Amateur Photomicrography

A Complete Manual for the Beginner with Special Reference to the Bausch & Lomb Amateur Photomicrographic Outfit.

A Publication of the

Bausch & Lomb Optical Company

ROCHESTER, NEW YORK

New York Chicago San Francisco

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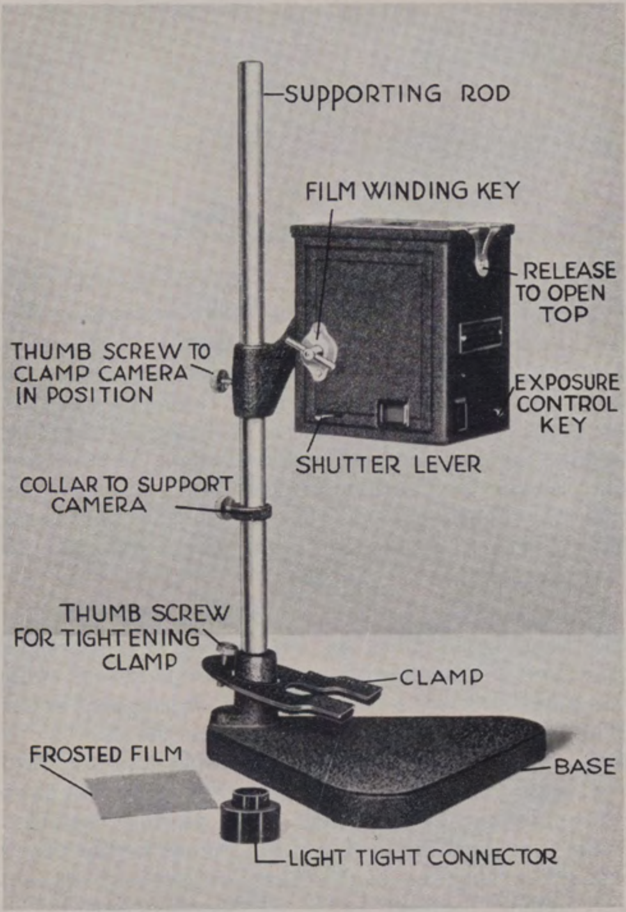
Introduction

ONE of the most interesting phases of working with the microscope is making snapshots of the world it opens up. No explorer into unknown jungles can bring back more exciting pictures than you can from the tube of your microscope. Weird forests and strange monsters roam beneath its lens. The flowers that bloom there are more gorgeous than any seen with the naked eye, and there you will find beasts more fascinating than any found in the hinterland of Madagascar.

Photomicrography, it is called, snapshoting through the magic lens. Once the fascination of it has taken hold, you will never give it up. There is always something new, always a challenge to do better and better. Photomicrography, at its best, tests the skill of the finest microscopist, yet the beginning amateur finds that with surprisingly little experience he can make photomicrographs that will bring gasps of astonishment from both himself and his friends at the beauty and the strangeness of the things they reveal. No one can consider himself a true microscopist until he has made photomicrographs.



Left Side of the B & L Outfit

What Is Photomicrography?

EVERYBODY knows what photography is. But we can divide photography into three parts. First, there are the photographs with which we are all familiar, ranging all the way in size from natural down to the 8mm moving pictures. Then we can go beyond this range to microphotography in which the picture must be examined with a high powered lens. There are microphotographs in which the paintings of the great masters have been reduced down to the size of a head of a pin and mounted on a slide just like any microscopic specimen. They must be examined with a microscope at 50 to 100 diameters, at least. Extremely interesting as these are, their only use is to serve as curiosities. The third class of photography is just the opposite of the other two; the object pictured ranges in size from natural up to several thousand times its actual size. This is called photomicrography. Notice the difference between *micro*photography and photomicrography. These are confused in many people's minds, but the microscopist must never make the mistake of using one for the other.

Why Photomicrography?

OUTSIDE of being an intensely interesting part of a very interesting hobby, of what use is photomicrography? Its primary purpose is to preserve indefinitely for anyone to see the marvelous and varied specimens which we study under the microscope. You look at a specimen through your microscope, you adjust the illumination just so, you focus very carefully and bring out some very important details. Now you ask your friend to look into the microscope and are proud of what you have accomplished. Yet, your friend may not see the same thing that you see. Your only way to be sure of showing him just what you want is to make a photomicrograph and point it out to him.

When the amateur or professional discovers something entirely new under his lens, he cannot run out and call the world in to see what he has found. But he can call in his camera and later show the photographs to all the world, if he wishes. Photomicrographs are a very important part of the records of our advance into the subvisible world. Today the doctor discovers some new bacterium, within a month the whole world knows what the criminal looks like and is on the watch for it. Tomorrow you may suddenly find in a drop of stagnant water a protozoan that has never been seen before. You photograph it and have added your bit to a very important science, but if you had no means of showing it to others far away, it would be something like the fish that got away.

You Will Want an Album

YOUR photomicrographic album is a whole museum which you can keep on your bookshelf. By all means, build up an album. At first, you will want to take photomicrographs of anything and everything. This is very good because you need the experience and there are so many subjects which are too beautiful or strange to miss. Later you will find your interest developing along certain lines and your album will become not only a record of your progress, but also a concrete expression of your ambition. We venture to say that that book will become more valuable to you than any rare first edition.

What Can Be Photographed Through the Microscope?

THE answer to that question is quite simple: Anything that can be examined through the microscope can also be photographed through it. You can make photomicrographs of any of the specimens in your collection, alive or dead, opaque or translucent. Each one of them presents a different and pleasure-filled problem and, remember, each one is a tiny miracle in itself.

Bausch & Lomb Amateur Photomicrographic Outfit

THE photomicrographic outfit which you have just purchased was designed by Bausch & Lomb especially for the amateur. Professional photomicrographic equipment ranges in price from $100.00 all the way up to $1,000.00 or more. Bausch & Lomb knew that the amateur cannot always afford these high prices and, therefore, developed something more simple but adequate for amateur needs. The result is the photomicrographic outfit which you have just purchased. It is modeled after one of the professional equipments.

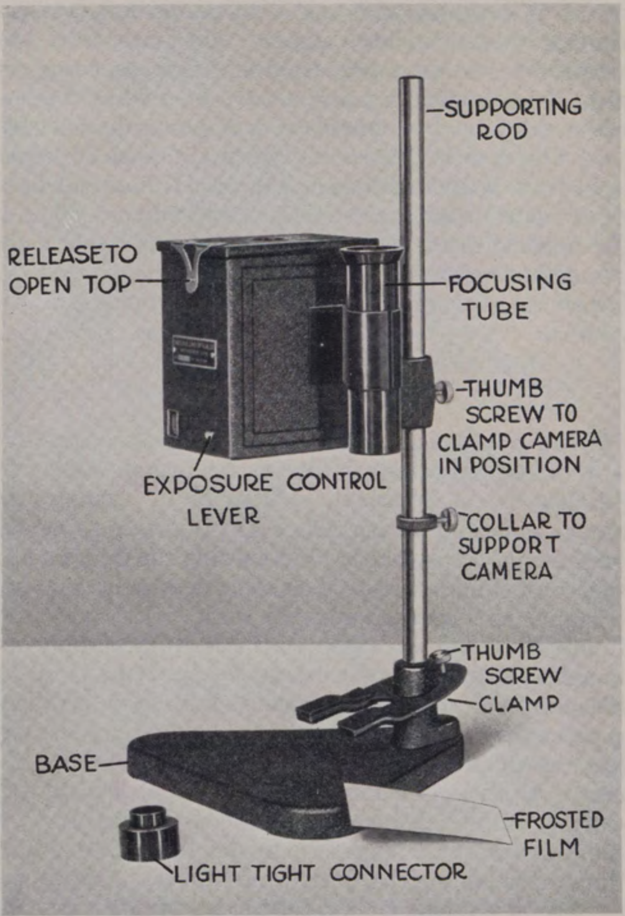
The instrument consists of a heavy, cast metal, triangular base from which arises an aluminum supporting rod. On this rod is mounted the camera. The camera can be adjusted to any height on the rod by loosening the thumb screw of its support and tightening it again when the desired position has been obtained. On the rod there is also a small ring with a thumb screw. When the camera has been placed in the desired position, the small ring is brought directly against the support and the thumb screw tightened so that when the thumb screw of the camera support is loosened the camera will not slip down the rod. Also, attached to the rod down at the base is a metal piece with a thumb screw. The forked part of this metal piece fits around the pillar of the microscope. When the thumb screw is tightened the two prongs clamp down on the base of the microscope to hold it perfectly steady and in the correct position.

Attached to the side of the camera is a focusing tube. In the upper end of this tube is mounted a frosted film disc exactly in the same plane as the film in the camera. At the front of the camera near the bottom is a little metal lever which you can pull out by inserting the fingernail under it. It comes out about ½" and in that position sets the shutter for "time" exposure. When this lever is all the way in, the shutter is set for snapshots (1/25th of a second).

On the opposite side of the camera from the focusing tube is another little lever which controls the shutter. When the shutter is set for a "time" exposure, the movement of this lever will open the shutter, and moving it back again will close the shutter. When it is set for snapshots, one movement of the lever will both open and close the shutter in 1/25th of a second. On this side of the camera there is also the film winding key which can only be turned in the correct direction. The film winding key also serves to lock the film holder which is inside of the camera. To unlock it, the film winding key is turned slowly and pulled out.

At the front and top of the camera is a clasp which when pulled gently toward you allows you to open up the whole top of the camera. You will find immediately inside a piece of frosted film which is used as a focusing screen when cut film is utilized and as a means of determining when the light source is centered. Remove this piece of frosted film and turn the film key, pulling it out so as to unlock it. You can now remove the whole interior of the camera, the part that carries the roll film.

Part of the equipment that came with your photomicrographic outfit is a light-tight connector which looks like two short tubes, one larger than the other, placed end to end. It is made of aluminum and lacquered black. The larger end fits over the eyepiece



Right Side of the B & L Outfit

of the microscope, and the smaller end fits into the shutter opening in the camera. The purpose of this connector is to keep any stray light from reaching the film. The connector must always be used when you are making a photomicrograph or you will find that your film is either streaked or entirely black from the light from your illuminating source. It does not have to fit tightly over the eyepiece of the microscope or in the opening of the camera, but when it is in place the camera and microscope should be adjusted so that the larger tube of the connector is fairly close to the camera.

The Light Source

ANY photomicrographic set-up consists essentially of the following: A film in a film holder exactly parallel to the specimen, a control to regulate the amount of time during which the image is projected on the film, a microscope for enlarging the image and a source of illumination. The light source is very important, but the one for use with your Bausch & Lomb Photomicrographic Outfit is quite simply arranged. It consists of a frosted 100-watt bulb with a reflector behind it. The 100-watt bulb in an ordinary gooseneck desk lamp is excellent for this purpose, and has any number of uses when working with your microscope otherwise than in photomicrography. Lower wattage or higher wattage bulbs can also be used. If the lower wattage is used, it means that the exposure time must be longer. This would do no harm except that there is bound to be a certain amount of vibration from automobiles, street cars, people walking in the house, which will tend to make your photomicrographs fuzzy and the details indistinct. Obviously, the shorter the exposure time the less the vibration has a chance to act, and the better the results. It is well to guard against vibration in any case. This can be done by setting the photomicrographic outfit and the lamp on a thick felt pad. Sponge rubber is also very good. You can buy a sponge rubber chair seat pad and cut it to a convenient size for use under your set-up. On the other hand, too high a wattage is not only expensive, both from the standpoint of the bulb and the amount of electricity consumed, but is also likely to cause the amateur some difficulty, since the exposure time must be very accurately controlled or the film will be over-exposed. For general purposes we recommend the 100-watt bulb, though later you will probably be interested in experimenting with more powerful light sources, such as an automobile headlight bulb which has a more concentrated filament, arc lamp, etc.

If you do not have a desk lamp and do not wish to purchase one, a good arrangement can be made at very little expense. At any hardware store or electrical supply store can be purchased a porcelain socket of the "screw-down" type for 10c or 15c; a reflector, like those used on desk lamps, for 25c; a length of wire for 10c; and a plug for the wall outlet for 5c.

The socket is screwed down on a 4″ square board which can be sanded, stained and varnished if you desire. The wire is attached to the two connections and the plug attached to the other end of the wire. The reflector is now placed over the porcelain socket, the two clamping screws tightened. The bulb is screwed in and the lamp plugged into a convenient light source. Using this type of lamp it will be necessary to raise the entire photomicrographic outfit so that the mirror of the microscope is approximately in line with the center or the round part of the bulb. Of course, it is quite possible to make this one complete wooden base with a thick piece of wood screwed to one end to raise the photomicrographic equipment to the desired height.

What Film Should Be Used?

THE camera of the Bausch & Lomb Photomicrographic Outfit is a standard Brownie No. 0. With it you can use Eastman film No. 127 or Verichrome film V-127. When exposed this roll of film can be taken to a regular commercial developer the same as if you had made ordinary snapshots. However, this takes some time and it is necessary to wait until the entire roll is exposed before you see your results. Professional microscopists use cut film—flat celluloid film, or plates—glass negatives. These can be used in the Bausch & Lomb Photomicrographic Outfit also.

There are many advantages to using these types of negatives. In the first place, you yourself can develop it immediately after exposure and within fifteen minutes know just what kind of photomicrographs you have made. If it does not suit you, you can then take another one, changing the conditions to improve the quality as you see fit. Also, by the use of cut film you can take advantage of the more sensitive emulsions, such as panchromatic, which registers colors in their true intensity, whereas other films print blue and other colors at that end of the spectrum as lighter than they really are in the specimen. Panchromatic film is somewhat difficult to handle since it is sensitive to the red rays of light used in the ordinary dark room lanterns. It must be handled in entire darkness both before and after its exposure, unless you have the special safelight (dark green) for these negatives. However, it is a favorite film of both amateur and professional photographers and you can very soon get used to its manipulation.

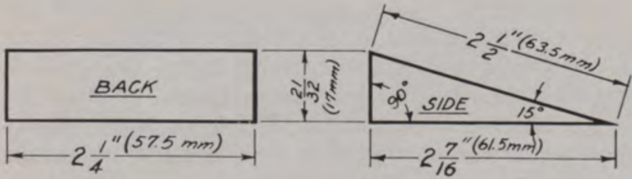
Details in regard to doing your own developing and printing are given later in this book.

If you decide to use individual film instead of the roll film, we recommend the celluloid negative. It can be purchased in different sizes and types of emulsions, does not take up much space in filing and does not break. This film cannot be purchased already cut to the size for use in the Bausch & Lomb Photomicrographic Outfit. It is a relatively simple matter, however, to purchase a larger size film and cut it down to size. The size necessary for this outfit is 2¼ x 3″. The film should be cut in a darkened room. The light of a developing safe lamp can be used to furnish illumination. Cut out a piece of black paper to the correct size and use this as a guide. This black paper should be used afterwards to place on top of the film when it is in the camera to protect it from any light coming through the little red window. Cut film rests emulsion side down in the top of the camera.

Some workers may find it possible to take the ordinary roll film and cut it into the correct sizes. The difficulty is that roll film is a much lighter celluloid than the cut film and will ordinarily curve in the camera so that it is almost impossible to obtain a perfect focus.

Making Our First Photomicrograph

AND now we have our photomicrographic outfit, microscope, film and light source. For our first specimen let us choose something that is fairly transparent, such as an insect wing. A fly's wing is excellent with which to start. If you do not have a fly's wing permanently mounted on a slide, it is quite easy to make a temporary mount. Kill a fly and pull off one of the wings with tweezers, holding the wing at the base so as not to crush its delicate structure. Place this in the center of a clean glass slide and put a small drop of glycerin on it. Over this drop a clean cover glass. If there are any air bubbles directly over the wing, it will



Dimensions of Wooden Wedge Used Under the Base of the Gem Microscope

be necessary to press the cover glass very gently with a pencil so that these are squeezed out at the side. Do not press the cover glass unless necessary.

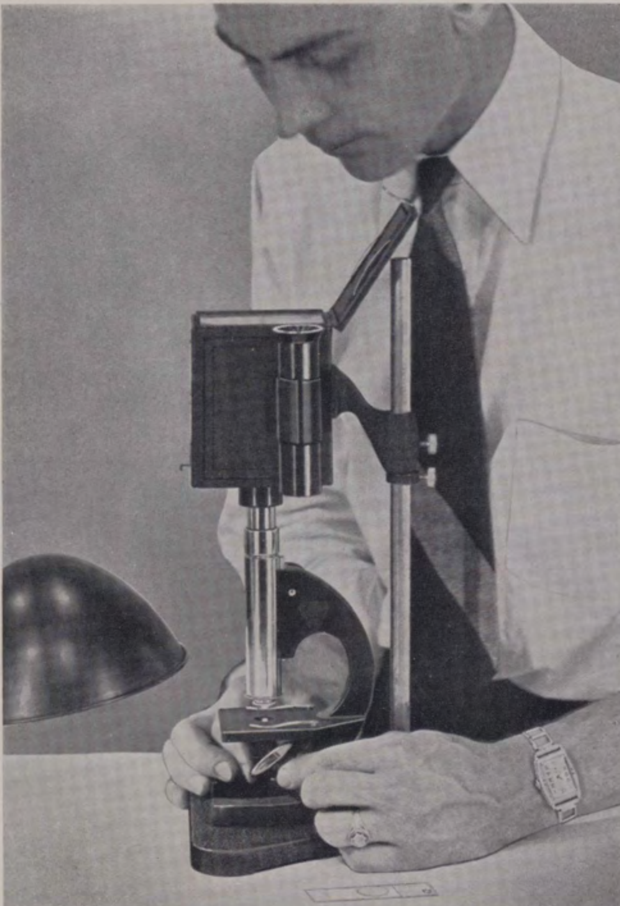
If your microscope is a Bausch & Lomb New Gem, it will be necessary to cut a wedge shaped piece of wood to place under the base and bring the body tube to a vertical position. The New Gem body tube is permanently inclined for greater comfort in use. An ordinary "Ruby" eraser can be used, but it is much better and more accurate to have a special wooden wedge. The dimensions of such a wedge are shown in the figure above. For appearance's sake it should be sand papered smooth and painted black.

Set your photomicrographic outfit on the table with the front of it facing your right. In this position it should also be facing away from the window, if you are working in the daytime. Now place your microscope on the base of the photomicrographic outfit so as to bring the forked clamp around the pillar of the microscope. Place the light-tight connector over the eyepiece and adjust the body tube so that it is approximately in focus, though as yet you have no specimen on the stage. Now loosen the thumb screw of the camera support and bring the camera down so that the light-tight connector fits into the shutter opening of the camera. Again tighten the thumb screw to hold the camera in this position.

Bringing the microscope into position before clamping to base

Draw out the time exposure lever and click the shutter open.

Bring the light source up to about six inches from the mirror of your microscope. You are now ready to definitely line up the camera and the microscope. Open up the top of the camera and lay the piece of frosted film in the opening, frosted side down. Adjust both the mirror and the microscope until the spot of



Adjusting the illumination

light coming through the instrument is centered on the film. The mirror should be adjusted until the field seen on the film is even and as bright as possible. When this adjustment has been completed, turn the thumb screw on the clamp to the right until it is holding the microscope firmly in place. Be sure not to disturb the arrangement of your light from here on.

At this point we will load the camera with film. Let us assume that you will first use regular roll film. Turn the film winding key slowly and pull it out. This will release the box-like film carrier which can then be removed entirely from the camera.

You will find that one side of this carrier is stamped with the word "Top."

Place film carrier on the table with large opening at the top and with the side marked "Top" toward you. The empty spool should be in the metal brackets to the left with the slotted end of the spool toward you. The roll of film is to be placed in the bracket on the right of the carrier. Swing out the hinged metal bracket on the side and insert the end of the film spool in the other bracket, then swing the hinged bracket back in position so that the end of the film spool fits in the hole of the bracket.

The film roll must be held so that when the seal of the roll is broken the paper leader will unroll from the bottom and to the outside. Bring the paper leader up over the large opening of the film carrier so that it runs between the guides. Insert the tapered end of the paper into the larger slot of the empty spool. Turn the spool to the left a few times to hold the paper securely. The red side of the paper leader will be to the outside if the film has been put in properly.

The spools are held in place by metal brackets. The two brackets on the side of the film carrier marked "Top" are hinged to permit putting in or taking out the film spools.

First step to put in roll film

The film carrier can now be put back in the camera, the top closed and the film winding key again turned slowly and pushed in until it slips into place. Keep turning the film winding key until the numeral "1" shows in the little red window at the top.

Second step to put in roll film

Now we are ready to focus on the specimen. Center the specimen over the opening in the microscope stage. Loosen the thumb screw of the camera support and swing the focusing tube over and bring it down on the light-tight connector. The disc in the focusing tube

Focusing with the focusing tube when roll film is used will naturally not give you a view of the whole specimen which will eventually appear on the film, but it is adequate to allow you to adjust the microscope for detail of the specimen. Detail is the important thing in the photomicrograph. For instance, in a fly's wing, you will wish to bring out as sharply and clearly as possible the little hairs that cover it.

When you have secured the exact focus, bring the ring up the rod against the camera support and clamp it tightly in place. You can now move the camera up and swing it around in place over the microscope. If the camera support is resting on the ring, your film will be in exactly the same plane as the disc in the focusing tube. In other words, your specimen is now accurately focused on the film. You are already for the exposure!

Making the Exposure

EXPOSURE is just as important in photomicrography as it is in regular photography. And as in regular photography the only true guide to the exposure time is experience. However, this does not mean that you will not get good results right away. We have compiled some tables after numberless experiments which will help you a great deal. You will find that in a very short time you will be quite expert in judging the exact amount of exposure to give each specimen to bring out the details you want.

To understand what causes the variation in exposure we must know something about what happens when we make the photograph. The negative is celluloid or glass, coated with gelatin, through which there is evenly distributed little particles of a silver compound. Now, no one knows exactly why, but when light strikes these little particles of the silver compound, something happens so that when the film is immersed in a certain chemical solution, called the developer, this silver compound changes and leaves tiny particles of pure silver. Pure silver in its powdered form is black, not shiny as it is in a fifty cent piece. If we now put the film in another chemical solution called the hypo bath, all of the silver compound that was not touched by the light will be dissolved out of the film entirely, but the pure silver will not be affected.

So you see that if only a little light strikes a certain portion of the film, there will only be a few silver particles there, and if a lot of light reaches it, there will be a dense mass of the black silver. On the other hand, if no light reaches it at all, there will be nothing on that portion of the film but the clear gelatin when we have finished.

The film is the negative. That is, wherever there were white or clear parts on the subject, there are black parts on the negative, and where there are black parts on the subject there are light areas in the negatives with different gradations of gray in between. To make the finished picture, or print, as it is called, we practically repeat the process. The negative is laid against another film, which this time is on paper, and exposed to light. Where there were many silver particles in the negative the light will be cut off and so the silver in the print will not be affected. Where there were few or no particles of silver in the negative, the light will pass through easily to the print.

It all depends upon how much light strikes each particular little particle of silver compound in the film. There is one other thing—the "sensitiveness" of the film to color. Normally the silver compound in the

Making the exposure

film is only sensitive to blues and violet, but the film manufacturers have found after long experimentation that by adding certain dies to the gelatin which holds the silver compound, they can make it sensitive, in varying degrees, to the other colors. Thus, Panchromatic film is sensitive to all colors almost exactly as is the human eye. But the more common films are most sensitive to blue and gradually decrease as the red end of the spectrum is approached. This matter of sensitiveness of the negative to color is somewhat confusing to the average person, since if the *negative* is not sensitive to red, the final *print* will show red as a deep black, whereas blue, to which the negative is very sensitive will appear white. But it is easy to see why the sensitivity of the film to color is important. We do not ordinarily make colored photographs. The only way we have of interpreting the color is by accurately registering its *intensity*—dark blue or light blue, for instance—in tones of gray or black or white. In photomicrography if you had a specimen nicely stained with colors other than blue, you would be disappointed to see the detail reproduced all in deep black instead of various tones of grays in the final print. It is for this reason that we recommend Verichrome film or its equivalent above ordinary film, and Panchromatic film above all, if you feel that you can handle it.

Every specimen presents a different problem as to how much light it will allow through to the film. This specimen may be mediumly translucent and be fairly easy to judge. The next one is extremely transparent and we must be very careful of over exposure. There is just as much danger of over exposure in quite opaque objects also, since in trying to get the light through the opaque part, there is danger of allowing too much to go through the more transparent sections. That would be all right if the light confined itself to the transparent parts on the film, but unfortunately it has a tendency to spread beyond them and affect the silver particles all around. The result is that not only are all the details "burned" out in the more transparent parts, but the opaque parts will have fuzzy, indistinct edges, and sometimes great spots of light reaching out over them.

Two other factors influence the exposure time of the Bausch & Lomb Photomicrographic Outfit. One of these is a filter which we shall go into further on. The other is the amount of magnification. This last factor has been worked into the table for the Bausch & Lomb Model R and the New Gem Microscope. It can be figured, without much difficulty, for other microscopes. It is simply a matter of the higher the magnification the longer must be our exposure time.

This uncertainty about exposure time is what makes photomicrography such a pleasure. If anyone could put a microscope and camera together and snap a picture and have an excellent photomicrograph, you would soon get tired of it. But when there is a chance to make a photomicrograph better than the other fellow, and by your own skill and experience you can bring out details scarcely visible to the eye itself, it becomes an absorbing pastime, furnishing you hours of enjoyment.

Exposure Tables

THE exposure factors for the Model R Bausch & Lomb Microscope are given in Table I, and for the Gem Microscope in Table II. If you have some other make of microscope, you can work out a table similar to these by following the same procedure as outlined below. First of all, let us see how to use these tables. We will assume that you have a Bausch & Lomb Model R Microscope. On its draw tube are noted the magnifications with one or two objectives. These are referred to in the first column of the table. In the next column is given the magnification on the film when the microscope with one objective has the body tube set as noted in the first column. In the third column is the exposure factor. The same data

TABLE I

Table of Magnifications and Corresponding Exposure Factors for Model R Microscope

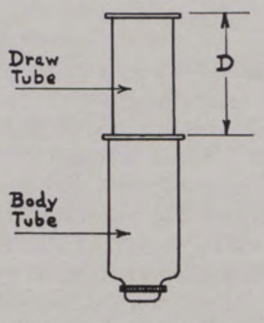
Magnification engraved on Draw Tube of Micro.	Single Objective		Double Objective	
	Magnification on Film	Exposure Factor	Magnification on Film	Exposure Factor
75 150	30.0×	(*Standard*) 1.0	60.0×	4.0
100 200	40.0×	1.8	80.0×	7.0
125 250	50.0×	2.7	100.0×	11.0
150 200	60.0×	4.0	120.0×	15.5

TABLE II

Table of Magnifications and Corresponding Exposure Factors for GEM Microscope

*D	Single Objective		Double Objective	
Measured in milli-meters †	Magnifica-tion on Film	Exposure Factor	Magnifica-tion on Film	Exposure Factor
5.0 mm	37.0×	1.0 (*Standard*)	79.0×	4.6
10.0 mm	38.0×	1.1	80.0×	4.7
20.0 mm	42.0×	1.3	87.5×	5.6
30.0 mm	47.0×	1.6	93.3×	6.4
40.0 mm	51.0×	1.9	107.0×	8.4
50.0 mm	56.0×	2.3	115.0×	9.7
60.0 mm	60.0×	2.6	120.0×	10.5
65.0 mm	62.0×	2.8	125.0×	11.5
70.0 mm	65.0×	3.1	133.0×	13.0

*How to measure "D"



† There are 25.4 millimeters to the inch

is given in the next two columns when the microscope has the second objective added. The exposure factors do not refer to any particular amount of time. That is, 1.0 does not mean one minute or one hour. What it means is simply this: if we photograph with the Model R a certain specimen at the lowest magnification and find that best results are achieved with a three-second exposure, three is substituted for 1.0. Then if we go on to make a photograph of that specimen, or one very similar to it, at a magnification of 60X (on the film) it would take just four times as long, or twelve seconds (4.0 times 3 seconds), since four is the exposure factor for 60X magnification according to the table. If we wanted to photograph it at 100X, it would take eleven times as long, or thirty-three seconds, since the exposure factor is eleven. If, when working with these tables, you figure out an exposure time that comes to a fraction of a second, such as 2.7 or 12.7, do not think that you immediately have to purchase a stop watch to check up on it. The exposure times are not quite as critical as all that and, if under ½ second, drop the fraction, if over ½ use the next larger figure. Of course, when you are making very short exposures such as 1/25 of a second, a half second will make a lot of difference, so the shutter on your camera is automatically set to open and close in 1/25 of a second.

But how was the original three-second exposure determined above? This was merely a matter of trial and error. As you grow more experienced the number of trials you will have to make will grow fewer and fewer. If you are using roll film, the first film should be exposed with the microscope at the lowest magnification and an exposure time which you judge to be too short. Leaving all the conditions just the same, you bring the next film into place and expose it for twice as long; the third picture four times as long as the first; and the fourth picture eight times as long as the first. To use the rest of the film, choose a different specimen that presents different conditions, such as greater density, stain or whatever you would be uncertain about, and go through the same process. When these are developed, possibly no one of them will be perfectly exposed, but you can judge in between which two exposure times the correct time lies, and then make the final exposure for that time.

It is much better to use cut film for these trial exposures, as a saving in both time and expense. You can cut the film in half, or even a narrow strip, to make the trial exposures, and develop each one yourself directly after using it. Professionals use this method. Do not think that it is just because you are an amateur that you have to do these things. Even professionals of long experience must make trial exposures, although their trials are usually cut down to only one or two.

This also illustrates the importance of making notes of whatever you do in photomicrography. If you trust to your memory your gain in experience will be a long, tedious and somewhat expensive procedure. Write down immediately every condition affecting the photomicrograph. For this purpose a small card index file, using a card similar to that shown on page 42, which can be bought at any stationery store, or a loose-leaf notebook should be an essential part of your equipment. A month from now you will have forgotten the exact exposure time and several other things which resulted in your getting a very good photomicrograph of a fly's wing. But a month from now you may wish to make a photograph of a bee's wing. It would be somewhat foolish, would it not, to have to go through the whole procedure of trial and error again? But if you have a notebook or card index, you merely have to look up a fly's wing, duplicate the conditions and the very first picture you make will be just as you want it. Remember, also, that one slide may closely resemble another and offer much the same photographic conditions. If you have made a photograph of an opaque crystal slide, you can refer to it if you with to make one of silk cloth, and so forth.

Exposure Tables for Other Microscopes

AS was said above, if you have another type of microscope besides the Model R or New Gem, you can make out tables similar to those above.

The magnification of your photomicrograph is in proportion to the distance between the eye point of your microscope, a point a few millimeters above the top lens of the eyepiece and the camera film. This distance in your photomicrographic outfit is 4.1 inches. From these facts we can set down a formula:

$$\text{Magnification at the film} = \text{Magnification of the Microscope} \times \frac{\text{Distance between Eye Point and Film}}{10}$$

Supposing you have your microscope arranged to give a magnification of 75×, then:

$$\text{Magnification at the film} = 75 \times \frac{4.1}{10}$$

Dividing 4.1 by 10 and multiplying by 75, we get a figure of 30.75. In other words, the image on your film is 30¾ times the size of the specimen; call it 31 times to make it a round number. In this manner you can fill in your magnifications in the second and fourth columns of a table similar to the ones given.

Now to figure out the exposure factor. Put down in the exposure factor column opposite your lowest magnification the numeral "1." This is your standard exposure for any particular type of specimen. As explained above, it might be three seconds or three minutes; you can only find out by trial and error. Now divide your next highest magnification on the film by the lowest magnification on the film. Multiply the answer by itself (if the answer is 2, multiply by 2) and the result is your next exposure factor. Do this for each magnification in turn—divide it by the lowest magnification and multiply by itself, (that is, "square," the answer). This table will serve for any of the usual amateur microscopes.

When you are working with a standard laboratory instrument something else enters into your figures. On a standard laboratory instrument you increase your magnification by changing to a higher power objective or eyepiece. These objectives have, as you know, different numerical apertures. The numerical aperture of each objective is usually engraved on it, N.A. 0.85, etc. Given below is a table to follow if your microscope is one of the standard laboratory makes.

The effect of the N.A. of an objective is such that as one objective is substituted for another, the exposure varies as the reciprocal of the square of the N.A. That is, *Exposure varies as* $\frac{1}{(N.A.)^2}$. The following tables give the approximate exposure factor for the most generally used type of microscope objectives. These factors will hold as long as the objective is worked at full aperture. The 16 mm objective is taken for the standard with a factor of 1.

Equivalent Focus of Objective in mm.	Numerical Aperture	Exposure Factor
16	0.25	1.0
8	0.50	0.25
4	0.65	0.15
1.9 oil im.	1.25	0.04

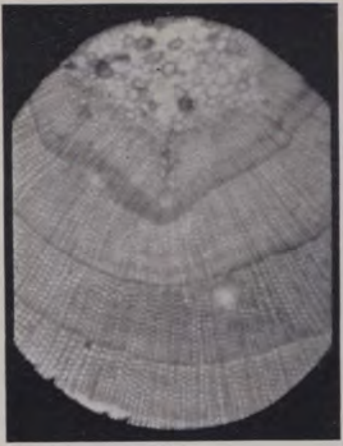
This is true when an observation is made by looking through a pin hole held over the eyepiece tube (eyepiece taken out) shows the back lens of the objective to be filled completely with light. If a substage diaphragm is used to reduce the aperture part way, then it is necessary to estimate the portion of the aperture in use and allow for that variation in the exposure.

The various factors governing the exposure may be tied up in a formula, which may be used to compute new exposures with different conditions after a standard exposure is found.

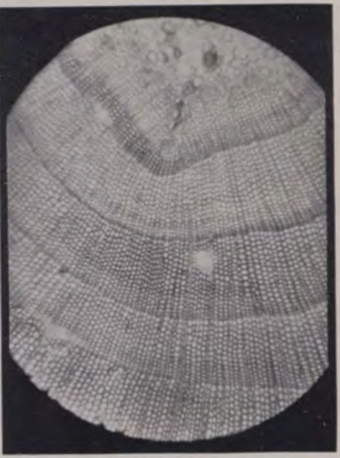
New Exposure Time = Standard Exposure × filter Factor × N.A. Factor × Magnification Factor. The eyepiece for a standard microscope affects the magnification only and knowing the magnifications given visually by the microscope (product of objective magnification × the eyepiece magnification) the magnification at the film in the camera can be determined as explained previously.

Filters

MOST microscopes, except the very expensive ones, are not perfectly correct for what is called "chromatic aberration." Chromatic aberration sounds formidable, but in reality it is quite easy to explain.



Without Filter



With Filter

You know that white light is made up of many different colors. Each one of these colors has a particular wavelength. As the white light passes through a lens the difference in wavelengths bends each at slightly different angles so that they come to a focus at different points. This results in fuzzy color fringes around the edges or around separate points in the specimen. Now, if we only allow light of one color to pass through the specimen and up to the lenses, we automatically eliminate this chromatic aberration. We use a filter for this purpose.

It might be supposed that, since the film is normally sensitive to blue, that a blue filter would give the best results in photomicrography. However, a blue filter is not the best choice for most specimens. If you wish to buy but one which will give the best results in general with most specimens, a yellow green filter should be obtained. This color gives a very sharp image, both for visual work and in photomicrography.

A filter of this color is used extensively in photography and is known as a Wratten "B" Filter. It can be purchased from your photographic supply store. All that it is necessary to do is to lean it up against the stage between the mirror and the source of light. Filters, of course, considerably lengthen the exposure time, but it is well worth while, considering the much better results achieved. Information on complete sets of filters can be obtained from Bausch & Lomb.

Examples of Good and Bad Photomicrographs

IF a professional were to show you two photomicrographs of the same subject and ask you to pick out the best one, you would almost invariably pick the poorer of the two. This is not any reflection on your judgment, but serves to indicate the fact that there is quite a difference between ordinary photography and photomicrography. We must remember that in photomicrography our purpose is to get on the film every little detail in the specimen. When such detail has been achieved, the final print usually looks indistinct at the first glance, whereas the poorer photomicrograph has a good deal of contrast and looks much sharper until carefully examined. Therefore, when you make a photomicrograph, look for some parts in the print in which there are lines or dots in the structure lying very close together. If these appear well separated and sharply defined, you have a good photomicrograph.

Another thing to look out for is the ridges or depressions in the specimen. These should be recognizable as such.

We are printing on pages 35-37 a number of photomicrographs which show the major faults. These have been purposely exaggerated so that the results of incorrect technique will be easily seen. When you come to make photomicrographs these different faults will not be quite so apparent, but if you look carefully, you will see them in a much smaller degree. Of course, you understand that the pictures shown must be interpreted through the printing screen, which is made up of a great number of dots which will not be seen on your film.

Number 1. This is an under-exposed negative. The detail is fair in the thin parts of the leaf, but the thicker part of the cluster is lost in a black mass. This is what is meant by too much contrast.

Number 2. This shows how the detail is "burned" out in an over-exposed negative. Details in the thin part of the leaf are entirely gone, but are seen in the thicker parts. Of course, this may be desirable in many instances. Usually, however, it is possible to get good detail in the more transparent parts and some detail in the very opaque sections.

1

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3

4

Number 3. Here is the correct exposure of the same specimen. It is a very good reproduction of the original subject, which is the ultimate end of photomicrography.

Number 4. It is easily seen that the illumination is off center in this photomicrograph. It has been exaggerated here beyond what will probably happen to you in actual practice. You will see how it completely changes the appearance of the specimen, giving an untrue picture.

Number 5. A blurry print like this is immediately recognizable as an out-of-focus negative. In focusing be very careful to get sharply the more important parts of the specimen since in thick structure these may lie either above or below the rest. The unimportant parts would be slightly out of focus, which would not matter.

Number 6. All of the above pictures were taken with a Wratten "B" Filter. This picture shows the specimen taken without the filter. Note the fuzzy appearance near the edges and the thicker parts of the cluster. Especially note in this thicker portion that it seems to be somewhat out of focus. If you have read the section on filters, you know what causes this.

Photographing Living Specimens

ALL your ingenuity will be needed to get good photographs of the little creatures which dart about so swiftly under your lenses. We will attempt to give you a few hints here, but in the long run you will have to think out your own solution, since each specimen presents its own particular problem.

Three things are necessary in making photomicrographs of the specimens we include under the general term of "pond life"; a powerful light source, a quick exposure and a good deal of patience. However, the game is well worth the candle. For some reason or other, it seems more worthy of one's skill to make a

5

6

picture of these elusive little creatures alive than if they were laid out dead in a permanent slide so that you could do with them as you please. As a matter of fact, these photomicrographs are only satisfactory for special purposes and do not show the detail as well as a good stained specimen mounted in clear balsam or other medium. But, you should certainly try them and realize what a broad scope of technique they allow, especially in illumination.

It is possible to slow down your specimens so that you can take them under somewhat longer exposures than if they were swimming freely about in their native water. There are a number of means of doing this, some working better on one specimen than on another. The most convenient to use are anaesthetizing with menthol or thickening the medium in which they are swimming with a jelly.

For the first, purchase ten cents worth of menthol crystals at the drug store and place a tiny one of these in the water at the edge of the cover glass, where it will not be in the way when you come to make the pictures. Watch the results carefully to see if you need more menthol, or have to make a new slide, and use less. About fifteen minutes can be taken as an average time in which the menthol should act on larger specimens the size of Paramecium or greater. When last examined before swinging the camera into place, some movement should still be detectable.

Gelatin is excellent for slowing up the movement of the larger organisms. It simply makes the medium in which they are swimming too thick for them to go very fast. Pond life in general will live in it for an hour or more if you do not make it too thick. It is quite easy to make at home, and a quantity of it will keep well in a tightly corked bottle. You will want it for your regular visual study as well as photomicrography.

To make this jelly, soak a quarter of a teaspoonful of ordinary unflavored gelatine that is used for making desserts in about two teaspoonfuls of cold water for ten minutes. Pour over this a cup of *boiling* water and stir until all the small particles are dissolved. Allow to cool and pour into a bottle.

There are numerous other methods of slowing down micro organisms for study and photomicrography, but they require the use of drugs not generally available to the amateur. If you are interested in these other methods, refer to Lee's "The Microtomist's Vade-Mecum."

The Photomicrography of Opaque Objects

PHOTOGRAPHING opaque objects offer unlimited opportunities for you to exercise your own talent. Opaque objects, of course, must be lighted from above. The mirror, as usually positioned below the stage of the microscope, is not used at all. The Bausch & Lomb amateur microscopes are so designed that the mirror may be taken out and placed in the hole in the arm above the stage to reflect down upon the object. This is not always true of other microscopes so that different arrangements must be made. Professionals use a special lamp which focuses a very sharp beam. They also use a regular microscope lamp with very high power bulb and focus a beam with, what is known as, a bull's eye condenser. These bull's eye condensers are simply double convex lenses, mounted in a stand, which allows their adjustment in any way desired. They are the same as a reading glass which you focus in the sun on a piece of paper to make it burn. There are also other arrangements for standard microscopes which reflect the light right down through the objective or have a ring of light just above the object.

The amateur, however, can get good results by using one or more lamps and perhaps a mirror. Pocket mirrors, such as those sold in the Ten Cent Stores, can be mounted on stands to allow them to be adjusted.

Things to remember in providing your illumination for opaque objects is that it must be very bright in comparison to the light used for translucent specimens. All of the light that gets into the camera is that reflected from the object itself. Opaque objects almost always require extremely long exposures.

In arranging your illumination for opaque objects, examine the specimen first through the microscope itself and not through the focusing tube. Shift your lights around so as not to have too deep a shadow and yet some shadow to bring out the various contours. The idea to be followed is that details shall be quite plain in the shadows, as well as in the more brightly lighted part.

Developing and Printing Your Own Films

YOU can, of course, simply take the roll of film out of the camera down to the drug store or photo supply shop and they will develop and print it for you. However, the usual commercial staff is used to only the regular run of snapshots and aren't likely to give you the results you require when developing and printing your photomicrographs. Naturally, these people cannot be expected to know the criteria which you follow in your scientific hobby. For better results, saving of money in the long run, convenience and greater satisfaction from this phase of your hobby, develop and print your own film.

It is really very simple, and the outfit required is comparatively inexpensive. The work can be done in the kitchen, the basement or the attic—any place that can be thoroughly darkened, either temporarily or permanently. It is not absolutely necessary that running water be handy, though it is very convenient. Gas is not used and for light, you can simply run a wire over from the nearest socket.

A dark room can be made in the basement or attic of wall board nailed to a frame of 2″ x 4″ 's. Also, wires can be strung from which to hang heavy cloth to form the walls. The small fruit cellar found in the average home is not used for storage of preserves and fruits today as it used to be. This makes an excellent dark room. But it is not necessary to go to so much trouble if you do not want to. Simply cut pieces of heavy cardboard and hang them by hooks over the windows. A strip of heavy cloth, felt or velvet can be thumb-tacked around the edges to close any small cracks.

The tray system of developing is recommended for the amateur photomicrographer. All the materials can be bought in a complete set from your photo supply dealer. Once the set is bought, the only things needed for future use are a few chemicals, which are extremely inexpensive. The essentials necessary are a developing solution and a suitable pan or tray; a means of timing the developing process (watch, alarm clock or other type of clock); a pan or tray of water for rinsing the film after developing; a tray filled with the "hypo" or "fixer"; a means of drying the film; printing paper, frame for holding the negative in contact with the printing paper and an ordinary lamp such as a gooseneck desk lamp.

Developing

LET us go to work with our equipment. You have exposed your roll of film or a single piece of cut film in your photomicrographic outfit. This film is coated with an emulsion of silver bromide grains suspended in gelatin, as was explained before. If this exposed film is placed in a solution known as a developer, a chemical reaction takes place. Where the light has reached the film the chemical action deposits silver particles in the gelatin, producing a black area. The blackness or density varies with the

FROM THE LIBRARY OF J. W. BRANDT — File: *H*

635 St. Paul Street, Rochester, N. Y. — Card No. *8*

Date *4-7-34*

Subject: *House Fly Wing*

Magnification: *40X.* **Microscope:** *B & L Model R*

Objective: *Single* **Eyepiece:** *Drawn out to 100X mark*

Light Source and General Remarks on Illumination: *100 watt frosted bulb in reflector, 6 inches from bulb to mirror*

Filters: *Green* **Type of Negative:** *Verichrome* **Exposure:** *15 sec.*

Remarks *Focused to show base of hairs and frame work of wing. Print on medium paper. Print exposure 5 seconds, 40 watt lamp 10'' from paper. Negative No. 138.*

Suggested Form of Card for Filing Notes amount of light which reached the film at that particular point. We find now that the bright and dark areas of the image in the camera have been produced on the film, only in reverse order.

To carry out this first step in developing you must have a tray, pan or dish to hold the developer. This can be a regular photographic tray of glass, enamel, composition or hard rubber, or we can use one of the various kitchen pans of enamel or glass construction. Preferably these should be of rectangular shape, at least one inch deep, and the other dimensions about 4 by 5 inches. A tin or other plain metal pan should not be used, since the chemical action of the developer will corrode them and spoil the solution. It is possible to make a tray out of heavy cardboard and then soak it in melted paraffin until it is water tight. Shallow cardboard boxes can be used for this.

There are a number of different kinds of developers, but to start with we would suggest that you try one of those already mixed and sold in glass tubes by photo supply dealers. One tube will mix with eight ounces of water to make a solution enough to develop a couple of rolls of film or the equivalent in cut film. Full directions are given with the tubes of developer as to the temperature of the water in which they should be dissolved and the length of time in which the film should remain in it.

This time is usually about four minutes and should be as accurate as possible. Therefore, have on hand your watch or alarm clock.

All of the work of developing and printing is done by the light of what is called a safelamp. This is a small lamp which can be bought from your photo supply dealer, having special red filters which will furnish enough light for you to work in the darkroom, but still will not harm the negative. When you are ready to go to work, turn out all the lights except the safelight and remove the piece of cut film from the camera or from the box in which you put it after exposing it. Immerse this piece in the developing solution quickly and evenly, noting the time. Handle negative by the very edge and keep the emulsion side up in the trays. During the time of development the tray should be rocked continually so as to wash the solution about over the film. After it has been in the developer the proper amount of time it should be removed to a tray of clean water. This tray should be fairly large and can even be one of the usual round, white hand basins. If there is running water in your darkroom, so much the better. Run a light stream of cold water from the faucet over the film for a couple of minutes until it is thoroughly rinsed.

Now the exposed portion of the film has been taken care of and we want to remove the unexposed portion. This is done in the hypo or acid fixing bath. A pound package of hypo can be bought from a photographic supply dealer for about 25c and will make a half-gallon of the solution. This is offered plain or accompanied with a box of acidifier. Purchase the latter at least until you become more familiar with the whole process. The hypo solution lasts for a considerable time in use and that part of it not used will keep indefinitely. Have one bottle in which you keep the unused hypo solution and another into which you can pour the used solution when cleaning up your bench after work. You can tell when your hypo solution is getting worked out by the milky appearance it gives to the film or by sediment in the bottle. When that happens, pour out the old hypo and transfer the film to some fresh solution.

Place the hypo solution in a tray similar to that used for the developer and immerse the film in it so that it is entirely covered. After a minute or two you can turn on the light, since the unexposed portion of the film is practically all dissolved by the hypo. When all unexposed parts of the film are clear the film is "fixed."

Remove the film to a tray of clean cold water for a final rinsing. Change the water every ten minutes and move the film about occasionally so that every trace of the chemicals used previously will be washed away. If possible, place the pan in a sink or washtub so that you can have running water in the pan all the time. A thorough rinsing requires at least one hour.

There are a number of different devices for drying film. A piece of wire can be strung in some convenient place, and with the spring type of clothes pin holding the film by a corner, it can be strung along this wire. To keep roll film from curling up fasten a small block of wood across the lower end with thumb tacks. A slight draft will hasten the drying, but never use heat as it will melt the gelatin and make it run.

Roll Film

DEVELOPING roll film may seem awkward at first, though it is really quite easy. Roll film is wound with a piece of paper to protect it from the light. Turn off all the lights in the darkroom except the safelight. Hold the roll in one hand and the paper with the other hand. Slowly unroll until the film appears. Now take hold of the film itself and continue to unroll until you come to the place where the film is glued to the paper. Separate the glued end gently and set the film spool and paper aside. The film will naturally curl up into a cylinder since the gelatin is quite stiff. To make it easier to handle and to guard against the gelatin cracking, immerse the whole film in water. Take hold of the free end of the film and pull it up and then allow it to roll back. Repeat this two or three times until the emulsion has softened enough to keep the film from curling up.

Extend the film full length, holding one end in each hand. Let the water drain off and then dip one end

Developing roll film: method of holding film while running it through the solutions in the developing solution. Now lift this end, allowing the rest to pass through the developer. Thus you can cover the whole roll of film in a very small size pan. The film is allowed to fall in the shape of a U with the lower end of the U in the solution. The right end is pulled up while the left end is let down and back again. This is done in even strokes so that all parts of the film remain in the solution the same amount of time, and is continued until the end of the proper developing time. Allow the developer to drain off and rinse the film in clean cold water by the same process. The film is then run through the hypo solution two or three times in the same way, until you are sure that it is well covered. It is then allowed to fold over until it is completely immersed in the hypo solution. There should be no definite creases in the film, of course. You can now turn on the light, but leave the film in the pan for five or ten minutes longer to allow the gelatin to harden well. A hardening agent is present in the fixing solution. After fixing wash the film in gently running water or in water that is changed every ten minutes for an hour, and then hang up to dry. When it is dry the film is ready to print and is cut up into the single picture sizes.

Printing

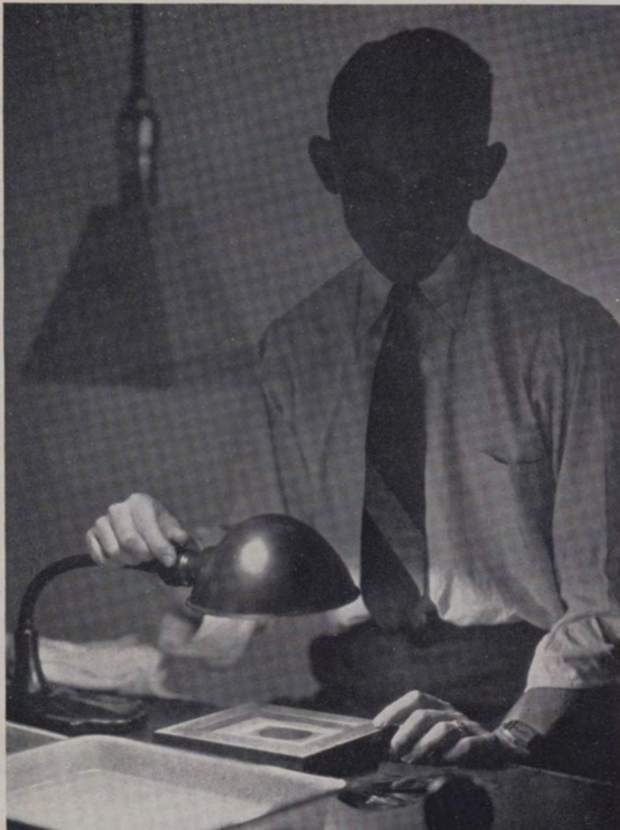
FILM is the reverse of the object; light areas are dark and dark areas are light. It is for that reason that it is called a negative. To get a true representation of the object we must now, in effect, make another film. This is called printing, and the main difference is that the "film" is now paper instead of celluloid or glass. This paper is coated on one side with the sensitive emulsion. With a printing frame we hold the film against the paper and allow light to pass through the film to the paper. The black areas of the film will not allow much light to pass and therefore that part of the paper is unexposed, while the more transparent areas will allow a good deal of light to pass and affect the emulsion on the paper the same as it did on the film.

A printing frame is much like a picture frame except that the back is hinged and held by two springs. One, 4 by 5 inches, is large enough for work with the Bausch & Lomb Amateur Photomicrographic Outfit. The same chemicals used for developing can also be used for printing. The gooseneck desk lamp with the usual shade is used for exposing. The neck of the lamp should be adjusted until the light is about eight or ten inches above the table top and the shade turned so the light is reflected downward. A 25 to 40-watt frosted bulb is best to use. The switch should be convenient and easy to manipulate so that the time of exposure can be controlled without difficulty.

Although the same chemicals can be used, separate solutions should be made up especially for printing. The developer, especially, requires a different concentration as will be noticed in the directions for use which come with the bottle. In printing, one tube of developer is generally dissolved in six ounces of water instead of eight to ten for film. After the amateur has gained some experience he can buy the various chemicals and mix his own developer after the formula recommended and published by the companies making film. The same hypo solution as used for the film can also be used in printing, as long as it is clean and free from sludge or coloration and "smells acid." Select the negative you wish to print and then turn off all the lights except the safelight, and place it, the shiny (or glass) side down, in the printing frame. That is, the shiny side of the negative should be against the glass of the printing frame. Take a piece of printing paper from the box or envelope. The printing paper should be a little larger than the desired picture, to permit trimming later. You will note that the paper also has its glossy side and plain paper side. The emulsion is on the glossy side. Place the paper in the printing frame so that the emulsion side is against the negative and see that the negative is completely covered by the paper. If the film has a tendency to curl, breathe lightly on it and the added moisture will flatten it out. In clamping the back of the printing frame closed, make sure that the negative and paper do not slip out of their proper positions.

Turn the printing frame face up on the table under the desk light. Make sure that all unexposed film and printing paper are under cover, and then turn on the desk lamp for the required amount of time. The time of exposure depends upon the density of the negative and the type of paper being used. For a medium density negative and a medium speed paper (normal) the exposure with the 40-watt bulb about 12 inches away from the printing frame is from 8 to 10 seconds. To count seconds have a watch with a second hand, or a loud-ticking alarm clock. Four ticks of an alarm clock are usually one second, or at least near enough to it to be used as a measure. You will soon learn to count every fourth tick without paying attention to the others. One tick out of every four seems to be louder than the others, and so you count one-two-three-four, two-two-three-four, three-two-three-four, etc. This method is useful up to times of thirty seconds or so.

After exposure the paper is removed from the frame and immersed in the developing tray. It should be slid in edgeways so that the developer will cover it quickly and evenly. The finger tips can be run lightly over the surface of the paper to break any air bubbles that might form on it. The shiny surface of the paper



Making the print: Exposure

should be up when the paper is immersed in the developer and the time should be carefully noted. Forty-five seconds to one minute is the usual developing time. If the paper is correctly exposed, the image will start to appear at the end of about ten seconds and gradually come up until the picture is complete.

If no picture appears or there is a very faint image, it means that either the exposure was too short or the developer has been worn out. Of course, if the developer is worn out the only thing to do is to make up another batch of it and try again. If it is the exposure, double the amount of time of the unsuccessful attempt. In photography, exposures are always either doubled or cut in half. Amounts in between are usually not enough to have an effect. Your judgment will tell you when you have made a nearly perfect exposure and this rule does not hold.

The prints should be rinsed well between the developer and the hypo bath. In handling them it is best to slide your hand under them so that it does not have to touch the emulsion side. Any developer carried over to the fixing solution on the fingers to the emulsion surface of the paper will produce a stain. It is better to go further than this and use what is called a "short stop" bath between the developer and fixing solution. This consists of a tray of water with a little acetic acid added. Acetic acid may be purchased from the photo supply dealer in the "glacial" grade. One part of "glacial" acetic acid is mixed in eight parts of water. The "short stop" solution is then made by dissolving one and half ounces of this solution in thirty-two ounces of water. If there is no acetic acid available, use good strong vinegar and add a little to the tray of water until it has a pronounced vinegar taste.

The print is taken from the developer, rinsed in plain water and then placed in the "short stop" solution until all of the prints are made. The "short stop" solution immediately counteracts the basic developer and stops development. The light may be turned on a print in the "short stop" solution without damaging it. The advantage of putting the prints in the "short stop" solution, and leaving them all there until the last print has been developed, is that it then requires only one timing operation for all of them when you place them in the hypo (fixing bath).

No visible change occurs in the print when placed in the hypo as there is in the negative when immersed in that solution. It is therefore necessary to allow fifteen minutes for the print to be immersed in the hypo. With the print the process must be controlled by time.

From the fixing bath the prints are removed to a pan of either running water or one in which you change the water about every ten minutes, agitating frequently to make sure that they are thoroughly rinsed.

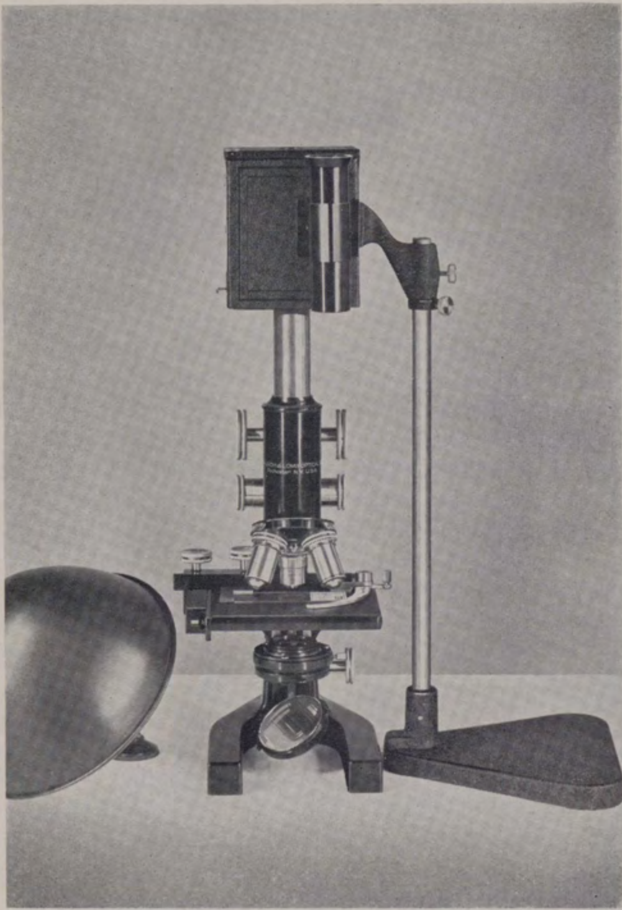
Prints are not hung up to dry as are the negatives. The best way is to place them face down on a piece of lintless blotting paper, which can be secured from photo supply dealers, and a squeegee roller run over them until they are fairly dry. They are then laid out on a clean white piece of cloth until almost dry. If they are then placed between two sheets of the dry blotting paper with a weight on top to keep them flat, they will dry without curling. However, if they should happen to curl they can be flattened out by moistening the back with a little bit of wet cotton, or cotton dipped in a mixture of half wood alcohol and half water, and then closing in a book or put under weight for a few minutes until dry.

Glossy Finish

Putting the glossy finish on a print (the same as those that come from the regular commercial developing and printing places) is called ferrotyping. This process is very effective in photomicrography, as it seems to bring out detail so much more clearly. Ferrotype tins are sheets of heavy tin which have been heavily lacquered or japanned to produce a hard, glossy surface. They are then coated with a solution of beeswax in benzol, and, when dry, polished with a piece of flannel. The prints are taken from the rinsing bath and laid face down on the waxed surface. A piece of blotting paper or clean white cloth is laid over them and the squeegee roller run back and forth several times to force out the excess water. The cloth or blotting paper is then removed and the individual prints treated in the same way with the squeegee roller. Any excess water squeezed out from underneath should be blotted up with the cloth or paper. The prints are allowed to become bone dry on the tin, at which time they will pop off and will be found to be glazed.

The tins must be waxed occasionally to prevent the prints from sticking, and between each batch of prints the tin should be rinsed, dried and polished with a piece of flannel cloth.

●

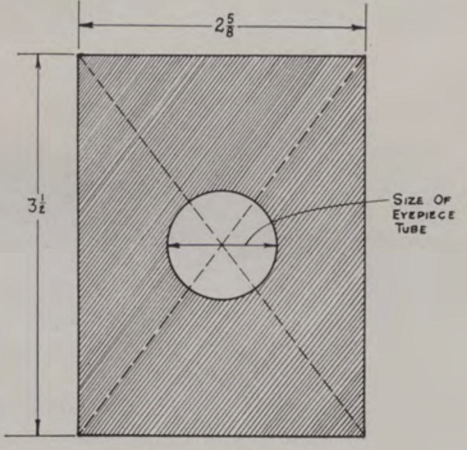


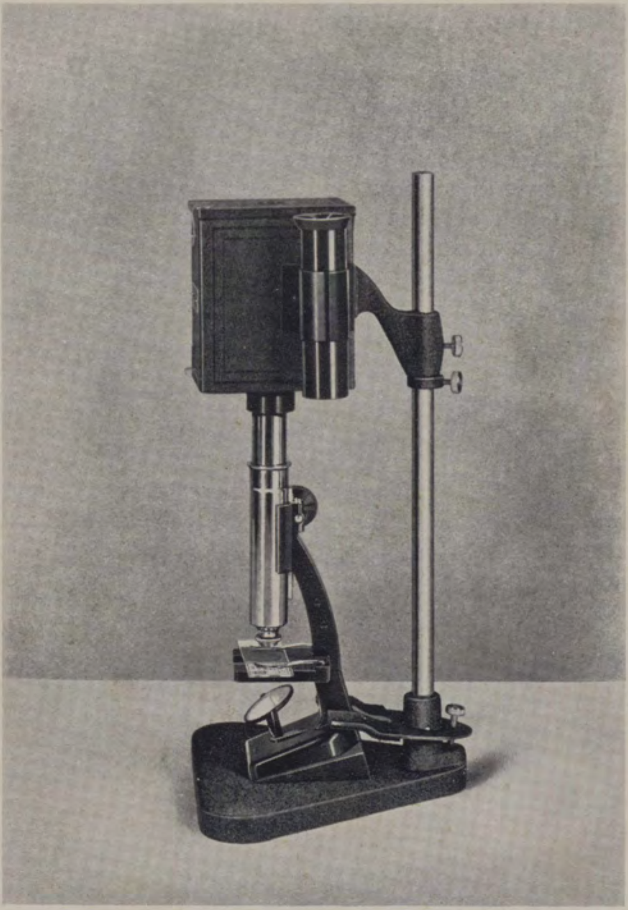
Method of setting up the Photomicrographic Outfit for use with a standard laboratory microscope

Using the B & L Photomicrographic Outfit with a Standard Microscope

When using a standard microscope with the Photomicrographic Outfit it will be found best to place the microscope in back of the base as shown in the illustration. Standard instruments are heavy enough not to need clamping, though it might be well to weight the base of the Photomicrographic Outfit. Just place any convenient heavy object on the base.

The light-tight connector furnished does not fit all standard microscopes. However, it is simple to make a light shield to serve the same purpose. Cut a piece of stiff cardboard the size of the bottom of the camera. In the center cut a circular hole of the size of your eyepiece tube. Put the eyepiece through this hole and then place it back in the microscope. When the microscope and camera are lined up, the black card covers the whole face of the camera and effectively blocks off all stray light.





The Photomicrographic Outfit ready for use with Bausch & Lomb's New Gem Microscope. Note the wooden wedge under the base used to bring the body tube to the vertical

VIII-34, 500

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