THE AMATEUR IN PHOTOMICROGRAPHY.

BY PROF. W. F. WATSON.

Those who use a microscope, whether for amusement or scientific investigation, frequently meet with objects which are worthy of permanent preservation and subsequent study. This is especially true in the examination of stagnant water, which teems with organisms varying in size from bacteria to water-fleas and hydra. The observer not infrequently meets with forms exhibiting marvelous structure and exquisite beauty. Those organisms are often too delicate for mounting in permanent slides, or, if they can be so mounted, the technical skill required is too great for the amateur. But it is possible for the amateur with quite a slender outfit to make respectable photomicrographs, provided he has some natural skill and possesses the virtues of patience and perseverance.

For a wide range of work the microscope accessories should include quite a number of objectives and oculars of different powers, a sub-stage condenser and a mechanical stage. Yet these are not essentials, and the amateur can get along without them if he does not care to photograph very minute objects.

The essentials for photomicrography are a microscope and camera with some means of making a light-tight connection and focusing. Any kind of camera will do, as the only lenses used are those of the microscope. Great care must be taken that no extraneous light enters the camera, as the slightest leakage will have its effects intensified during the long exposures which are sometimes necessary.

In Fig. 1 is shown the apparatus with which the accompanying illustrations were made. In the lumber room of the laboratory a small box was selected for a base. To this were nailed two uprights having half-inch grooves on the sides facing each other. A half-inch board is prepared to fit the grooves and slide freely up and down. This board may be clamped in any position, and to it the camera is attached by its

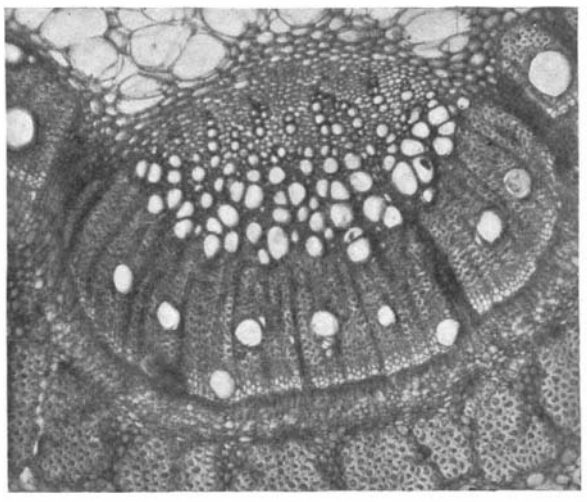

Fig. 2.—TRANSVERSE SECTION OF BLACKBERRY WOOD.

screw. The lens of the camera is removed and a square of wood is substituted, which has a hole in its center for the reception of the microscope tube. A small strip of black cloth wound around the tube makes the connection light tight. A gas jet which is adjustable in any direction is supported in front of the sub-stage mirror. The whole apparatus rests upon three projections as indicated in the picture, and a weight is placed inside the base to make it more stable.

For such apparatus the vertical position seems much better than the horizontal. In this case the effects of vibrations are reduced and the focusing adjustments are within easy reach. In the horizontal position focusing is generally much more difficult.

Figs. 2 and 3 of the accompanying illustrations were taken by transmitted light; Figs. 4 and 5 (being opaque) were made by reflected light. Fig. 2 represents a very small portion of a transverse section of blackberry wood (Rubus villosus). Such a section of wood, cut very thin with the microtome and presenting an even surface with good contrasts, is an excellent specimen for photomicrography, and from it good results can easily be obtained. The next object, a bee's sting, represented in Fig. 3, is far more difficult. The delicate striations on the sting were very hard to bring out clearly. This picture was made by using oblique light with the sub-stage condenser and developing for contrast.

In photographing opaque objects more difficulties arise. Most prominent among these is the matter of suitable illumination. The picture of the needle point, Fig. 4, was made by placing the apparatus about four feet from a north window and turning the apparatus until the light fell slightly to one side of the object, which was an ordinary smooth sewing needle. The picture was taken on a non-halation plate.

The bee's sting and needle point pictures were made for comparative study, and for this purpose the sting was taken straight and in sheath. It was considerably magnified, which would render conspicuous any

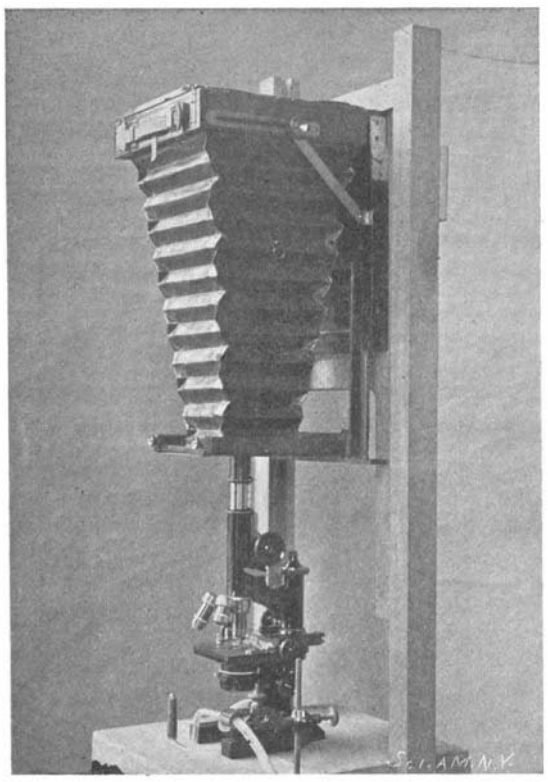

Fig. 1.—APPARATUS FOR PHOTO-MICROPHOTOGRAPHY.

imperfections if they were present. But the microscopic smoothness and perfection of detail in the natural object present a striking contrast to the clumsy workmanship exhibited in the magnified needle, though its magnification is very much less than that of the sting.

An extremely difficult object for photographing is the keen edge of a polished razor blade, which is shown quite highly magnified in Fig. 5. It appears next to impossible to secure good magnifications with delicacy of detail from a brightly polished and glimmering surface, and the amateur who attempts it without much experience must count on a long series of experiments and many spoiled plates before he is likely to succeed.

In photographing the razor edge the blade may be attached to the mechanical stage of the microscope by means of fine copper wires twisted around the shank. A better way, however, is to prepare a little block of wood, as shown in the diagram, about 3 by 1 by ½ inch, cutting a groove along one of the longer edges for the reception of the back of the razor blade and leaving the edge exposed. If the groove be properly cut (which can be done with a fine saw and an awl), the blade can be pushed in from the end and should fit it well or be tightened in place by little wooden wedges. Of course the upper surface of the razor's edge must be level. When once fitted in this way, the block of wood carrying the razor can be

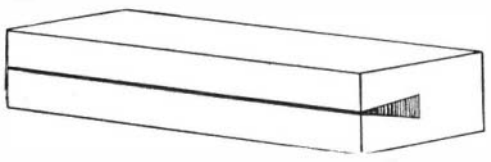

Fig. 6.—BLOCK FOR HOLDING RAZOR BLADE.

moved into any desired place on the stage. These manipulations have to be done with deliberation and care to prevent injury to the keen razor edge and to prevent the fingers of the operator from being gashed.

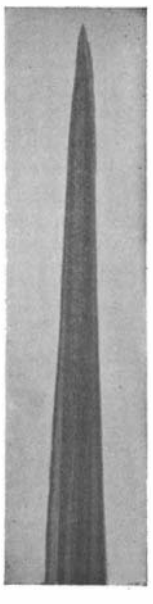

Fig. 3.—BEE'S STING.

Fig. 4.—NEEDLE POINT.

The light used in making this picture (Fig. 5) was supplied by a large gas burner placed at a distance of one foot from the blade and elevated so that the light fell upon the object at an angle of about 30 degrees. A large plate of ground glass was interposed between the source of light and the razor to prevent the glimmering effect from the polished steel, which would have resulted in a fogged appearance in the negative. The actinic action upon the dry plate was very slow, owing to the loss of light, both in its passage through the ground glass and in its reflection from the razor's surface. There was, of course, the additional weakening effect caused by magnification, the light from a minute area on the razor edge being spread over a comparatively large area on the dry plate. This picture was made by an exposure of one hour on a 26 Seed plate.

On account of the weakness of the light, the focusing, which had to be done with great precision, was difficult. The image in the camera was very faint. When focusing such a dim image the focusing-cloth must be opaque and must shut out every ray of outside light. In addition to this, a hand lens must be used to make the image still more distinct.

Perhaps it is possible to get good pictures of the razor's edge with a stronger light and correspondingly short exposure, but so far the results obtained by using a stronger light with this object have proved unsatisfactory, though the lime light, acetylene and daylight were tried. As an all-around good light, daylight is probably the most convenient and satisfactory of all lights for the amateur.

In photographing transparent objects it is important that reflected light should not enter the lens. A useful attachment is a small cylinder made by rolling up a piece of black photographer's paper and gumming the edge. This cylinder should fit over the end of the objective lens and reach nearly down to the stage. By using this cylinder the brilliancy of the negative is sometimes greatly increased.

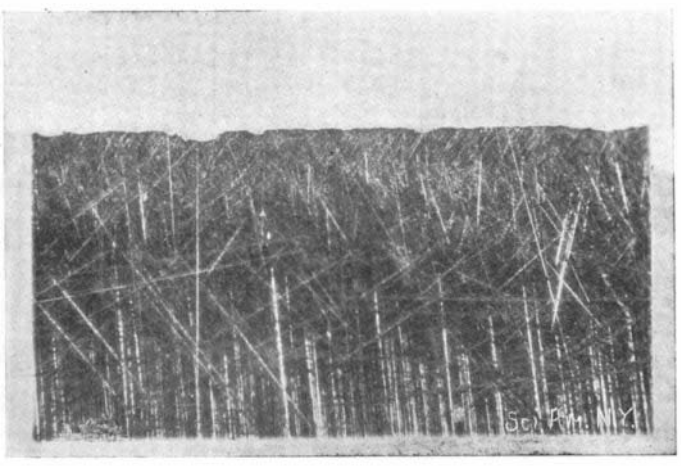

Fig. 5.—RAZOR BLADE HIGHLY MAGNIFIED.

The amateur is sometimes advised to use only the objective lens in photomicrography. The propriety of this is questionable. The pictures made with one lens are generally very small, or the apparatus is inconveniently long. In addition to this it is almost impossible to prevent some light being reflected from the sides of the microscope tube when only the objective is used. It seems better, therefore, to use a low-power eyepiece with the objective.

The time of exposure is an extremely variable element. It varies with every change of objective or of ocular and with every change in the character of the object and nature of the illumination. The time of exposure in the case of the accompanying pictures differed from a few seconds to one hour. No rules of much value can be given, but the beginner will gradually learn by experience to observe the strength of the image when it is focused in the camera, and estimate the time of exposure accordingly.

Acetylene Search Lights in Sweden.

Sweden is one of the countries in which the application of acetylene as an illuminant has already acquired considerable importance. Its use on board ship is perhaps most open to objection since any access of water may cause an explosion. Yet acetylene searchlights are being employed on the fleet of small steamers which ply between the numerous small islands with which the Swedish coast of the Baltic is dotted. During trial runs it resulted that objects could easily be examined at a distance of 500 to 600 meters (1,640 to 1,802 feet) when the acetylene beam was thrown on them, and the manipulation of the lanterns caused no difficulties. The saloons and cabins of some of these steamers are also lighted with acetylene.

Japanese cotton mills are now running 22 hours a day with double shifts, and while wages have been increased they are still ridiculously low. Watches are made in Japan as low as $2, bicycles at $12, and pianos for $100.