contagious diseases of swine appear to promise adequate results. One is the old stamping out method, the slaughter of diseased and exposed animals, the quarantine of infected farms, the regulation of transportation, and the disinfection of stock cars,

stock pens, infected farms, and all other places harboring the contagion. The other is the treatment of diseased and exposed animals with antitoxic serum.

The stamping-out method is attended by many difficulties and limitations. Farmers often object to the slaughter of exposed animals which are still healthy, unless paid more than the animals are worth, and they are unwilling to have their breeding stock killed so long as there is a chance of saving a part of it. On the other hand it is embarrassing, if not impossible, to utilize in any way the carcasses of exposed animals which have not yet developed symptoms of disease, and to destroy these adds largely to the expense. Again, it is next to impossible to control transportation and the disinfection of cars so as to prevent constant reinfection. The disinfection of farms is also a troublesome matter, as the germ of hog cholera has great vitality, and is able to maintain its existence and virulence in the soil, in moist organic matter and even in mater, for several months. Finally, the wide distribution of the disease, the ease with which the contagion is carried, the numerous agencies which contribute to its spread, are all elements which increase the gravity of the problem and militate against the success of the stamping out method.

The use of antitoxic serum appears at present to be a much more promising method of diminishing the losses, and it is possible that it may be combined with sanitary regulations, such as quarantine of infected herds, disinfection of premises, and supervision of transportation, so as to give the advantages of the stamping-out method while avoiding many of its embarrassments. The serum is prepared by inoculating horses or cattle with cultures of the disease germs and repeating these inoculations with gradually increasing doses until the animals have attained a high degree of immunity. The blood of such animals injected under the skin possesses the power of

curing sick hogs and of preventing well ones from becoming infected. Unless the blood is to be used immediately after it is drawn, which is not often the case, it is allowed to coagulate or clot, and the liquid portion, or serum, is separated and preserved for future use.

The Agricultural Department has been diligently working for several years to bring the serum treatment of hog cholera to the highest degree of efficiency. The most important point is, of course, to secure a serum with high protective and curative power. This is by no means an easy task. The products of the hog cholera germ are irritating, and when injected into the tissues their tendency is to cause paralysis and death of the part, with the formation of large abscesses. The intense local action hinders the absorption of the cultures into the general circulation and prevents the animal from acquiring immunity. It is doubtless for this reason that the inoculation of swine has generally failed to give the necessary degree of protection and that inoculated swine are found to contract cholera when they are afterwards exposed.

The serum produced in 1897, when used in affected herds, saved over 80 per cent of the animals. The methods have been considerably improved, and it appears proable that a serum of higher efficiency will be the result. There is no danger connected with the use of this serum, as it is absolutely free from the germs of the disease. It is easily applied, and the good effects in sick hogs are seen almost immediately. There is every reason to believe, therefore, that we have in this serum a practicable method of preventing the greater part of the losses from hog cholera, but it must be tested upon a larger scale before absolute assurance can be given.—*Report of Bureau of Animal Industry.*

Practical Suggestions.

By L. A. WILLSON,
CLEVELAND, OHIO.

The Centrifugal Method of Collecting Objects in Water.—By the use of a special, large centrifugal machine, devised by Dr. C. S. Dolly, objects in water may be accurately collected. This machine driven by hand or motor quickly separates all the suspended matter, living plants, including bacteria, animals and inorganic matter in such a way that it can be readily weighed, the total volume determined, the number of particles counted under the microscope and tables made for comparison showing the economic yield of any given area of water. This centrifugal method is of wide application and probably will be a great aid in separating diatoms. —*Scientific American, June* 11, 1898.

A Curious Leaf.—Moss leaves exhibit an almost endless variety, most of them requiring the use of a microscope to reveal their peculiarities. The leaves of Hypnum schreberi are very curious. The borders of the leaves are recurved at the base and incurved at the apex and are persistently orange at the base. The moss is quite common. The incurved apex resembles a tube. The leaves are readily removed by holding a stem with a pair of forceps at the top end and scraping upwards with a sharp dissecting knife. One upward cut is sufficient and more scraping will injure the delicate leaves. Place the leaves on a glass slip cover, fill with water and examine with a one-inch objective. To properly study the areolation of the leaves a one-quarter objective is requisite.

Rotifers.—These remarkable beings are mostly found in water that has become stagnant but is partially purified by the presence of the Infusorians, which always swarm in such localities. There is, however, one very

strange residence of the common Rotifer, namely, within the leaf cells of the common bog moss or Sphagnum.—(*Wood, Animal Creation.*) The writer has already mentioned the discovery of Rotifer vulgaris in the under lobes of the livermoss, Frullnaia. The plant had been in a cabinet for at least two years when upon moistening the leaf on a slide lively rotifers were seen living in the under lobe. Sometimes two rotifers were found in company in one lobe.

MYRIANGIUM DURIÆI.—This microscopic plant is described on page 261 of Tuckerman's Synopsis of North American Lichens as a member of the order Lichenes, and on page 620 of Ellis & Everhart's North American Pyrenomycetes it is described as one of the latter plants. The last mentioned authors state that "its true place in the mycological system is doubtful." Here is an opportunity for an ambitious microscopist or botanist to distinguish himself. A supply of plants may be obtained from almost any one who possesses a collection of lichens.

EDITORIAL.

Slides.—The following new preparations have been made and are for sale by J. D. King, Edgartown, Mass.

445. Evening Primrose. Anther and pollen.
42. Chalcobrichite.
61. Cuprite with native copper crystals.
131. Gold from Denver, Colo.

HYDROIDS AND POLYZOA.

78. Udendrium tenue. Two slides of different growth.
2. Campanularia volubilis on Porphyra crona.
60. Porphyra crona. Edgartown.
109. Bugula turrita with diatoms,—expanded tentales.
19. Bugula flabelata.

SECTIONS.

34. Root of high blackberry.

3. Asclepias, stained to show pitted ducts and spirals and not later tubes.
62. Clematis virginiana. First and second year's growth.
72a. Cycas revoluta. Leaf.
78. Leaf steam of canna—radial structure and stellate-parenchyma.
86. Fern root. Dicksonia punctulata.
133. Leaf of Trias elastica, showing cystoliths.
234. Lillium reseum. Cross and surface sections of leaf.
238. Spirals of ricenus.
253. Transverse and longitudinal sections of mullen.
255. Nuphar advena.
274. Fern, Osmunda cinomonia.
280. Ovary of Onothera. Transverse section.
281. " " Longitudinal "
305. Phytalacca. Epidermis of leaf.
320. Sasifras cut thick necessarily to show pitted ducks.
321. Sycamore.
309. Pauperia. Soapwood from Brazil. Full of crystals.
421. Zoa. Indian corn. Long. and Tr. sections.

Rotifers.—During the warm days of June 16-18 the Asplanchna priodonta, was found by S. J. Hickson of Owens College, Manchester, England, in the surface waters of Lake Bassenthwaite in great abundance. He dragged a small tow-net from a row-boat for 20 minutes and the water collected in the bottle at the end of the net was rendered turbid by the multitude of individuals. Probably he would respond to calls for exchange of specimens.

American Microscopical Society.—At its recent annual session, it elected the following officers for the ensuing year: President, Dr. William C. Krauss, of Buffalo; first vice-president, Professor A. M. Bleile, of Columbus, O.; second vice-president, Dr. G. C. Huber, of Ann Arbor, Mich.; Secretary, Professor Henry D. Ward, of Lincoln, Neb.; Treasurer, Magnus Pflaum, of Pittsburg; Execu-

tive Committee, Professor S. H. Gage, of Ithaca; Dr. A. Clifford Mercer, of Syracuse, and Dr. V. A. Moore, of Ithaca.

Lime Light.—The surface of the lime is not so evenly incandesced as that of carbon. It gives a small homogeneous point of light and quite intense. But by reducing the pressure of the gas to about one inch and using a very hard lime and a jet with a medium-sized bore a fairly steady light is obtained. Still the arc light is better.

Electric Arc Lamp.—There has been great difficulty in using this light for photomicrography because the position of the arc was not constant and the source of light not uniform. Messrs. Barnard and Carter of the Quekett Club devised a form in which the distance apart of the carbon points is regulated by hand, their position thus controlled easily. By reference to cross-wires on a glass screen the source of light can always be kept in the same place. The oblique position in which the carbons are set enables the small point of intense light from the incandescent crater of the positive carbon is used as a source of unvarying and steady illumination of small area and of very great intensity.

Dry Mounts.—The Postal Microscopical Club people have been discussing dry mounts and appear to disapprove of them as liable to deterioration. The great difference of refractive index between the objects and the air which makes them nearly opaque from total internal reflection of the light results in foggy images and often totally obscures the structure. A medium of higher refractive index should be used for hyaline forms like diatoms, even higher than balsam for very thin forms. During mounting the organic matter is burned out by heating the cover-glass. During this process, some of the forms may be melted into the cover-glass. They may be observed profitably if the glass be made with the same refractive index as that of the front lense of the objective. A common accident to the mount is the running in of the cements but this accident sometimes changes the dry

mount to an immersion mount and thereby greatly improves it. It is, also, almost impossible to make a dry mount which will not deteriorate by deposit of moisture beneath the cover.

Meat Inspection.—The inspection of meat for interstate commerce was instituted in 1891, and now there are 128 abatoirs in 33 cities where the Government inspects all meat slaughtered. The number of live animals inspected in 1897 was as follows: Cattle, 8,250,025; sheep, 8,044,355; calves, 448,983; hogs, 25,566,744; total 42,310,107. Of these the following numbers were rejected: Cattle, 25,-146; sheep, 11,260; calves, 2,653; hogs, 53,145; total condemned, 92, 304. This last total does not show a large percentage of diseased animals in this country, but it is unpleasant to think that, without inspection, many of them would find their way onto the butcher's block; some would be condemned by State or municipal inspectors.

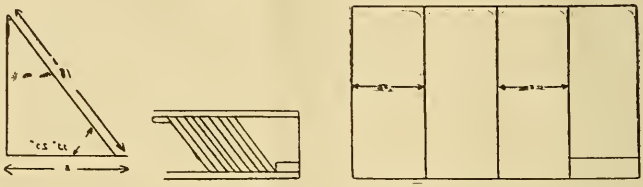
In addition to the above figures, there were post-mortem inspections of 26,580,689 animals, and 49,295 parts of carcasses were condemned. Besides, there were killed by city inspectors 641 cattle, 1,527 sheep, 40 calves, and 2,081 hogs that had been rejected in the stock yards by officers of the Bureau of Animal Industry.

Crystals in Paper.—It has been discovered that old paper, such as is found in old books, sometimes contains beautiful dendretic crystals. It is supposed that particles of brass or copper have fallen on the paper pulp and have been partly dissolved in the chemicals. The lapse of years permits crystalization. Twenty years is supposed to be required and a certain amount of dampness in the paper. The star-like cluster has a width of about 1 mm. and may be examined with a small lense or a low power objective. Dr. Shanks has recently found three of these forms upon linen paper whose age was not known. Thick and rather soft papers are most likely to contain them.

Personal.—Wm. F. Kuder is instructor in microscopy in the Cleveland School of Pharmacy.

SCIENCE-GOSSIP.

A Cheap Polariscope.—The following cheap polariscope will be found to give first-class results:—Cut 20 to 25 pieces of thin glass, 18mm by 12 mm. Now make a cardboard tube from a marked card, as shown below.



The pieces of glass should now be fixed in tube with strips of card shown in sketch. If all is done right, the glass will be at an angle of 35 degrees. Of course, two may be required. The square tube can be fastened in a round tube to fit the microscope.—*Eng. Machanic.*

Carborundum Crystals.—The Physikalish-Techniche Reichsanstalt is now using carborundum crystals to a great extent to replace diamonds in the producing of finely divided scales. Small flat hexagonal crystals are chosen of from half to one mm. side and mounted in a steel holder by means of a drop of shellac. The lines are said to be much more even than those produced by a diamond; they have been examined when magnified fifty times and found to be still sharply defined.

Sheep Scab.—The disease commonly called sheep scab is the mange, or scabies, of the sheep. It is a contagious skin disease caused by a microscopic parasitic mite. This disease is one of the oldest known, most prevalent and most injurious maladies which affects this species of animals. It has been well known for many centuries, and references to it are found in the earlier writings, including the Bible, where we find, in Leviticus xxii: 22, the use of scabbed sheep forbidden in sacrifices. Some think that the mite which causes the disease was known to Aristotle, 322 B. C. The errors and uncertainties which came down

to us through centuries of controversy were finally and for all time dispelled by conclusive experiments upon animals made during the first half of this century. It was shown that scab does not develope and cannot be produced without the parasites. The complete life cycle of the mites was studied and demonstrated from the eggs to the adult parasites. It was shown that mites are always the offspring of ancestors, the same as are the larger animals, and it has in later years come to be admitted that there is no such thing known as spontaneous generation of any living thing under any circumstances. The demonstration was repeatedly made that the disease always developed if mites were taken from diseased sheep and placed upon healthy ones, and that diseases of the skin resembling scab are not contagious unless the mite is present.

The female mite lays about 15 to 24 eggs on the skin, or fastened to the wool near the skin; a six-legged larva is hatched; these larvæ cast their skin and become mature; the mites pair and the females lay their eggs, after which they die. The exact number of days required for each stage varies somewhat, according to the writings of different authors, a fact which is probably to be explained by individual variation, and by the conditions under which the observations and experiments were made. Thus Gerlach, in his well-known work (1857), estimates about fourteen to fifteen days as the period required for a generation of mites from the time of pairing to the maturity of the next generation. He divides this time as follows: Under ordinary conditions the eggs hatch in three to four days, although two authors allow ten to eleven days for the egg stage; three or four days after birth the six-legged larvæ moult and the fourth pair of legs appears; this fourth pair is always present when the mites are two-thirds the size of the adults; when seven to eight days old the mites are mature and ready to pair; several (three or four) days are allowed for pairing; another generation of eggs may be laid fourteen to fifteen days after the laying of the first generation of eggs. Without going into all of the other observations on these points, it may be remarked that the

eggs may not hatch for six or seven days ; the six-legged larvæ may moult when three to four days old, and become mature ; after pairing a second moult takes place, lasting four to five days ; a third moult follows immediately, then the eggs are laid and the adults die ; in some cases there is a fourth moult, but apparently without any further production of eggs. Accepting Gerlach's estimate of fifteen days as an average for each generation of 10 females and 5 males, in three months' time the sixth generation would appear and consist of about 1,000,000 females and 500,000 males.—*Bu. An. Industry*.

Intensity of Light.—At the Quekett Club Mr. Goodwin said that in trying some experiments with his little lamp, he tried to fill the field with light without using a bull's-eye condenser, and he had adopted a method of adding a small lens to the ordinary combination of the substage condenser. By this means he had been enabled to bring the lamp within three inches of the back combination of the substage condenser, and in this way he got a full field of light without in any way impairing the definition. He thought this plan worth the attention of those who desire to make the best use of their appliances.

Mr. Nelson said he had seen the contrivance and tried it and got one made for himself and though he had not exhaustively tested it he was assured of its merits. In the ordinary way the lamp must be put about 8 inches from the back of the lens of the condenser for best effects. His plan places a plano-convex lens of 5 inch focus in the screen holder of the condenser, which enables us to bring the lamp up closer—to 3 inches instead of 8 inches which is a matter of great importance when high powers are used. The idea is simple and capable of development.

Mounting Diatoms.—The best workers now use either Styrax, liquid ambar or a mixture of balsam and monobromid of naphthalin. Moller, Thum and Tempere all use the latter a great deal, while Van Heurch prefers liquid ambar.—D. B. Ward.

MISCELLANEOUS.

Bound Volumes.—We can supply copies of the Journal bound in neat cloth of every year from 1884 to 1897 inclusive. Price for a complete set of these 14 volumes in cloth binding and subscription for the current year $20. Price of single volumes bound in cloth $1.50 each.

For Exchange.—Pritchard's Infusoria illustrated with 306 figures: O'Mera's Diatomaceae with 46 figures, and many other works dealing with Microscopy offered in exchange for micro-rock sections, geological literature and other desiderata. Write to J. H. Cooke (Editor of Microscopy in "Science Gossip") Edleston, Battenhall, Worcester, England.

An Old Book.—Zahn's "Oculus Artificialis" was published in 1702. It contained among other things figures of a telescope-sight for a musket and a cannon with the legend: "Bombardæ et omni genere balistarum ac torbellicorum tubum opticem sive teliscopicum aptare, quo visus ae scopum exacte dirigi poterit." A sunshine recorder, "Organum heliocausticum" had the legend: "Horas luce sono tibi sphaerula vitret monstrat, ignis nil mirum coelicus urget opus." A series of mirrors for telescopes were called "Catoprico dioptsica telescopica."

Books.—Micrographic Dictionary by Griffith & Henfry, 845 pages and 48 plates in 2 volumes offered for $10.00 by Pierce & Zahn, Denver, Colo. Also Carpenter's Microscope for $4,00 ; Harris' Insects Injurious to Vegetation for $4.50 ; Strasburger's Microscopic Botany for $1.50.

Books.—The Chemical and Micromineralogical Researches on the upper Cretaceous Zone of the south of England by William Fraser Hume, D. Sc., can be bought from Whitehead, Morris & Co., Ltd.,9 Fenchurch St., London.

Catalogue.—We have received the priced and illustrated catalogue of microscopes and apparatus for sale by Paul Thate, N. Eisasser-strause 52, Berlin, Germany. Our subscribers can obtain copies by mentioning the fact to Mr. Thate on postal card that they have seen this item.

Elmira, N. Y.—The society formerly existing in Elmira is now the Updegraff Microscopical Section of the Elmira Academy of Sciences.

Opticians.—On October 10th the American Association of Opticians was organized in New York City. It does not appear that microscopy will be covered at all by the new organization.

Osprey Plumes.—The feathers are stripped from birds in the breeding season, involving their death and the starvation of their young. Sir John Lubbock has secured their abolition from the British army.

Objective.—Leitz has made a 1-10 inch oil immersion objective with a numerical aperture of 1.3 the price of which is $18.50 only and it is pronounced superb by highest authority. It is the first of the kind made for a long tube. Semi-apochromatic lenses have been brought up to almost equal apochromatic. The difference in aperture is in proportion of 13 to 14. Many of the more difficult objects can be resolved by them.

Reynolds and Branson's Microtome.—The instrument is arranged to slide on a glass plate with a circular roughened ring, the substance to be cut being imbeded and fixed on that plate. Sections of any degree of thickness may then be cut by simply raising or lowering the screw. The microtome is so arranged that any razor may be clamped to it, and it will be found extremely useful to students in physiology, botany etc. The price of the microtome, with glass plate, is only 4s., and razors are supplied at 1s. and 2s. each. Write to Reynolds and Branson, Leeds, England for full description.

Paraffin Imbedding Table.—It is made of a triangle of sheet copper, with a base of six inches and a perpendicular height of fourteen inches. The edges of the triangle are turned under and inward, giving to the table a smoothly rounded margin. In height, the main part of the table measures two inches, and it is four inches high under the apex of the triangle, where is placed the heating flame, which may be gas, or oil, or alcohol lamp.

THE AMERICAN

MONTHLY

MICROSCOPICAL JOURNAL.

VOL. XIX. NOVEMBER, 1898. NO. II.

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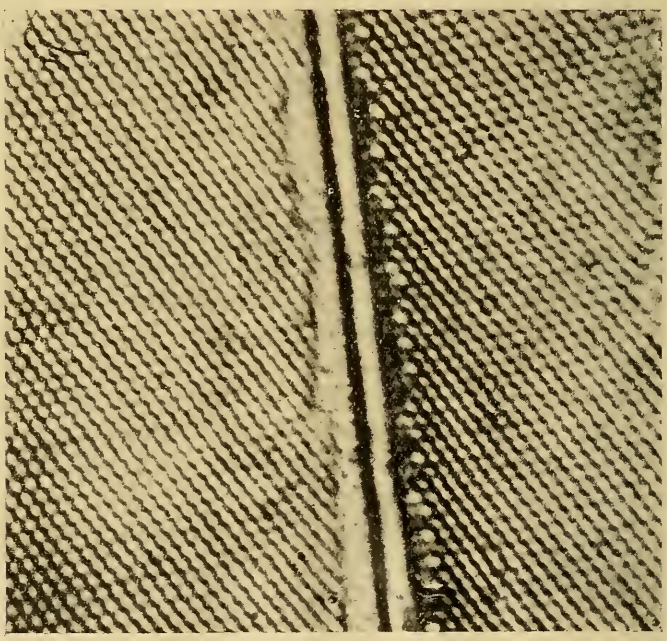
The Double Microscope.

It is now nearly a year since Professor Elmer Gates announced his success in photomicrography with two microscopes placed end to end. A large amount of frothy talk has emanated from a superannuated microscopical editor against the plan, and the English authorities have denounced the scheme. All these people have without exception contented themselves with denunciation or denial, and scorn to try even to repeat the experiments. The absolute stupidity of refusing to try the arrangement is laughable. No person has come forward to say: "I have given Gates' plan a full, fair, and honest trial and it is a failure for such and such reasons." Meanwhile the matter is taking shape. Some people who have repeated the experiments have reported success, including E. Gerber of the New York Microscopical Society. A business concern is now making a supply of microscopes containing two objectives as directed by Professor

Gates. He intends hereafter to use a heliostat instead of an arc-lamp.

In a recent letter to the editor of this journal he says: "I enclose a picture of the new double microscope (frontispiece). You understand that it is extremely difficult to keep the arc-lamp, the condensing lenses, the alum filter, the parallelizing lenses, the two microscopes and the



camera in alignment, and that when once focussed to secure a good definition that it is extremely difficult to adjust the camera so as not to throw the image out of focus.

"Fig. 1, is a photomicrograph of Pleurosigma angulatum made with a one-sixth inch objective and a one inch ocular in the first microscope and 14 millimeter objective and a one inch ocular in the second microscope. The definition in this particular photograph is bad but as

you will see, if you will take the trouble to call at my laboratory, the definition and detail can be strictly first class, but that with my present arrangements in not having all the parts upon the same bed-plate, it is almost impossible to adjust the camera without disarranging the focus. I have tried all of the usual test objects, such as the pygidium of a flea and the Amphipleura pellucida, and the usual test lines, and I can find nothing capable of being resolved with a 24th objective that I cannot much better resolve with a 6th inch objective in the first microscope and a half inch in the second. I submit that if this be true, and I will be very glad if you will call and see if it be true or not, we can place at the disposal of biologists a much cheaper and much more convenient and a much better microscope than the usual high power lenses."

I think I fully understand the influence of the cone of light admitted by the objective, and so on. Long before I commenced my recent microscopic experiments I made myself familliar with the subject, and I am prepared to show, in my laboratory, at any time, the resolving power of a half-inch objective on a sixth. With two such lenses, one inch ocular, and an arc light, I can show details in an object which cannot be shown with a 1-16th or a 1-25th! By using monochromatic light I avoid chromatic aberation, and I have no false images."

The authorities are all sceptical about this work because the idea is not new. Many men have many times unsuccessfully tried putting two microscopes together,but they have never had the necessary light nor the photographing apparatus attached. This combination constitutes the novelty of Professor Gates' arrangement and the intense light makes it effective.

Professor Gates published in the Popular Science News last December, a lengthy account of his work illustrated by: Photograph of the apparatus which magnifies 360,000

diameters; Pleurosigma with 2-3 inch objective; Pleurosigma magnified 450 diameters; Same, 1450 diameters; same, 6,000 diameters; same 10,000 diameters and same 360,000 diameters showing part of the lattice-work opening made by a sixth objective focussed on a sixth.

Description of the apparatus is as follows: "Upon the extreme left of the picture, and under the table are three resistance coils used to regulate the five-hundred volt alternating current with which my laboratory is supplied, so as to reduce it suitably for the arc lamp, shown at the extreme left upon the table. Next to the right are the condensing lenses, and then the alum filter with its bellows, and after that the lenses used to render the rays parallel. The revolving diaphragm is placed at the right hand end of the parallelizing lenses. Between the bellows of the filter-cell and the parallelizing lenses there is a screen holder, in which I place stained gelatin films to screen out such rays as may not be desirable. Beyond the revolving diaphragm the light next enters the sub-stage Abbe condenser and thence through the microscopic slide to the two microscopes and camera. The light is about 2,000 candle power and the results are extremely satisfactory.

In a slightly modified form of the same apparatus, the two microscopes are provided with tripple nose-pieces and projection lenses.

The complete form of the instrument now being manufactured, will consist of a solid brass bed-plate long enough to hold the entire system of apparatus, with means for adjusting the various parts from the rear of the camera. The entire system will be enclosed in a box capable of screening out all actinic rays. Dust and aqueous vapor particles will be removed from the interior of the instrument by a special device which need not here be described. I am having made a similar outfit from which I will have eliminated all the lenses which have

hitherto been used for correcting chromatic aberration; also a new apparatus for furnishing parallel rays for monochromatic light of great intensity, and I am satisfied that ten million diameters can easily be photographed.

Can a second microscope be used to view the magnified result of a first microscope so as to give details which the lens of highest power would not give singly? It is necessary to prove this, because it is widely taught that to get greater magnification and *detail* than a given lens, say a one-sixth inch objective, we must use a smaller lens, for example an eighth-inch, and get nearer the object. That this is not true I can demonstrate.

If the widely accepted theory be true, the only way by which I can get a better magnification than with a one-twelfth inch objective is to use a 1-16th inch, with greater aperture because among other things no other lens would be smaller and nearer the object. But instead, I took a one-sixth inch objective for the *first* microscope, and a two-thirds inch objective for the second microscope, and focussed the objective of the second instrument upon the focal plane of the image in the ocular of the first instrument, the outer lens of the ocular having been removed, and then, to the ocular of the second instrument, I adjusted my photomicrographic camera, and the result was the magnification greater than a one-sixteenth inch lens, and more detail far beyond any 24th inch objective.

This proves that with two lenses low down in the series —a two-thirds and a sixth—I have obtained a better result than with an expensive sixteenth.

Then I tried a still lower lens in the second instrument —an inch lens— and a twelfth in the first instrument. I used shortest tube-lengths and two-inch oculars, and the result is the magnification is nearly 10,000 diameters.

So far I have demonstrated that better work can be done with low power lenses by using a double-microscope than with the highest power lenses, if but a single

microscope be used. This augurs well for the popularization of the study of the higher and more interesting domains of microscopy, because an instrument can now be constructed with a few cheap objectives capable of doing better work than has hitherto been possible with objectives costing twenty times as much. With a sixth-inch objective in the first microscope and a one-half inch in the second, I have resolved many markings and details in well-known microscopic objects that could not be resolved with the best sixteenth-inch apochromatic of high aperture.

When higher objectives than a sixth and a half are used the eye can no longer see the image, because of its faintness. But where the eye fails, the sensitive plate comes to our aid, and photographs the otherwise invisible image. The sensitive plate acts cumulatively and gathers into one concrete result the continuous action of the faint rays, for seconds and minutes of time, and thus records the higher magnifications.

A sixth on a sixth is probably the limit with an ordinarycamera in an ordinary dark-room, and with ordinary photographic technique. Photomicrography has hitherto, so far as I know, obtained no results much beyond 10,000 diameters or 100,000,000 times the area of the original object. Any given detail in such a photomicrograph is made with the 1-100,000,000th the amount of light that comes from the corresponding part of the object observed. But I have succeeded in getting a picture with only 1-1300th of that amount of light.

In the photomicrographic apparatus now being constructed, I have arranged to exclude from the interiors of the microscopes and camera all dust particles and aqueous vapor globules. Then the light can act cumulatively hour after hour and day after day if necessary, and the photogenic changes made on the sensitive plate will result wholly from the action of the image. From

some tests already made I think I am safe in saying that owing to this device I shall be able to photograph with less than the one-tenthousandth part the intensity of light formerly considered necessary. This improvement is applicable to photography in general, but especially so to photomicrography. First by using the wider lenses of the double microscope, I photographed with the 1-1,300th the usual amount of light, thus making a magnification of 360,000 diameters or 129,000,000,000 times the *area* possible. Exclusion of dust particles promises to permit the use of a hundreth part of this latter amount of light, that is, it makes possible the photography of over *three and a half million diameters* or over 12,000,000,000,000 times the *area*.

But I found another source of trouble in the use of such very faint light, namely, the leakage of actinic rays through the wooden and leather walls of the camera and through the imperfectly-fitting sliding joints and connections of the microscopes. With reference to ordinary photomicrography this leakage is but a small percentage of the amount of light which reaches the sensitive plate, but when we get beyond a sixth-inch objective in the first microscope and a sixth-inch in the second, we are dealing with quantities of light much less than the amount of leakage in the best cameras probably ever before constructed. A sixth-inch objective can magnify, with proper oculars and tube-lengths, at least 600 diameters, which is an area of 360,000 times that of the object. Hence any point of the magnified image has only the one-three-hundred-sixty-thousandth the intensity of light of the corresponding part of the object. But when on this already faint part of the image I focus another sixth inch objective I still further spread that light over an area 360,000 greater and I get the 1-360,000th of the intensity of light with which such photomicrography has hitherto been accomplished, that is, I have the 1-360,-

000th of the 1-360,000th the amount of light coming from the corresponding part of the object.

If I use a one-twelfth in the first microscope and a sixth in the second, the magnification will be 2,000 times 600 diameters or 1,200,000 diameters which equals an area of 1,440,000,000,000 times that of the original object. This seems incredible, but I have already obtained evidence of being able to photograph a magnification of over three million diameters, or over twelve trillions of times the area. But if I mistake not, the limit is far beyond this, and that limit is one of photochemistry and not of photography as hitherto known. Beyond a certain point the rays will doubtless grow too weak to effect chemical changes. The energy may not be sufficient to decompose the molecule, no matter how long the ray acts. We do not know where that limit is, but it can be shown to be very far beyond three and a half million diameters.

If in addition to using the larger lenses of the double microscope and to the exclusion of dust and aqueous vapor, we also put the entire apparatus inside of an actinic-proof box, we still further extend this capacity to act with a fainter light. If only one-tenth less light can be used it will make possible ten-million diameters or one hundred trillion areas. If one-hundredth the amount of light can be used, then 100,000,000 diameters are possible. So far, I am quite sure of being able to effect more than 3,500,000 diameters; how much more we do not now know and that is what I am busy upon.

There is another source of leakage and interference that has not, so far as I know, been hitherto corrected, namely, that which occurs in and between the objective and the condenser. Light from all directions impinges upon the condenser, upon the glass-slide, upon the tissue being examined, upon the cover-glass, and upon the front surface of the objective, thus distorting and weakening

the rays from which the photographic effect is to be obtained. This produces a vast amount of useless interference of waves. I find that when I protect all those parts from light, a much better result is obtainable with a given amount of light. Hence in all cases where the light is transmitted through the object the use of such a light-shield from objective to condenser will still further extend the probable limit of magnification.

But there is a limit not so far away as that of the before mentioned photochemic sensitivity of light, namely, the destruction of the energy of those rays within the perfected camera by their mutual interference. This will probably place the practical limit somewhere between about ten million diameters and the much higher limit of photochemic sensibility.

By using monochromatic light this "interference" limit will be at a much higher magnification than with white light. If we could get light of only one wave length it would certainly be quite useful to the new microscope, but a narrow range of the best actinic portion of the spectrum will do much better than polychromatic light.

But monochromatic light is desirable for quite another reason. It enables a much greater amount of light to be concentrated upon the tissues being examined upon the slide without acting as a burning glass to destroy the object. Rays near the upper limit of the spectrum do not so rapidly heat an object as the lower rays or as white light. Hence I am arranging to focus the blue and violet and ultra-violet rays upon a large prism, parallelize them, and then transmit them through the objective. By starting with a large area of monochromatic light I hope to get a much greater intensity of light into the microscope than has hitherto been attempted. As far as I know I shall have at least one hundred times as much. This will extend the heretofore assigned limit of photomicrography.

Monochromatic light makes possible another important improvement. I do not mean the use of the well-known sub-stage spectroscopic attachment, but of large prisms in series so as to give a large area of actinic rays of one color, and then the focussing of these rays to a diameter several hundred or thousand times less, than making them parallel, and sending them into the substage condenser as you would a beam of sunlight from the heliostat. Such rays obviate the necessity for the usual additional lenses for correcting chromatic aberation. As is well known, the different colored rays come to a focus at different distances from the lens. In microscopes of the usual pattern it requires several lenses, in addition to the ones required for resolution and magnification, to correct this and make the rays come to one focus. If rays of one color are used only, then no corrections need be made for the rays of the colors not used. This requires less thickness of glass for the rays to pass through, and consequently the light will be stronger, and this again slightly extends the formerly assigned limits. As far as I know the microscope which I am now having built is the first *one that has been made especially for one-colored* light. It requires correction for only one color, and for spherical aberration, and this latter presents less difficulty for larger than for smaller lenses.

The first statement generally made by microscopists in discussing the new double microscope is one which affects profound pity for the man who could presume to do what has not been done before. This is generally coupled with the statement that every microscopist well knows, and has known for a long time, and that every beginner in microscopy ought to know, that if you produce more magnification than has hitherto been produced that you cannot see the image ; and that, therefore, my claims to a higher magnification are erroneous. Now the very gist

of my discovery consists in the fact that I have *not tried to see this* image! In fact, in all the articles that I have published on this subject I have stated that I had discovered how to make this image visible, and that I had succeeded in getting a magnification beyond that of former microscopes. I have stated over and over again that I have succeeded in getting a photograph with less than the one-thousandth part of the light that has hitherto been considered necessary. Beyond a sixth on a sixth, with one inch oculars, the image becomes so faint as to be scarcely visible. Now, when I use higher objectives, or when I place a third microscope in tandem with a double microscope, it is necessary to resort to a technic which enables me to photograph the invisible image thus produced. This technic consist in eliminating from within the camera and microscope tubes all traces of dust and aqueous vapor, and in enclosing the entire system of microscopes and camera within an actinic-proof box so that the rays which produce the image may act cumulatively. As a matter of fact, however, a magnification far beyond that of a 16th objective can easily be seen by the eye. The first statement that I made with regard to this discovery was that with a sixth inch objective in the first microscope and a two-third inch objective in the second microscope, and with a powerful source of light, such as an arc-lamp and parallelizing lenses, I could get more magnification and greater definition than with the 16th inch lens. As far as I have learned, whoever has tried this has admitted this statement. It is not a matter of argument, but of proof, and that proof I have on hand. I also said that by putting higher objectives in place of the ones just named I could get still greater magnification and detail, but that it would be necessary to photograph the image because it was *too faint* to be seen by the eye. I had one photograph in which the magnification was so great as to show the

irregularly opaque structure *between* the "lattice work" openings in the Pleurosigma angulatum. This is at least 300,000 diameters beyond that ever before achieved but I think this is but the beginning of the new field into which I have entered. A practical test exhibited to practical men led to the investment of sufficient capital to put this instrument upon a commercial basis, and such instruments will be upon the market as soon as all the details of manufacture can be arranged and patents obtained. The most important improvement beyond the ones just mentioned is that of making a microscope specially adapted to mono-chromatic light. This obviates the necessity of using lenses for chromatic aberration. The advantage is obvious. It makes not merely a cheaper microscope but it makes one in which the definition is improved. By using a large area of mono-chromatic light made by large quartz lenses, and then focussing this to a narrower beam rendered parallel by suitable lenses, I expect to get into the microscope from one hundred to one thousand times the amount of light that has ever been put into it before. If any one will take a Bausch and Lomb microscope, with a one inch ocular, and put in it a one-sixth inch Bausch and Lomb objective and focus it upon a pleurosigma, using a ray of condensed sunlight, because ordinary sunlight would not be intense enough, or using a powerful arc-lamp, with a sixth-inch condensing lens and bringing the beam down to one-quarter of an inch in diameter, and then parallelizing the rays, he will have the first part of the experiment complete. The definition will not be so good with an arc-lamp as with sunlight because it is impossible to have the arc-lamp rays entirely parallel. This owing to the fact that the light from an arc-lamp does not come from an absolute point, but from an area. If the experimenter will then remove the front lens of the ocular and adjust upon the focal plane of the image in the ocular a

two-thirds inch objective of a second microscope containing a one inch ocular, he will find, if his microscopes are in alignment, and if the foci are correctly adjusted, a better and larger image than can possibly be produced by a sixteenth inch objective. In fact, a magnification equal to the best twenty-four inch objective, and a field from ten to fifty times as large, and a depth from five to twenty times as great. It is useless for microscopists to deny this because I have the evidence in my laboratory. It is not a matter of discussion.

Can any one suppose that I would make these statements at random without having tried the experiments? And is it true that microscopists are willing to make criticisms without first having tried the experiments? It may not be known to some microscopists that recent progress in physics has been enormous, especially in the field of ether-dynamics. This progress makes it possible for me to predict that the very best microscopy will soon consist in using the invisible rays above the violet and of the spectrum for best results. I expect to see within a year a photograph made of the inner tissues of the body of a living person by means of photo-micrography, and ordinary photography with invisible rays. I do not mean a skiagraph, such as are produced by the ×-rays, but a photograph of the details of the surface of organs and of their inner structure. I have provided myself with a heliostat, made for me by the Societe de Genevoise. The mirror is 12 inches in diameter and it will throw a ray of sunlight into my microscope with considerable precision. This beam will be condensed into a beam at least one hundred times less in diameter and then rendered parallel and then thrown through the microscope either before or after having been rendered monochromatic by means of suitable prisms. A microscope made especially for mono-chromatic light will replace those of usual form. I am experimenting to get

lenses which will act upon the invisible rays in a manner the same as glass acts upon luminous rays. If I achieve success in this field I shall expect to obtain photographs of the interior of the body, and photomicrographs of interior tissues of the living body.—ELMER GATES.

Curious Leucocytes.

BY EPHRAIM CUTTER, M. D., NEW YORK.

(Tolles' 1-16th inch 180° objective, two inch ocular and B. stand, ten inch tube were used with the direct light of a small oil lamp, condensed direct with an one inch ocular.) Mar. 16—A middle-aged man nervously complained of his tongue being over sensitive. It looked like an average tongue and the case was deemed to be neurasthenic. This opinion was sustained by the morphology of the urine presenting protoplasmic and filamentous catarrh, slight albumen, kidney casts and fatty epithelia. These were not continously nor largely nor contemporaneously present but were disclosed at different times of examining the urine for about 20 successive days. The morphology of the saliva on top of the tongue showed the ordinary but overgrown papillæ distended with bacteria; epithelia invaded with spores ; giant mucous corpuscles distended with granular but motionless contents, some with two or three nuclei. The ordinary automobile movements were not visible within. But curiously enough they were found in full activity within the leucocytes of the blood of the same case! The outlines and swarming changes of place of the introspores were optically identical with those found in the oral mucous corpuscles! There were four or five of them, some with two nuclei and one with three. Some had amœboid movements. March 17, the oral mucous corpuscles were found with motionless contents. Also from active automobile swarming contents of leucocytes. On March 29th, the spores in the oral

mucous corpuscles were all active and the leucocytes presented no sign of them. It should be said that the blood serum presented on March 17, quite a number of automobile saltatory copper-colored spores which I have been taught by another observer to be syphilitic and which I have for many years found to be as reliable a sign as any other physical sign. I think the said intra leucocyte spores were syphilitic. I am not so sure of the intra mucous corpuscle spores, though the re-establishment of their motions after the cessation of the intra leucocytal movements is an exceedingly interesting chemical fact. Long ago was I taught by another observer that the swarming bodies in the oral mucous corpuscles were cryptogamous spores introduced from the outside in food and that a healthy baby nursing a healthy mother's breast has no such enlarged oral mucous corpuscles nor swarming molecular contents. I corroborate this. In the above case the abnormal morphology of the urine became normal and not long ago the patient returned to give thanks for his entire restoration to health. New York Oct. 24th, 1898.

Practical Suggestions.

By L. A. WILLSON,
CLEVELAND, OHIO.

Lake Erie Water.—Gatherings from this lake are now especially full of Melosira, Stephanodiscus, Ceratium, Daphnella, Pediastrum, Oscillatoria and a host of smaller things. Cyclops is conspicuously absent from the gatherings. The latter appear in great abundance, in the spring. The gatherings exhibit a different fauna and flora almost every month. Why is this so?

Cephalozia sullivantii—This is one of the Junger maniaceæ, the scale or liver mosses. It is the smallest of the species and one of the minutest plants visible to

the unassisted eye. It is rare and grows on rotten wood, generally amid a mass of black dirt. To properly see the plant it is necessary to soak for a long time the wood on which it grows and then to remove the specimen by the aid of a dissecting microscope.

PHYSCOMITRIUM IMMERSUM.—This is one of the Bryeraceæ, true mosses. The plant is so small that it makes a pretty mount for a two or one inch objective. It should be mounted so as to exhibit the leaves, with their marginal yellow cells, the male flowers on young plants, the calyptra and the immersed subglobose capsules.

DAPHNELLA TUCKERMANII.—This is a very strange animal. The genera belongs to the Anulosa Arthropoda, Crustacea, Cleodocera, a single eye, intestine simple, no black spot in front of the eye, Daphnidae, six pair of legs, 2x2 jointed branches of the antennae. The species was named by C. M. Vorce, in honor of a leading physician of Cleveland. The animal is a frequent denizen of the filterings of The Great Lakes, but is generally destroyed in the filter and is wholly disintegrated when pressed by a covered glass. It may generally be found floating on the surface of a gathering and should then be mounted in a rather deep cell for examination. In such a cell, filled with a dilute aqueous mixture of glycerine, it can be preserved indefinitely. It was figured in "The Microscope," some years ago. When examining filterings with a quarter inch objective, the fins of this animal are frequent and furnish a pretty and puzzling objects.

AMPHIGASTRIA.—In most liver mosses (Hepaticæ) there is frequently a third row of leaves on the under side of the stem called "under leaves" or Amphigastria. These strange leaves are always along the stem and generally in a different focus from the other leaves. They are of specific importance and are exceedingly interesting. The determination of their morphology and utility will be a valuable scientific achievement.

EDITORIAL.

Limitation.—There is a definite limit to microscopic vision. Abbe and Helmholtz attribute this to the nature of light for they despair of resolving lines closer together than the length of half a wave of light. The higher the magnification the smaller the speck that can come into the field of vision at once. In a magnification of 50 diameters the picture represents 1-8 inch of space; in 100 diameters, 1-16 inch; in 1,000 diameters, 1-150 of an inch which is too small to be at all visible to the naked eye. The germ within the nucleolus of a cell has a structure too minute to be seen by any microscope yet made. The human ovum is 1-120 inch in diameter and made up of a countless number of cells. The yolk which encloses the nucleus and its nucleolus within can be seen but not the structure of the latter.

Bacteria in Ground Water.—The readiness with which bacteria may be conveyed to wells in sub-surface water has been shown in some experiments made on the Rhine near Strasburg by Prof. E. Pfuhl. Two kinds of bacteria, neither occurring in the Rhine, were placed in a shallow pit nearly full of water and in one hour one species had passed through twenty-four feet of gravel to a second pit, the other species appearing in the second pit within two hours.

Quekett Club.—362nd meeting, October 21. Messrs. Beck exhibited a series of their new British students' model microscopes. Messrs. Watson showed their Fram microscope with sliding bar to the stage. George Massee described the growth, fructification and life-cycle of certain fungi which usually can be found in the foray in Epping Forest, but which this year were absent on account of the dryness. He showed colored diagrams, dry specimens from Kew herbarium and slides. It was announced that W. Bryce Scott of Ontario had sent a quantity of West India coral sand, and diatomaceous earth from Nova Scotia, North Atlantic Cable dredgings

in 2,300 fathoms, polycistina from Springfield estate, Barbados, etc. Mr. A. Earland had cleaned the foraminiferal sand for distribution and would supply those desiring some. Thanks were voted to Messrs. Scott and Earland. On November 18, Mr. Harris will read a paper on organisms invading calcareous and other Organic Remains.

Washington Society.—At the regular monthly meeting held on November 8th at the rooms of Dr. Reyburn, an abstract was presented of Foster's lecture on the Physical Basis of Psychical Events.

SCIENCE-GOSSIP.

Imbedding Lichens.—For many lichens a harder grade of paraffin must be used than for most vegetable structures. A mixture of hard and soft paraffin, which melts at about 60 degrees C., is recommended. Clear the specimens in pure xylol, and to this add small pieces of paraffin, keeping the dish warm at the same time both to increase the solvent power of the xylol and also gradually and finally to evaporate it all. By this means the material is slowly warmed and penetrated with paraffin. After remaining in melted paraffin absolutely free from xylol for three hours the subject may be imbedded. The sections should be very thin, and before cutting the block should be chilled to somewhat below 20 degrees C. The microtome knife must be very hard, sharp and rigid. Stain by any of the usual methods.—*Science Gossip.*

Photo-Micrography of Opaque Objects.—At a recent meeting of the Botanical Society of Edinburgh, Mr. R. A. Robertson, M. A., B. Sc., read a paper on "A New Method for the Photo-micrography of Opaque Stem Sections." One difficulty in making photo-micrographs from recent or fossil stem sections is the trouble of getting a sufficiently large section to bring out diagnostic features. Another is, that it is a difficult process to cut and grind and polish large sections of fossils for photography by transmitted light. Neither can one always get permission

to make sections of valuable museum specimens of recent and fossil woods. Mr. Robertson has found that by directly photographing the surface by means of a microphotographic apparatus, excellent pictures, giving all necessary histological details of the tissues can readily be obtained. The recent wood surfaces are planed with a steel plane, and if at all rough the surface is wet. Very careful focussing is necessary, so as to get equal illumination. An opaque focussing plate should be used for rough adjustment, but the final focussing must be done with a clear glass plate. The illumination was by means of a magnesium ribbon fed through a fixed tube and placed at an angle of 45 degrees and a distance of ten or twelve inches from the surface to be photographed. An exposure of about forty seconds with Ilford plates gave the best results.—*Science Gossip.*

Quick Method of Preparing Sections.—It is often desirable to prepare sections of soft tissues in a very short time. To those who are familliar with the collodion method the following suggestions by Mr. M. P. Thomas in the "Journal of Appeal Microscopy" will be helpful. Place the tissue at night in forty per cent alcohol in the dehydrating apparatus. Remove it at 7.30 the next morning. Leave until 10 o'clock in two per cent collodion. Then place in five per cent collodion until 11.45. Arrange on the cork and place in eighty per cent alcohol. The material will be ready to section at 1.30. A total of eighteen to nineteen hours covers the whole operation.

Nematodes for Microtome Sections.—The following methods of preparing nematodes for sectioning with the microtome has been used by Dr. Kaiser with much success. The main difficulty to be overcome is the curling up while being killed. To prevent this place the worm on a slide with a few drops of water. Over it place another slide and move it slowly to and fro. This movement causes the worm to straighten. As soon as the nematode assumes the desired position the fixing liquid is pipetted between the slides, the motion of the upper slide being continued until the worm is dead. By this method one can

obtain a specimen which is perfectly straight and round.

Sectioning Bolitic Grains.—Lay a glass slip on a metal plate and place it over a spirit lamp. Soften a drop of nearly dried balsam upon it with heat, and lay a small plate of mica on it so that it will become cemented to the glass. Upon the mica surface imbed in balsam and arrange the small objects of which sections are desired. When the balsam is cold and firm the glass is used as a handle by which to hold the objects whilst grinding. A flat surface may be given them as they lie in the balsam, by rubbing with a hone. Heat the glass to release the mica by softening the lower film of balsam, lift the mica with forceps and turn it over on another glass which has been provided with balsam. The ground glass is now downwards, and the other side may be ground as desired. —*Science Gossip.*

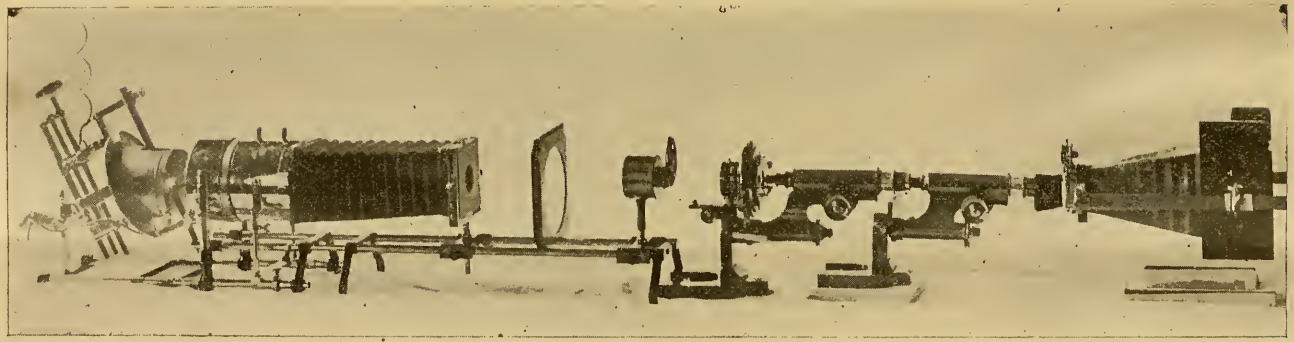
MISCELLANEOUS.

Slides.—Geological specimens nicely mounted $2.25 per dozen. Address: Micro., 34 Trederwen road, Dalston, N. E. London, England.

For Sale.—Fatty Ills and their Masquerades, By Ephraim Cutter, M. D. LL. D., and J. A. Cutter, B. Sc., M. D. $1.00. Box 494, 120 Broadway, New York.

Personal.—F. E. Twining, Fresno, Cal., makes bacteriological investigations for the medical profession and others.

Desirable.—Mason, 69 Park road, Clapham, London offers two new sets lantern slides photographed from nature and especially fitted for public exhibition, 38 slides in each ; packed in box for $8.50 each set ; 18 slides illustrating anatomy of honey bee $4.25 ; 9 slides anatomy of blowfly $2.10. He sends a sample slide for 30 cents post paid, or 18 misceallaneous specimens for 25 cents each. He has stem sections to illustrate distinct orders of plants, sections of cell contents, also reproduction. These with 12 special exhibition slides for $2.75 post free.



Gates' Double Microscope with Arc-lamp, Condensing and Parallelizing Lenses, Alum Filter and Camera.

THE AMERICAN

MONTHLY

MICROSCOPICAL JOURNAL.

VOL. XIX. DECEMBER, 1898. NO. 12.

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An Episode in the Artificial Culture of Diatoms.

BY WILLIAM A. TERRY,

BRISTOL, CONN.

Late in August, 1895, I made a gathering of sediment from the margin of a pond in Bristol at an elevation of some 800 feet. The water was low in the pond and had left this sediment uncovered for some time. The previous year I had made a similar gathering from the same place, and, on stiring it up in water found it very rich in desmids, numerous in variety and some of them very rare. This gathering contained also numerous varieties of desmids, but not in sufficient quantity to be easily separated from the mud. It had also diatoms, particularly Surirella biseriata, and, as I believed it contained spores also I gave them a chance to develope. Stiring it up in water, after the sand and coarse debris had settled, I poured the lighter part into a glass dish about one

foot in diameter. The material formed a sediment about one-half inch deep with three inches of water over it, about one quart in all. I placed this in a cool room exposed to a strong light. In a few days a curious growth developed at points all over the sediment. This growth resembled a miniature moss, clubshaped, with a dark green top shading from pale green to light brown in the stem. Dozens of these peculiar growths appeared, about one-half inch in height and all very similar in form and coloring. The stem had no elasticity. When pressed carefully down it would remain on the bottom for some time but would finally rise up again upright. I pulled up one of these carefully with tweezers. The part below the mud was dark brown in color and resembled a root. Placing it on a slide under a one-inch coverglass, I found the green top to be composed wholly of desmids, magnificent specimens of Microsterias radiosa in all its various types with M. furcata and M. americana and many others, a dozen species of Closterium, as many of Cosmarium, with Penium, Euastrum, Staurastrum, Docidium and many others, some of them unknown to me. All made up a rare collection of varieties which I had never before seen equaled. The stem was made of a tough mucous which contained small varieties of Cosmarium, Penium and Euastrum, but was chiefly filled with minute species of diatoms, Navicula, Amphora, Nitzschia, and a somewhat larger variety which from their darker color and slightly bellows shape I concluded to be developing Surirella. The root was composed chiefly of gelatinous hydrate of iron oxide. By the disturbance caused by the pressure of the cover-glass thousands of the diatoms were liberated and were rapidly traveling to and fro in all directions. These diatoms, were of well-known species, and most of them appeared to be destitute of silex. I considered them immature forms.

As they were protected to some extent by their gela-

tinous matrix from the attacks of the Ciliata and Amœba, I hoped they would survive long enough to develope sufficiently to settle this question, and I watched them with great interest from day to day. That there should have been so many of these peculiar growths I thought remarkable. I had often before noticed the tendency of the desmids to climb upon projecting points, and probably the buoyancy given by the gases liberated by their vital processes was sufficient to stretch out the yielding gelatinous envelope of the diatoms into this shape.

Destructive animals did not appear very abundant. There were many rotifers but they live upon minute organisms circulating in the water. Around the root and climbing upon the stem of this growth under examination, I counted fifteen of those very curious sloth-like creatures, the Tardigrade or Water Bear. Some of these were very large, but, as the contents of their stomachs was colorless, they did not appear to have been feeding upon diatoms. Although I have watched these animals for a considerable time in hundreds of instances, I have never seen them feed. Notwithstanding, their formidable claws do not appear to me to be very destructive. Their comical contortions while painfully clambering over the debris look appealing rather than ferocious.

In a very few days it became evident that these growths were being rapidly devoured. Every morning a larger tract was cleared until finally all were gone. I then poured off the whole and strained it through a fine wire sieve, capturing a large number of that miserable crustacean,the aquactic representative of the common sow bug, a freshwater relative of the so-called sandflea of the seashore. This is the most omniverous destroyer I know. Fish, flesh and fowl come alike to him including animals, plants, vegetables, algæ, fungus, desmids, and diatoms; and he will even devour their empty shells. During the three years that have passed since these oc-

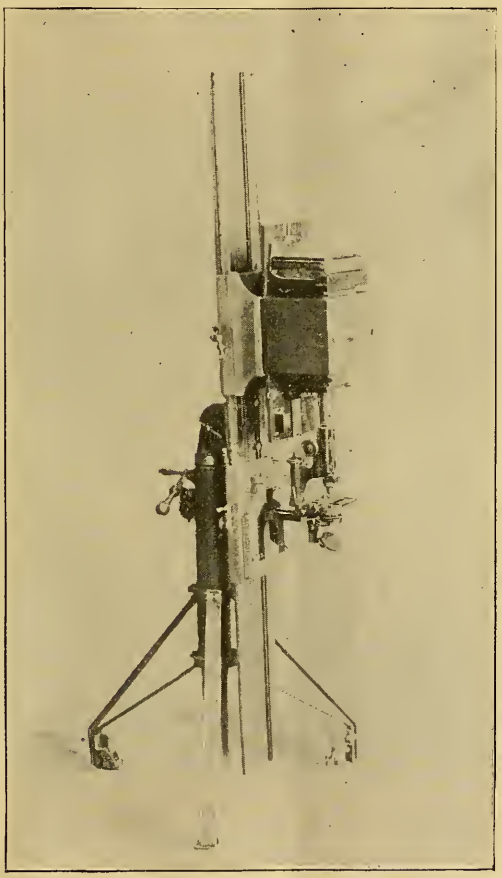
currences, frequent observations have been made, but no more of these peculiar growths have formed, although the material still contains living desmids and diatoms. Numerous colonies of minute diatoms enclosed in gelatine have formed but have not persisted long enough for conclusive results. A drop of the sediment now under observation shows six species of desmids, countless numbers of empty frustules of large Surirella and a few living ones, but their number has been constantly diminishing for a year past. A few specimens of Surirella biseriata still live but are very sluggish. S. splendida are nearly all dead, but active frustules of a very elongated type of S. elegans still survive. I wish those scientists who believe that the motions of the Surirella are confined to a "languid roll" could see one of these ploughing its way through the debris and crossing the entire field of the microscope in a little over one minute. Two or three species of Pinnularia also appear healthy.

A New Photo-Micrographic Apparatus.

A. W. Bitting, Lafayette, Ind.

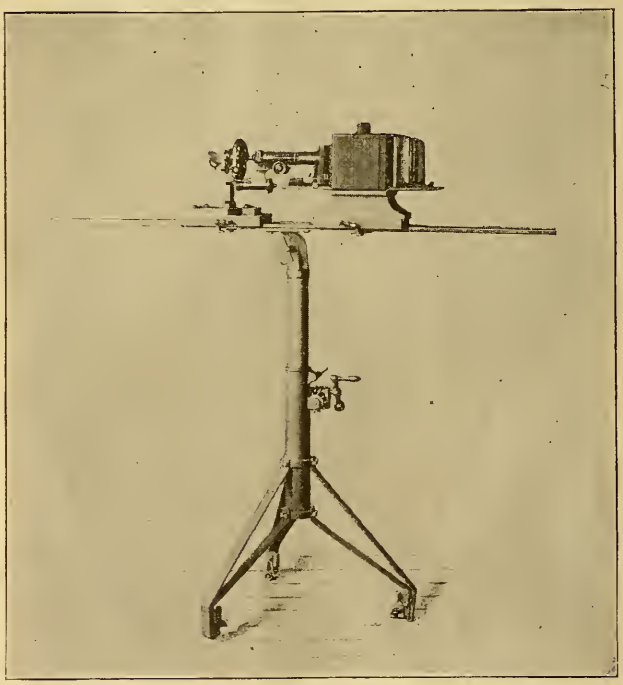
The apparatus consists of an upright cast-iron post supported by three cast legs. The center of this post is bored out to receive the elevating post. Near the top is a sprocket wheel, which is turned by a screw and crank. A binding screw is also placed in the top to clamp the elevating post in position. The upright post, with its legs, stands 28 inches high. The elevating post is 28 inches long, is of two-inch steel tubing, turned to fit the hole in the upright post. A series of holes are drilled into the tubing to receive the sprocket wheel, which raises and lowers it. Upon top of the elevating post is a head-post which receives the bed plate for carrying the camera and microscope. The head-post is turned

to exactly fit the inside of the tube and permits the bed plate to be revolved on its horizontal axis. The bed plate is five feet long and five and one-half inches wide. It consists of a piece of three-sixteenths-inch rolled



steel, to which is riveted two dressed half-inch steel tubes. These tubes are placed near each edge and give rigidity as well as serve for guides for the camera and microscope carriages. In the centre of the bed plate is a rack for the adjustment of the camera and microscope

The attachment of the bed plate with the head post is by two dressed circular surfaces and a bolt. Upon the head post is mounted a screw which turns in threads cut upon the edge of the circular plate attached to the bed plate. By loosening the bolt and turning the crank upon the end of the screw the bed plate may be made to rotate upon its vertical axis.



The carriages are twelve inches long, grooved to fit upon the steel rods, and are provided with pinions, cranks and binding screws to make accurate adjustment. The stand is provided with castors so adjusted that it may be thrown on or off its legs with the foot. All the handles are nickel-plated and the whole apparatus enameled black.

The requisites of a good photo-micrographic apparatus are rigidity, ease and accuracy of adjustment and adapt-

ibility to all kinds of work. The first condition has been met by using metal in the construction, thus obviating shrinking, swelling and warping, inherent qualities of wood. The second and third requirements have been met in the mechanical construction.

With this apparatus it is possible to work in the vertical or horizontal position or at any inclination. The adjustment is easily and quickly made by loosening the binding nut between the friction plates aud turning the bed plate to the desired position. The bed plate can be rotated on the horizontal axis to get the advantage of room and direction of light without moving the stand upon its legs. When the bed plate is turned to the horizontal the top of the bed plate is 33 inches from the floor; too low to work with comfort. By raising the elevating post the bed plate may be carried up to the height of five feet. This adjustment makes it possible to always have the work at a comfortable height, either in sitting or standing position, and regardless of the stature of the operator.

Diagnosing Yellow Fever.

In an official hand-book on yellow fever, its nature, diagnosis, treatment, and prophylaxis, which has just been prepared by the Surgeon-General's Office, Acting Assistant Surgeon John Guiteras says regarding the use of the microscope:

"An erroneous belief has prevailed throughout the South, especially among physicians who were not practical microscopists, that the microscope should be an important aid in diagnosis of yellow fever. It appears that poorly prepared abstracts from the work of Sanarelli have led many to believe that a characteristic feature, the bacillus of Sanarelli itself, was found on examination of the blood. Now the truth is, that even with the as-

sistance of post-mortem examinations, Sanarelli was able to discover his bacillus in only 58 per cent of the cases of yellow fever. He would be a poor clinician, indeed, who could only diagnose about one-half of the cases. The truth is, however, that during life the microscope could not establish a positive diagnosis. As far as our present methods go, it would be impossible to distinguish between a drop of yellow fever blood and blood from a healthy man. Negative evidence may be presented by the microscope. The presence of the plasmodium malariæ, for instance, would prove that a case was suffering from malarial poisoning, and presumably not with yellow fever. But the differential diagnosis between these two diseases is usually easy. The billious remittent fever that in our old text-books of medicine occupied a conspicuous place in the tables of differential diagnosis with yellow fever, has practically disappeared from the Southern sea border since yellow fever ceased to be an endenic there. It was, in fact, the yellow fever of the natives and of places in the interior. The former were supposed to possess in a certain degree immunity against yellow fever, and the disease was believed to be restricted almost to the littoral. The plasmodium has been found in the blood in cases of yellow fever. The mistake made by the board of experts of New Orleans, when they failed to recognize the existence of yellow fever at Ocean Springs, was due to the finding of the plasmodium in at least two of the cases."

In February, 1896, Sanarelli discovered and named the Bacillus icteroides having found it in 58 per cent of the cases of yellow fever examined. Why could he not always find it? He states that in laboratory work these bacilli are quickly killed off by the common pus organisms, the colon bacillus and others. Having gained entrance to the circulation through the destruction of the natural barrier by degenerative changes brought by the

icteroides, these other organisms proceed at once to kill off the icteroides. By inoculation, Sanarelli produced a disease much resembling yellow fever, but the analogy was not so strong as desired. The symptoms and pathological changes differed sufficiently from those produced by other organisms to warrant the belief that the yellow fever was actually produced. Serum from convalescents or from yellow-fever cadavers produced only slight agglutination of the icteroides. Antidiphtheritic serum produces rapid agglutination of the bacillus, which would indicate a close biological relationship between it and the Klebs-Loeffier bacillus. There are points of resemblance in the manner in which the infection of yellow fever and diphtheria spread. Typhoid serum also produces this phenomenon but partially, and, as would be expected, colon serum and that from normal man produces no effect. Serum from a convalescent possesses no curative action in the guinea pig simultaneously with the minimum fatal dose of icteroides, but 2 c. c. of the same serum administered 24 hours previous to the minimum fatal dose seems to confer immunity,—at least, the pig does not die. A horse has been immunized to the icteroides and .5 c. c. of his serum will give to the guinea pig the immunity above mentioned under the same conditions, and even after 48 hours has been allowed to elapse, 2 c. c. will save the animal. Saranelli used the serum of a horse inoculated with gradually increasing quantities of the icteroides for 18 months. In Brazil, he treated 8 cases with subcutaneous injections, the total quantity varying from 15 c. c. to 65 c. c. with a mortality of two. Many able and conscientious investigators are still working to verify the researches of Sanarelli and it is hoped they will succeed at an early date.

Fixing Blood for Microscopic Study.

Complex technique in the preparation of microscopical preparations has done more to limit the use of the microscope in the diagnosis of disease than any other one thing. Take the ordinary directions for the preparation of a blood slide. First the most careful soaking and scrubbing of cover glasses, then the application of one of the glasses to the drop of blood, followed by a second cover glass laid over the drop and the two pulled slowly apart, with the result that in fully half of the cases neither of the two cover glasses is spread in any way suited to the purpose; either no blood adheres or the corpuscles are found overlying one another,or matted to such an extent as to make them worthless. Finally, if a good spread is secured, fortunate is the ordinary worker if he does not find, after following the advised heat method for fixing, that he has not fixed the corpuscles, but simply distorted them.

The following method of blood preparation requires only ordinary skill and presents the advantage of almost invariably giving first-class specimens. A solution is prepared which will mechanically separate the corpuscles of blood mixed with it, and yet of such density and composition as to permit them to retain their proper shape and condition. There are several such solutions. The formula suggested by Hayem is as follows:

Chloride of sodium.....	1 part.
Sulphate of soda.....	5 parts.
Bichloride of mercury.....	5 parts.
Distilled water.....	200 parts.

Drop a few drops—about five—of this solution in a small test tube or vial. Then after scrubbing the skin with alcohol or ether, puncture with a triangular surgeon's needle. With a small wire loop or a pointed glass rod quickly transfer a very small drop of blood from the

surface of the skin into the solution and stir thoroughly. Use a looped wire, similar to the platinum loop used in transferring sputum to a slide, but with the loop made smaller. Now the blood may be carried any distance without change. This is all that is necessary to do at the bedside, and the subsequent manipulations may be made at leisure. When it is desired to continue and complete the examination, a slide and cover glass are cleaned in the ordinary way, the mixture of blood and Hayem's fluid is stirred or shaken, and a small drop placed upon the slide. If a stained preparation is not desired, the mixture is covered with a cover glass and examined at once. It will be seen that all the corpuscles are separate, with no tendency to collect together, and not distorted.

If it is desired to prepare stained specimens, then after the small drop is placed upon the slide it is to be subjected to the following manipulations. The following solution is to be used:

Formaline	8 drops.
Alcohol	3 drachms.

A quantity equal to twice the bulk of the blood solution which had been placed upon the slide is now placed also upon the slide, so that the blood solution and formaline in alchohol solution shall come in contact by their sides. At once it will be noticed that the blood is being precipitated as a very fine white precipitate. The slide should now be left to lie perfectly flat for at least one minute, after which time fixation is complete.

Now the fluids may be allowed to evaporate slowly, or if it is desired to rapidly complete the process, small pieces of blotting paper may be applied to the edges of the fluid, and some of it cautiously absorbed, always watching the white precipitate to see that it is not also removed by the blotting paper. When but little of the fluid remains, gentle heat may, in my experience, be used

to facilitate drying without detriment to the specimen. The blood is now fixed to the slide, and may be stained in any way desired. When the formaline and blood solutions are brought in contact, a rather violent movement occurs, due to the difference in densities between the two liquids, and if the formaline solution is dropped directly upon the blood solution, the latter will be forced to the sides and the specimen will not be a uniform spread, but rather in the form of a ring, which, of course, is of no importance whatever.

Those who desire to make permanent mounts, and, desire neat-looking specimens, should mark out upon the slide a square, a little smaller than the cover glass, by taking a small camel's hair brush or a match and dipping it in collodion and marking out a hollow square. In the middle of this square I place the blood solution, and then the formaline solution, and unless the quantity of each is excessive, the fluids are accurately confined by this collodion wall during the mixing, and after the fluids have dried the collodion will easily peel off by using a pin leaving a specimen with sharp-cut edges.

There is no doubt as to the value of the alcohol formaline solution as a fixative for the corpuscles. A good smear may be made by dragging the slide its whole length over the drop of blood on the ear or finger-tip. Such smear may be at once set by pouring the formaline alcohol solution over the slide. After drying, the blood may be studied directly without cover glass, using an eighth objective. Wherever the smear is thin and well spread, abundant corpuscles will be found, which are not drawn out of shape or vacuated by the formaline-alcohol.

The great advantage of the Hayem's solution is that the blood may be kept for an indefinite time and examined at leisure. Ten minims of the salt solution should be put in a half-drachm vial and a small drop of blood added. After mixing with formaline-alcohol solution on

the slide, and drying, a confusing mass of needles and crystals are found mixed up with the scattered corpuscles. This crystalline debris, may be washed away by pure water gently dripped on the slide without disturbing the corpuscles. They may then be colored with the eosin and methyl blue solutions in succession, covered with cover glass, and examined with a twelfth oil-immersion at leisure.

The methods suggested may be tried by those accustomed to fixing blood with the alcohol-ether solution, or by heat, or by saturated alcohol sublimate solution, and the relative results compared.

For staining the malarial organism after fixing the blood corpuscles, the method is :

1. The specimens are stained with eosin (one-half of one per cent eosin in ordinary alcohol) for five to fifteen minutes; the solution will not stain too deeply.

2. Wash in running water and dry in air.

3. Stain with methyl blue (one drachm of the laboratory solution to an ounce of water is strong enough), the time it takes to count ten—eight to ten seconds is long enough.

4. Wash in running water, dry, and mount in balsam. The blue stain colors the parasites : the danger is in overstaining with the blue. Good success is had by using a 10 per cent solution of methyl blue in alcohol, staining two or three minutes. But for the crescentic forms of the æstivo-autumnal fevers which stain with more difficulty than the ordinary forms of tertain type, the watery solution of blue is necessary.—*Ind. Med. Journal.*

Practical Suggestions.

By L. A. WILLSON,
CLEVELAND, OHIO.

Flagellum of Ceratium.—The flagellum of this animal when present is easily and plainly visible under an ordinary and inexpensive one-quarter-inch objective. It needs no staining nor a high angled expensive lens. The flagellum is seldom seen as the little animals are quite timid and at the slightest alarm retract this interesting appendage. It has been suggested that the animals pass into a "still condition" and in that state retract the flagellum.

Flagellum of Bacteria.—These illusive organs may be plainly and comfortably viewed with a cheap one-fifth when properly stained. The difficulty in demonstrating these minute organs lies not with the lens but with the lack of skill and technical knowledge in the method of staining. To stain them requires experience, technical knowledge and special skill.

Gum for Fixing Objects to a Slide.—Selected pieces of gum arabic are dissolved in distilled water, so as to form a thin mucilage. This is filtered, and the filtrate poured into a considerable volume of alcohol, which precipitates the arabic. This is separated from the mother liquor by filtration, washed with alcohol and finally dried. It is freely soluble in water and can be used instead of the ordinary gum with advantage. It will obviate the granular appearance of the gum when used to fix objects to a slide.

Blackening the Inside of a Draw-tube.—Many fine instruments are sold with the inside of the draw-tube covered by a bright metallic surface. With such an instrument it is impossible to obtain good photomicrographs or even to obtain a good deffinition. The following is a process for obtaining a dead black surface on

brass:—Put two grains of lamp-black into any smooth, shallow dish, add a little gold size and thoroughly mix the two together. Just enough gold size should be used to hold the lamp-black together. About three drops of size, as may be had by dipping the point of a lead pencil about half an inch into the gold size, will be right for the above quantity of lamp-black. After the above are thoroughly mixed and worked, add twenty-four drops of turpentine and again mix and work. Apply thin with a camel's hair brush, and when dry, a fine dead-black will result.

PRACTICE.—It requires considerable experience to interpret correctly the objects viewed in the field of a lens. It is generally impossible for a person unaccustomed to the instrument to know precisely what the field exhibits. When experts bring their instruments into court judges and jurors often take a look at an object and draw the most erroneous conclusions. Air bubbles, oil bubbles, stray debris and accidental particles are apt to most strongly engross the attention.

MUSCA DOMESTICA.—This is a common house-fly. On account of the conformation of its mouth parts, this insect cannot bite. Common and wide-spread as this species is, there is very general ignorance as to its life history and habits, except in its adult stage. Its length of life in the adult condition is not certainly known. In a warm climate it produces ten to thirteen generations every summer. A single fly will lay an average of one hundred and twenty eggs. Stables are their chief and favorite breeding places. They are carriers of contagion. In the autumn, they are attacked by minute reddish mites. As many as nineteen of these mites have been found on a single fly. Soak the fly in a shallow vessel in turpentine when the mites will crawl off and may be examined and mounted.

EDITORIAL.

Periodical.—It is unfortunate that the monthly, "Natural Science," is to lose its editor and perhaps its life with the end of the year, but while it lives it kicks, calling the Scientific American in its August number "an American Pirate," and accusing it of repeatedly stealing from the columns of Natural Science.

Cells.—At the late meeting of the British Association for advancement of Science, forty pounds ($200) were appropriated for Prof. E. A. Schafer to use in research upon the micro-chemistry of cells.

Diagnosing Diphtheria.—Jaques urges early bacteriological examination in all anginas. In malignant cases make a direct diagnosis. Take a little of the mucous or of the membrane directly from the site of the invasion. Spread it on a cover-glass or slide, fix by heat, stain and examine. In other cases a culture should be made. Jaques has laid aside the laboratory test-tube and substituted a small metal culture box. Having inoculated it he carries it in the vest pocket where the heat of the body keeps up the proper temperature. After three or four hours he makes the examination.

Phyto-Plankton.—George Murray and V. H. Blackman have studied the nature and extent of the little understood microscopic objects called coccospheres and rhabdospheres. Their calcareous plates are described in minute detail. The coccospheres have a central green chromatophore which separates into two on the division of the cell. These plants belong to the unicellular algæ. They are found on the surface, in deep-sea deposits and in fossil beds.

Forest Leaves.—Microscopic observation of the living leaf reveals that the chlorophyll granules are individually independent globules of dense protoplasm, without proper walls, plunged in the midst of the fundamental protoplasm and tinged by the green matter, their form and size remaining unaltered when extracted by ether, etc.

SCIENCE-GOSSIP.

Decaying Pine Wood.—J. S Dales reports a peculiar condition in a tree box. The decayed portion did not present the usual dull, dark, shrunken appearance common to rotten wood. Above the line of moisture, it was of bright, buff color, glossy and velvety to the touch but, upon slight pressure it crumpled into powder leaving a small mass of coarse and hard wood-fibers. Microscopic examination revealed a dark intersticial fungus and a great abundance of minute spore-like bodies which resisted many of the usual staining fluids.

Nucleo-albumin.—For anæmia, Dr. E. D. Klots, 156 W. 48th street, New York, has given haemaboloids, half an ounce four times per day, with the result of increasing the haemaglobin in two months from 41 to 69 per cent, the red blood-copuscles in ratio of 198 to 364 with a corresponding return of health. In another case the haemaglobin increased from 38 to 63 per cent and the red blood copuscles in ratio of 164 to 341. Photomicrographs of he blood before and after treatment are shown in the N. Y. Med. Jour. of Nov. 12, 1898.

Circulation of Blood.—The standard method of examining the circulation is that of extending on a frog-plate the web between the toes of a frog's foot. As, however, most amateur microscopists find it difficult to obtain a frog when they require one, it might be of advantage to some of them to know that the tadpoles of the common frog form excellent substitutes during their embryonic state, and that in the thin expansion of the tail the circulation is exhibited to perfection. These tadpoles are easily obtained in almost any district, and may be kept in a small aquarium or fish globe, where they will be handy when required. The method of examination is very simple. The tadpole is caught and transferred to an ordinary slide, and a lump of loose wet cotton-wool is placed over it, holding it down fast to the slide, and leaving the tail free for observation. If there is any tendency to curl the tail up on to the

object-glass, an ordinary thin glass cover may be placed over it to keep the tail steady. The tadpole can be kept thus for an hour or more withoutany apparent discomfort, provided that the cotton-wool be kept moist. It might be mentioned that the tadpoles are of very little use for this object after the development of the legs, as the circulation then ceases, and the tail becomes opaque. I always use a one-inch objective and dark ground a illumination.—*Lewis H. T. Chase in Science Gossip.*

Photo-micrography with High Powers.—In "Nature" Messrs. J. E. Barnard and T. A. B. Carver explain how they have overcome the difficulty experienced in photo-micrography with high powers and critical illumination, owing to the unequal intensity of the light emitted from the surface of incandescent limes, or the impossibility of controlling the electric arc so as to maintain a constant position and condition of the crater on the positive carbon. The latter difficulty has now been overcome by having a simple form of hand-feed apparatus, with a pinhole camera attached, through which an image of the carbon points is projected onto a ground-glass screen. With such a form of arc-lamp absolute "centration" of the light can be secured and mantained, without reference to the microscope, after the necessary position of the image of the arc on the screen of the pin-hole camera has been once obtained.

Effect of Different Media on Micro-organisms.—Professor Bitting has found by making ten exposures each of air, water and milk upon four different media (neutral agar agar, neutral glycerine agar, neutral beef gelatine and slightly acid wort gelatine) using some closed petri dishes all under like conditions, that agar agar gave the most bacteria and wort gelatine the most moulds. The average number of colonies of bacteria developed by ten tests of air was: On agar agar, 86; glycerine, 73; beef gelatine, 64; wort gelatine, 41. Ten tests of water gave the following number of colonies: Agar-agar, 2,370; glycerine agar, 2,260; beef gelatine, 1,470; wort gelatine, 480. Ten tests of milk gave the following

number of colonies; Agar agar, 7,967 ; glycerine agar, 11,207 ; beef gelatine, 7,416 ; wort gelatine, 1,700. Agar agar shows the highest number of colonies. The average number of moulds from air was as follows: On agar agar, 3, glycerine agar, 7 ; beef gelatine, 20 ; wort gelatine, 34. Ten tests of water gave: Agar agar, 12 ; glycerine agar 15 ; beef gelatine, 60 ; wort gelatine, 88. Ten tests of milk gave: On agar agar, 2 ; glycerine agar, 7 ; beef gelatine, 12 ; wort gelatine, 47. Wort gelatine showed the highest number of colonies of moulds. Hence, statements of the number of forms found, are of little value unless the media are taken into consideration.

RECENT PUBLICATIONS.

New Book.—The Microscopical Proof of a Curative Process in Tuberculosis, or the Reaction to Tuberculin Evinced by Blood Changes hitherto Unrecognized, by Chas. Denison, M. D., Denver, Colo.

Mushrooms.—The Asa Gray Bulletin for October is especially devoted to the Amanita and seeks to notice mosses, lichens and sedges.

Tumor of the Jaw.—In the transactions of the Manchester Microscopical Society for 1897 is a paper by Mr. Worstenholme on Botriomyces, a micro-organism that produces tumor of the jaw, chiefly in oxen. It was formerly known as osteo-sarcoma, a malignant cancer.

Algae.—A list of the Fresh water algæ of Queensland, has been issued by the government at Brisbane.

The Double Man.—This story reminds us of the novels of Bulwer, being filled with information of the sort that most men refuse to accept as truth and with recitals which most men declare to be imaginary. The very knowledge that most of all we shall sometime wish to have is covered under the false label of fiction. We now only amuse ourselves and forget the tale. Send fifty cents to Paul Tyner Denver, Colo., therefore and be amused with what he writes of man's powers in the occult realm.

Someday, when the non-material in us has evolved to higher planes and subordinated the material we shall find a higher use for this kind of literature than we make of it today.

MISCELLANEOUS.

For Sale.—A high-class microscope by a renowned English maker. High-angle objectives, 2-3, 1-6 and 1-12 oil imm. achromatic Abbe condenser, &c., &c. A bargain. Apply to Dr. Thomas, 222 Sansome St., San Francisco.

Dublin Society.—The Irish Microscopical club that has heretofore met at the residence of its members is to meet in the future at the rooms of the Royal Dublin Society.

Society.—The Hastemere Microscope and Natural History Society contains 452 members and has an annual income of $350. Mr. Grant Allen, the president, urges upon its members to each select some one branch of Natural History and endeavor to contribute something thereupon to the society.

Personal.—Dr. C. T. Caldwell is professor of Microscopy and Histology in the Medical Department of the National University, Washington, D. C. Dr. Willlam B. French is professor of Bacteriology in the same college. These branches are taught by lectures and laboratory work consisting in the preparation and examination of microscopic sections, the making of cultures and familiarity with bacteriological technique.

Personal.—Thomas King, one of the founders of the Microscopical Society of Glasgow, Scotland, which was founded in October, 1884, died Sept. 14, 1896. His biography has been published by the Natural History Society of Glasgow. From 1884 to 1896 he was an officer of the Microscopical Society, and being a skilled microscopist and having a thorough knowledge of vegetable tissues, as well as of lower plant forms he was able to read many valuable papers before the society.

Personal.—Dr. E. J. Lutz is Professor of Bacteriology in the Medico-chirurgical college of Kansas City, Mo.

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