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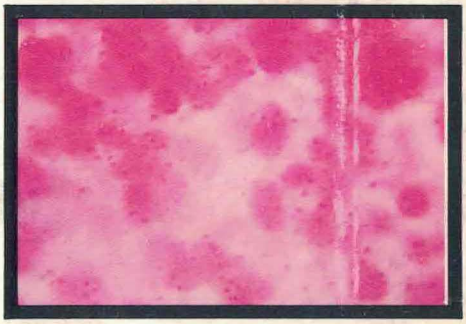

SIMPLIFIED photomacrography photomicrography

WITH

Canon | SYSTEMS EQUIPMENT

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forward

The contributions that photomacrography and photomicrography have made to the sciences are immeasurable. With this type of photography, technicians, doctors, students, and scientists can record for future study and evaluation those subjects that can only be seen by means of high magnification or through a microscope. Although this specialized type of photography is not quite the same as recording birthdays, trips, and family occasions, it can be simplified to the point whereby anyone familiar with the subject matter and its viewing method can also photograph it.

The intent of this booklet is to make the reader aware of the precision Canon photographic equipment sold by Bell & Howell, and how it can make photomacrography and photomicrography truly simplified. Also included is information on the techniques which will aid in this photography.

Text, photomacrographs, and photomicrographs by Merritt C. Flom, MFA, Bell & Howell Company.

introduction

What is photomacrography? Generally speaking, we can say that photomacrography is the recording on film of subjects that are smaller than the resulting film image. For our purpose, we'll say that images that are recorded on film as normal size to approximately 15 times normal size can be regarded as photomacrographs. A further requirement would be that the camera lens is used instead of supplementary optics such as those of a microscope.

Photomacrographs allow detailed study of minute subjects. Although the magnification of the image on the film might be limited, the negative or color slide can be enlarged to great proportions. For example, a 10 times magnification of a subject on a color slide could be projected to a X333 magnification on a 50" screen! The uses of photomacrographs are limitless. In the fields of research, education, manufacturing, and medicine, this type of photography is invaluable.

index

photomacrography

Figure 1: Set-up for same-size photomacrography; Canon FT-QL body, Macro Lens with 1:1 Adapter, Waist-Level Viewer, Copy Stand 3F.

equipment

The amount of equipment required for photomacrography is small, and consists mainly of a camera, a lens, and a means of extending the lens out from the camera body. The Canon FT-QL camera is ideal for this type of work as it also has a through-the-lens spotmetering system which assures convenient and accurate exposure measurements under all conditions. The Canon system of equipment includes a variety of ways the camera lens can be extended out from the body.

Extending the lens allows you to get closer to the subject — with a resulting larger image on the film. This can be done with extension tubes, rings, or with an adjustable bellows. Page 4 tells how the required extension can be calculated according to the magnification desired. Theoretically there is no limit as to the distance you can extend the lens, but the physical problems involved do practically limit the extension to about 500mm. If this extension is used with a 50mm lens, the magnification would be X10. For a greater magnification a microscope would be the best means.

The Canon FL 50mm f/3.5 Macro Lens is especially designed for close-up photography and photomacrography. The lens by itself will focus as close as 9.2" from the subject (measured from the camera's film plane). With the 1:1 adapter which comes in the lens set, you can focus as close as 8.2" from the subject (measured from the film plane) and this will result in a 1 to 1 or same-size image on the film.

Although the Canon Macro Lens should be used for the most exacting work, any normal or wide-angle lens could be used with excellent results. If the magnification to be obtained is more than X1, the lens should be used in a reversed position for a greater flatness of field. Canon has Macro Photo Couplers for the purpose of reversing a lens on the extension device. As an example, the photomacrograph in Fig. 2 was made with the Canon FL 28mm f/3.5 lens, the Macro Photo Coupler, the Bellows FL, and extension tubes. Using a wide-angle lens, such as the 28mm or 35mm, can be an advantage in those cases where a large magnification is needed and where it is not practical to use a long extension. For instance, a 500mm extension would be needed for a X10 magnification with a 50mm lens, but only 280mm would be needed with a 28mm lens.

determining the extension

Figure 2: Larvae of Ladybird Beetle, *Coccinella* (X7). Photomacrograph was taken outdoors in sunlight. The equipment in Fig. 5 was used.

Here's how to easily determine how much extension is required for a given magnification. As an example, you may want to photograph a subject that is 6mm long and have the subject image approximately 24mm long on the slide or negative. The ratio of the subject size to the desired image size is 1 to 4, which is an X4 magnification. To achieve this magnification, the lens must be moved away from the camera body by 4X the focal length of the lens, or 200mm in the case of a 50mm focal length lens. To do this, use the Bellows FL, 40mm of extension tubes, and the Macro Photo Coupler FL.

See the extension listing on this page for information on what equipment offers what extensions.

As another example, the desired magnification could be X3. With a 50mm lens, the necessary extension would be 150mm. To obtain this extension, you could use just the Bellows FL, the Macro Photo Coupler, and the lens in reverse.

There will be times when you may wish to vary the bellows extension or change extension tubes and it would not be practical to measure the extension for every shot. To have a visual record of the magnification in each of the pictures, just take one shot of a millimeter ruler or of an object of a known size. By measuring the ruler or object image in this "size record" shot, you can determine the magnification in the other pictures taken at that extension. Take another "size record" shot every time you change extensions. This system is very helpful when taking photomacrographs in the field.

EXTENSIONS OF PHOTOMACROGRAPHIC EQUIPMENT

Cat. No.	Equipment	Extension
112143	Bellows FL	34.5mm to 142.5mm
112144	Bellows R	30mm to 155mm
112242	Macro Photo Coupler FL (58mm thread size)	20mm to 33mm
112241	Macro Photo Coupler FL (48mm thread size)	24mm to 37mm
112214	Extension Ring FL Set (consists of one 5, one 10, and two 20mm rings)	5mm to 55mm
112240	Extension Tube FL	15mm
112178	Extension Tube FL	25mm

film

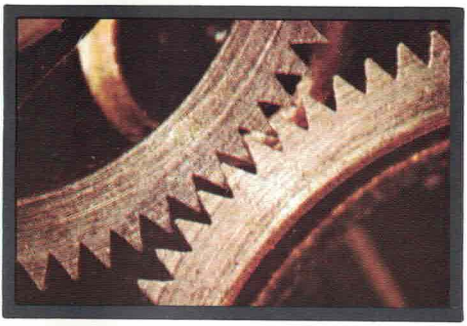

Figure 3: Watch movement gears (X22). The set-up was similar to that in Fig. 9 using a single high-intensity light to show the texture.

Figure 4: Pupae of Ladybird Beetle, *Coccinella* (X8). This shows the beetle emerging from the pupae as an adult. Outdoors with sunlight.

There are a great many films that can be used for photomacrography, and each one has its own characteristics. The desired results generally determine the type of film to use. Color-slide films come in a variety of sensitivities (film speed ratings) from ASA 25 to ASA 500. Color negative films are usually rated at ASA 64 which is a medium speed or sensitivity. Black-and-white films are available in all film speeds. When taking photomacrographs where the magnification is great, it is generally best to use a medium or high-speed film so that long exposures will not be necessary. Also, the smallest possible lens openings (apertures) should be used for the greatest depth-of-field or range-of-sharpness in the photograph, and this would also call for a medium or high-speed film so that the exposure time would not be long. Long exposure times sometimes introduce a film characteristic known as "reciprocity failure" which is explained on Page 10.

Black-and-white and color negative films can be used with almost any type of illumination. However, color-slide films are made in three general types for three different types of illumination. Daylight-type film is balanced for use with natural daylight illumination. Type A film is for use with photoflood lamps that have a color temperature rating of 3400°Kelvin. Type B films are balanced for use with professional-type photographic lighting with a rating of 3200°K. It is important to know the color temperature of the light source you are using so that the color balance of the slide is correct. Filters can be used to balance film and lighting and this information is included in the film instructions.

lighting

Figure 5: Typical set-up for outdoors; camera body, lens reversed on Macro Photo Coupler, Bellows FL, extension tubes, sturdy tripod.

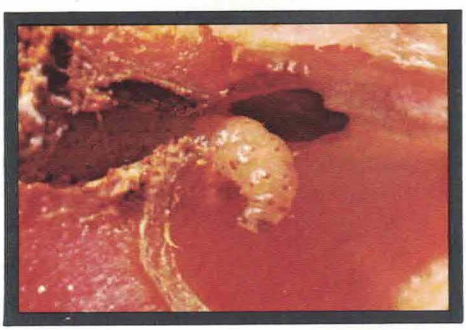

Figure 6: Larvae of large fruit fly. Family: *Trypetidae* (X8). This larvae is also called an apple maggot. Taken outdoors in sunlight.

The type of lighting to use would depend mainly on the subject. Daylight lighting would naturally be used for subjects in their natural outdoor habitat. Therefore, daylight-type film should be used. Reflectors can be used with daylight to help fill-in shadows and provide detail in the subject.

Artificial lighting is available in various types with different color temperatures. Photoflood lights are rated at 3400°K and come with many different types of reflectors. Other photographic lights are rated at 3200°K. Other handy light sources are the high-intensity lamps which have become popular as desk and study lighting. These lamps are generally rated around 2900°K or 3000°K and the lamp manufacturer can give definite information on the models they make. Some lamps have different intensity settings with different color temperatures. If a high-intensity lamp is used, a filter will be required to balance its light to the color temperature of the film you are using. For example, with a 3000°K lamp, an 82A filter is necessary to balance it with Type B color film, or an 82C filter with Type A color film.

The key to lighting is to show the subject to its best advantage. Two lights are usually all that are needed to show shape, configuration, texture, etc. One light should be closer to the subject than the other to provide the main light, while the second light would be used for filling in shadows. Reflectors can be added for further filling in of those areas not covered by the two lights. The important thing to remember is to light the subject so it looks "right" and shows all the parts and features.

set-up

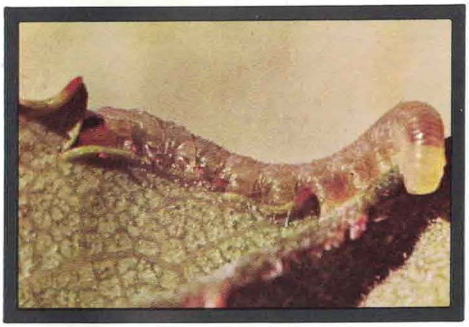

Figure 7: Larvae of Wood Nymph Butterfly, *Minois alope* (X7). The leaf was removed from the bush and positioned for the best angle.

The type of set-up to use would depend on the subject matter. Let's take, for example, the photomacrograph of the green larvae in Fig. 7. The subject was outdoors in its natural habitat. It was decided that the desired magnification was X4, and with the 50mm Macro lens, this required a 200mm extension. The Bellows FL, two 25mm extension tubes, and the Macro Photo Coupler FL were used with the lens reversed on the coupler. This gave more than the required 200mm extension and also allowed this extension to be varied if desired. The camera and attached equipment were mounted on a sturdy tripod and positioned at approximately the same height as the subject. In this particular case, the branch on which the subject was positioned was secured (stabilized) so that any wind would not move the branch and subject. This is usually necessary when there is even the lightest air movement, especially when long exposures are used, so that the image on the film is not blurred.

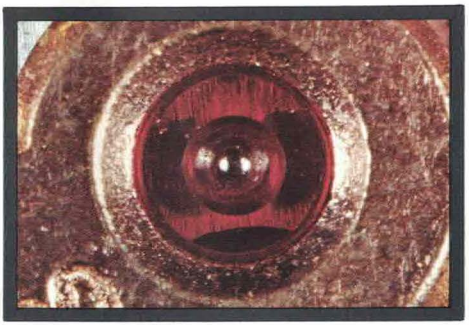

Figure 8: Watch bearing jewel (X22). A single high-intensity light was used to accentuate the texture and produce reflections in the jewel.

A vertical set-up is usually the most convenient for indoor photomacrography. Fig. 8 shows a typical photomacrograph taken on a copy stand with a large extension. The Canon Copy Stand 3F provides an extremely stable method of mounting the camera and accessories. The height of the camera is easily adjusted on the copy stand and the lighting can be placed around the subject without interfering with the other equipment. The Waist-Level Finder, when used with the vertical copy set-up, provides horizontal viewing through the camera's reflex system. Fig. 9 shows such a set-up with the equipment needed for a photomacrograph like the one in Fig. 8.

Subject placement can be an important factor in a good photomacrograph. Since the range-of-sharpness in this type of picture is extremely small, all parts of the subject you want to keep in focus should be in a plane parallel to the film in the camera. Using the smallest possible lens opening will give you the greatest range-of-sharpness. As an example, the subject in Fig. 7 was placed so that its length was almost parallel to the film in the camera. The result was good sharpness over the entire length of the subject.

The background is important in a photomacrograph as it should not detract from the subject. Since the background will always be out-of-focus, the color and tone are the important features. If the natural background doesn't seem to be suitable, an artificial background can be used. Colored construction paper is excellent for this purpose.

Transmitted light is necessary for photographing certain subjects. One example is the longitudinal section of the mouse embryo in Fig. 10. In this case, a vertical set-up was used with the slide containing the section positioned several inches above a lighted white card. The card was evenly lighted with two high-intensity lamps.

Other subject matter may require distinctive lighting so that desired characteristics will show up properly. For example, Fig. 11 shows the abrasion grooves in the head of a tape recorder. Low side-lighting was used so that just the high points of the grooves were illuminated and this helped to show the number of grooves and their direction.

Figure 9: Vertical indoor set-up; camera body, lens, Bellows FL, extension tubes, Macro Photo Coupler, Waist-Level Viewer, Copy Stand 3F.

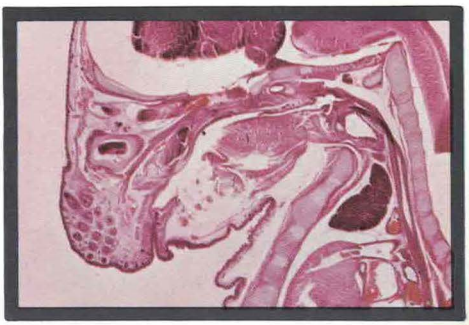

Figure 10: Longitudinal section of the head of a mouse embryo (X7.5). The slide containing the section was placed over a lighted white card.

exposure

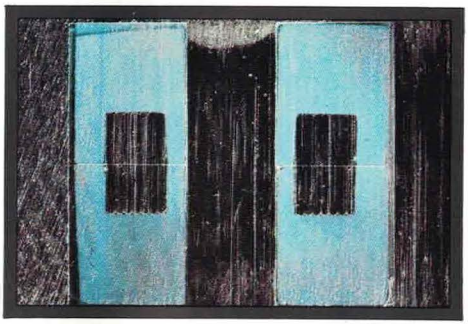

Figure 11: Tape recorder head showing abrasions (X7). A single intense side-light was used to high-light the groove pattern and quantity.

Figure 12: Head of garden slug, *Deroceras gracile* (X16). This subject was in its natural habitat with direct bright sunlight for lighting.

This is the area where the Canon FT-QL's through-the-lens spotmetering system is unique. You can measure the light reflecting from the subject and set the lens opening and shutter speed for the perfect exposure—all in an instant. Since the reading area is 15% of the total area of the picture, you can be selective about what part of the subject is measured. Readings can be made of that area which is the most important for detail, or you can average the readings between important dark and light areas. No matter what lens extension, what film, or what the lighting, you can set the proper lens opening and shutter speed for correct exposure.

Another unique feature of the Canon FT-QL is its ability to accept the Canon Booster for extreme low-light exposure readings. This accessory greatly increases the sensitivity of the camera's through-the-lens meter and allows measurements in sensitivity ranges not possible with other camera systems.

Any reflected-light type exposure meter measures the light reflecting from the subject. If you wish to photograph a relatively dark object, and keep the original dark tone, you can substitute a photographic gray card for the subject. The card will then be the meter reading area. This will assure proper exposure. If the reading were to be taken off the dark subject, it would be reproduced lighter than it actually is. The same holds true for an extremely light subject, as it will reproduce darker than it actually is if the meter reading is taken directly from the subject. Again, the gray card will assure the proper representation of the subject.

Flash is a very good source of illumination for photomacrography, especially if the subject is alive and moving. The proper lens opening to use with flashbulb or electronic flash illumination will depend on the flash's guide number. Just divide the guide number by the flash-to-subject distance to find the lens opening. Another way, which is generally easier when taking extreme close-ups, is to set the lens to the smallest lens opening, divide the guide number by the effective lens opening number, and the result would be the flash-to-subject distance. An extension cord would be necessary to move the unit away from the camera as the flash-to-subject distance will be greater than the camera-to-subject distance.

One must remember to determine the "effective" lens opening from the actual marked lens opening. This is the correction necessary because of moving the lens out from the camera body. The instructions that come with the equipment will give information on this compensation.

Electronic flash ring lights are very versatile for difficult-to-catch subjects. The high-speed flash (usually $\frac{1}{1000}$ second or faster) and the even axial lighting can cover a multitude of requirements. By presetting the lens extension and lens opening, you can move in to the subject (no tripod needed) until the subject is in sharp focus—then take the shot. Any camera movement or subject movement is frozen by the light from the flash. Because the ring light is very close to the subject, it is important that the proper lens opening be calculated very carefully to prevent under or overexposure. By using the Bellows FL and the Macro Lens, the automatic diaphragm features of the equipment are kept and the viewing of the subject can be done with the lens wide open. As the picture is taken, the lens will automatically close down to the preselected opening.

helpful hints

Figure 13: Larvae of the syrphid fly, *Syrphus americanus* (X7). The camera angle was selected to show the long side of the subject.

Figure 14: Winged rose aphis, *Macrosiphum rosoe* (X7). Back-lighting plus reflected front lighting was used to show maximum detail.

The set-up should be sturdy and as vibration free as possible. Use a cable release, pneumatic release, or the camera's self-timer to make the exposure. This will prevent any possible vibration through trying to use the camera's body release. With flash, however, this precaution is usually not necessary.

The Bellows FL contains a stabilizing strut which helps to steady the set-up on a copy stand. The strut can be extended until it touches the baseboard, then locked in position.

Exposures longer than 1/10 second sometimes call for an additional compensation due to what is called "reciprocity failure". Some films lose some of their sensitivity with long exposures, and an additional exposure is required. Since this film characteristic cannot be measured by any exposure meter, it must be calculated into the final exposure. The chart on Page 19 gives the additional exposure required for some of the commonly available color films. Other manufacturers can give you the proper information for their films.

Backlighting can be helpful to show certain subjects, but usually must be accompanied by some frontlighting to show the subject to its best advantage. For example, backlighting in the form of an extremely light background will show the translucency of an insect's wing, but frontlighting will have to be added to show the rest of the subject. Care should be taken so that one form of lighting does not overpower the other.

It is possible to expose some films at a film speed higher than their normal rating. When this is done, compensation is made in the processing so that the results will be acceptable. All black-and-white films and some color-slide films can be "forced" in processing to yield a higher film speed. This special processing can be done by laboratories specializing in custom work. Although it is not normally recommended that film speeds be forced, it is a solution to what might otherwise be a difficult problem. As an example where this may be required, you may have a situation where you have only ASA 64 film, you have to use the smallest lens opening possible for the greatest depth-of-field, and the exposure reading would call for a shutter speed of one second. The subject is the type that could move and a higher shutter speed would be desirable. You could use 1/2 second and have the film processed for ASA 125, or you could use 1/4 second and have the film processed for ASA 250. Remember, however, that all the shots on one roll of film must be exposed at the same rating.

photomicrography

introduction

If you can view it through a microscope, you can photograph it through the microscope's optics. In photomicrography, the camera lens is removed and the complete optical system of the microscope is used to project the image onto the film in the camera. The magnification of the subject is dependent on the (1) power of the ocular or eyepiece, (2) power or focal length of the objective lens, and (3) the distance of the camera's film plane from the ocular. Most microscopes used for scientific purposes are capable of magnifications to X1000 or higher, depending on the eyepiece and objective lenses used.

Since the microscope optics are used for forming the image of the subject on the film, it is important that they are especially designed for flatness of field, resolution, and color-correction. For example, apochromatic lenses are preferred over achromats, but either can be used. Compensating eyepieces are also preferred over the regular type as they produce a flatter field. Even the lenses in the substage condensers of microscopes come in different types and grades. The resulting photograph can only be as good as the microscope optics are capable of producing.

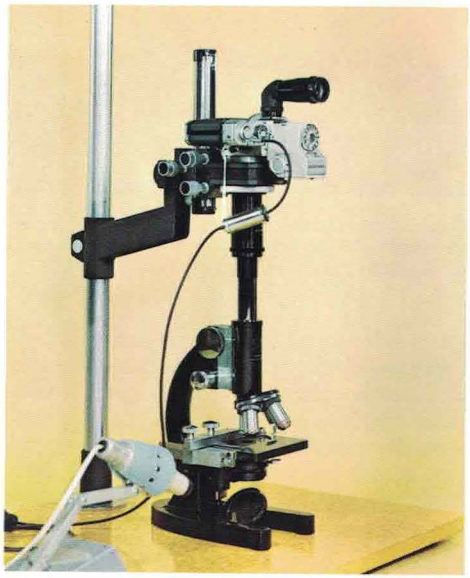

Figure 15: Set-up with body, Booster, Bellows FL, Photomicrographic Hood, Copy Stand 3F, Waist-Level Viewer, microscope, air release.

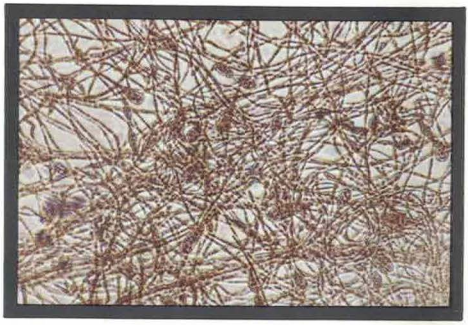

Figure 16: *Alternaria,* **conidia and hyphae (X113). This transmitted light photomicrograph was made with the equipment in Fig. 15.**

equipment

The Canon FT-QL single-lens reflex camera is ideal for photomicrography. It has an internal spotmetering system which also accepts the Canon Booster for low-light measurement. Besides the camera body and the booster, a means of positioning the camera above the microscope and a light-tight coupling system is necessary. Fig. 15 shows a typical set-up, consisting of the FT-QL camera body, Booster, Right Angle Finder, Copy Stand 3F, Bellows FL, and Photomicrographic Hood. Of course, the microscope and microscope lamp complete the equipment list. A release for the camera shutter, such as a cable release or pneumatic release, will make it much more convenient for making exposures. A pneumatic release is shown.

The ability to take a meter reading through the microscope optics assures you of correct exposures without the need for extensive bracketing. The booster, when attached to the camera body, allows the measuring of even the lowest levels of illumination. The right-angle viewer lets you view the image comfortably and lets you see the area selected for light measuring.

Using the Bellows FL also allows you to vary the magnification. When the film plane of the camera is approximately 10" from the microscope ocular, the image on the film matches in magnification the power of the ocular times the power of the objective. Raising or lowering the camera (by means of the bellows) from this point will either increase or decrease the magnification. For example, if the camera's film plane were 5" from the ocular, the magnification on the film would be ½ that as seen visually through the microscope.

Besides the photographic equipment, the microscope and the appropriate lenses are needed. Even a simple student microscope will suffice, but the photography can only be as good as the microscope optics. A microscope light with high intensity is recommended so that the camera exposures can be as short as possible to prevent vibration showing in the photos. The microscope shown in the examples is the Graf-Apsco Model GKM4 with the Model 59 Hi-Lite Illuminator.

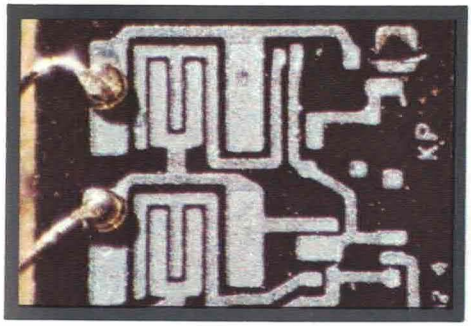

Figure 17: Part of integrated circuit board (X40). A single high-intensity microscope illuminator was used to directly light the subject.

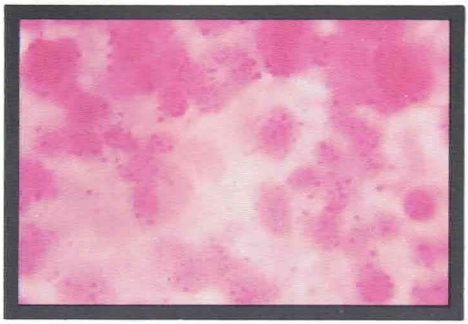

Figure 18: Diplococci bacteria, *Neisseria gonorrhoeae* (X1125). The microscope objective was the oil-immersion type. High-speed film used.

film

As with photomacrography, almost any type of color or black-and-white film can be used. When using high magnifications, however, the faster color or black-and-white films let you use shorter exposures. If photomicrographs of living subjects are taken, then using a fast film with high-intensity lighting is essential to keep the exposure times as short as possible.

The most important things to remember when selecting a film are that (1) it must have the same color balance as the lighting source, or close to it so that filters can make the correction, and (2) it should have sufficient speed so that the exposure will not be overly long. The required speed would depend on the magnification and density of the subject, the intensity of the illumination, and the filters to be used. For example, if polarizing filters were to be used over the light source and ocular for special effects, a high-speed film would definitely be recommended. Film speeds of certain films can be forced, if needed, and the film can be exposed at these forced speeds if compensation is made in the processing procedure.

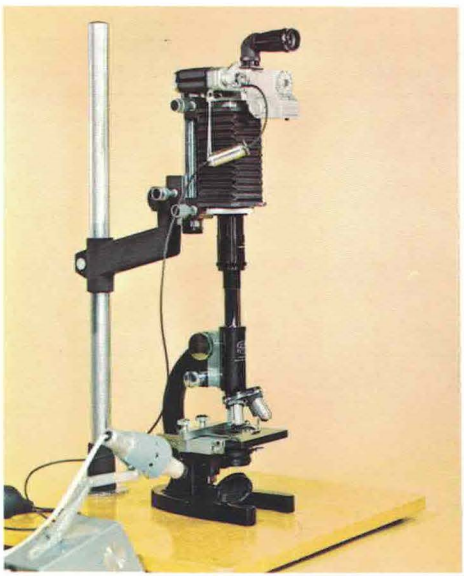

Figure 19: Set-up same as Fig. 15, but with bellows expanded for greatest magnification. Extension tubes can be used in place of bellows.

Figure 20: *Mycobacterium tuberculosis* **(X1125). The red bacilli indicate tuberculosis. With high magnifications, use high-contrast film.**

lighting

Figure 21: *Microsporum vanbreuseghemii,* **macroconidia (X113). This relatively transparent subject requires as much contrast as possible.**

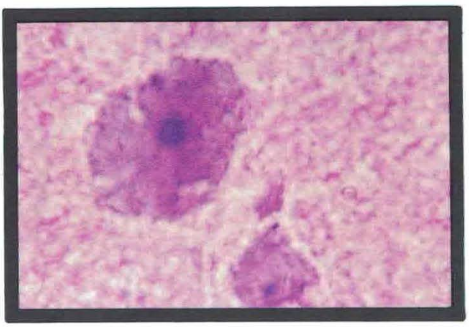

Figure 22: Negri bodies (cell inclusions) of rabies (X1125). This type of subject is more easily found using the equipment in Fig. 23.

There are many different types of microscope lights available. The one in Fig. 19 is the Graf-Apsco Model 59 Illuminator which has a color temperature of 2950°K when operated at a secondary voltage of 20V. This type of light can be used with a Type A film with an 82C filter for color correction, or with a Type B film with an 82A filter. Lamp manufacturers can give you the color temperature for their units. Reflected daylight can also be used for photomicrography with daylight-type color slide film and color negative films.

With black-and-white films, the color temperature of the light source is not important unless very subtle variations in the colors in the subject must be retained. Generally speaking, filters should be used to darken or lighten colors for desired results in the final black-and-white print. For example, if the specimen is stained light red on a relatively clear background, a green filter (such as a #58) would cause the red color to reproduce dark. In contrast, a red filter would tend to lighten the subject so it probably would not be readily visible. With a light blue specimen, a yellow, orange, or red filter would darken the blue color, while a blue filter would lighten it on the print.

Standard lighting for microscopy should be used for photomicrography. For example, the same light position and substage condenser setting should be used as long as the field is evenly illuminated with no bright spots in the center. Care must be taken, however, that there are no internal reflections in the microscope that might not be visible in regular viewing but which might show up in the photo. For example, a draw tube that is chrome-plated internally could prove to give a sharp "hot spot" in the photo, especially when used for high-magnification photomicrographs. Also, any bright-metal burrs, edges, or surfaces should be blackened against any possibility of reflections which might show up in the photograph.

exposure

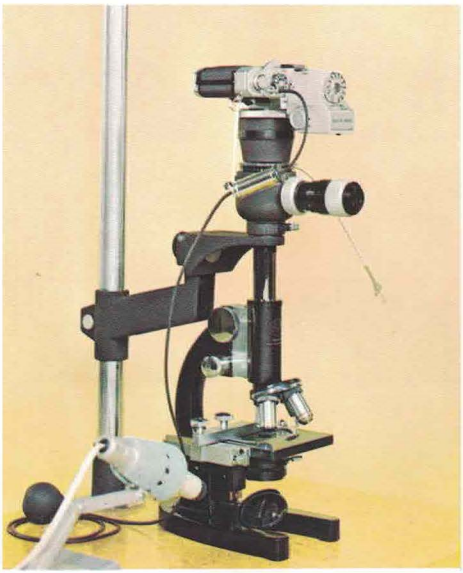

Figure 23: Canon Photomicrographic Unit CM-IIA and holder used in place of bellows and hood. This affords maximum viewing ease.

After the microscope is set with the proper lighting and with the slide in place, the slide should be positioned and focused. Recheck to see that the lighting is even over the entire field. If filters are to be used, they should be placed in front of the light or above or below the substage condenser (for transmitted lighting only). Position the camera (the bellows, hood, etc.) over the microscope ocular as shown in Fig. 15. Slide the bottom half of the hood down until it seats on the ocular.

Look through the right-angle viewer to view the subject in the camera's ground glass. With the microscope's fine focusing, adjust the image in the camera's finder until it is as sharp as possible.

Note the image area in the viewfinder that will be measured for exposure. If possible, move the microscope slide until an "average" density area is under the measuring square before the reading is taken. Then the slide can be repositioned back if the composition is not correct. Meter readings should always be taken of the important parts of the slide that have an average density. In those cases where the entire slide is extremely light or extremely dark, and where these areas are important, then a compensation should be made in the meter reading before exposure. For example, an extremely dark slide would require less exposure than that indicated by the meter if the slide darkness is to be reproduced on film. An extremely light slide would require more than the measured exposure if the lightness is to be retained. The preferred method of making the exposure is to take the original meter reading and the 1st exposure, then double (or half) it for the next exposure. Then, double (or half) the exposure again for the third exposure. By this method you can be assured of one exposure which would fill the photographic requirements. This system of altering the exposures can be used when photographing any slide that does not have an "average" area that can be metered.

Photographically speaking, an average tone is one that has an 18% reflectance. This is the standard for any exposure meter calibration, and is the reflectance of a photographic gray card used for photographic meter readings. These photographic gray cards are available from photo dealers and could serve as a guide when judging a slide for "average" density.

The Booster is attached to the FT-QL camera in the manner described in the instructions. The meter will give the proper exposure in seconds or fractions of a second. If desired, the light intensity can be adjusted so that the meter calculator reads in even seconds. The camera meter system and the booster can be left on at all times —it is not necessary to turn them off when making exposures.

Because exposures in photomicrography are usually long, it is sometimes necessary to make an exposure compensation for the "reciprocity failure" of the film being used. This is due to the characteristics of the particular film and the extra exposure needed will vary according to the original exposure determined by the metering system. The chart on Page 19 gives you the exposure compensations necessary for some of the more popular color films. For further information on other films, write directly to the manufacturer. Black-and-white films are not affected by this characteristic and they will not require any compensation.

The Canon Photomicrographic Unit CM-IIA, shown in Fig. 23, is an additional piece of equipment that is helpful under many conditions. This device allows viewing of the slide before the image reaches the camera viewfinder and provides a brighter viewing image. This device also contains its own shutter with speeds up to 1 second, plus B and T for time exposures. Because you can focus and compose a brighter image, the Photomicrographic Unit is more convenient to use when taking photomicrographs at high magnifications. Also, the bright image as seen through this device allows easier "searching" of the slide for the desired portion.

When using the CM-IIA unit, its shutter must be opened when taking the meter reading through the camera and booster. When making the exposure, it is best to have the camera's shutter set to B and the unit's shutter on T or on the desired speed. Then, 1) open the camera shutter and hold it open, 2) make the exposure with the unit's shutter, and 3) close the camera's shutter.

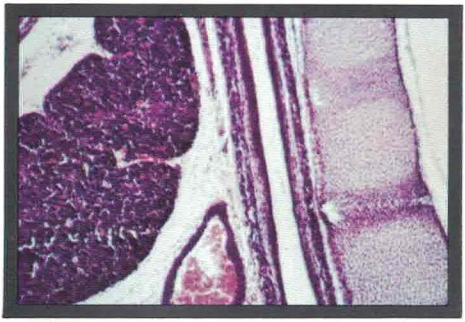

Figure 24: Longitudinal section of the spine and internal organs of a mouse embryo (X40). The stain gives this subject high contrast.

Figure 25: *Plasmodium vivax,* **malaria (X1125). This is a high-magnification photomicrograph which requires a relatively high-contrast film.**

helpful hints

When using reflected light for photomicrography, use caution that there are no reflections present on the subject that will show up on the film.

Focus of the subject is extremely critical when using medium and high magnifications. Always focus the microscope first, then check the focus in the camera's viewfinder for a final adjustment.

Another method of determining the exact magnification in a photomicrograph is to take a picture of a stage micrometer at the magnification you are going to use for the subject. Then, by measuring the scale on the finished slide or print, you can determine the exact magnification for that particular set-up.

Dark field lighting of a subject presents a very slight problem when determining exposure. Generally speaking, however, you can take a through-the-lens reading if you can average the dark background with the lighted subject when positioning the meter reading area. It is also recommended that exposures be taken on either side (more exposure and less exposure) of that determined with the metering system.

It is important that the microscope optics be kept extremely clean. If any dust or foreign particles are on the rear surface of the ocular's field lens, for example, they will show up in the picture. To check for dust on this surface, look through the microscope and rotate the ocular. If there are particles that move with the ocular, then they are on this rear surface. Particles on other surfaces can also affect the photographic image and these surfaces should be cleaned as carefully as possible.

Figure 26: Misshapen blood cells of pernicious anemia (X1125). With black-and-white film, a green filter would give high contrast.

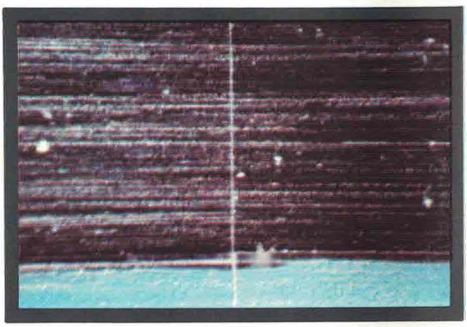

Figure 27: Record/Playback section of tape recorder head (X40). Intense side-lighting was used to show the abrasions on the head surface.

reciprocity characteristic chart

EXPOSURE COMPENSATION AND FILTER REQUIREMENTS FOR RECIPROCITY CHARACTERISTICS OF KODAK AND GAF COLOR FILMS				
FILM	EXPOSURE TIMES			
	1/10 sec.	1 sec.	10 sec.	100 sec.
Anscochrome D/50	None No Filter	+⅓ stop 05M	+⅔ stop 10M	+1⅓ stops 10M
Anscochrome D/100	None No Filter	+⅓ stop 05R	+1 stop 10R	+1⅓ stops 10R
Anscochrome T/100	+⅓ stop 10R	+⅓ stop 20R	+⅔ stop 20R	+1⅓ stops 20R
Anscochrome D/200	+⅓ stop 05R	+⅓ stop 10R	+1⅓ stops 10R	+2 stops 10R
Kodacolor-X	None No Filter	None No Filter	+1 stop No Filter	+2 stops No Filter
Kodachrome II	None 05R	+⅓ stop 10R	+⅔ stop 20R	+1⅓ stops 25R
Kodachr. II Type A	+⅓ stop 05R	+⅓ stop 10R	+⅔ stop 20R	+1⅓ stops 25R
Kodachrome-X	None No Filter	+⅓ stop 05M	+⅔ stop 05M	+1⅓ stops 10R
Ektachrome-X	None No Filter	+⅓ stop 05Y	+⅔ stop 20Y	+1⅓ stops 40Y
H.S. Ektachrome	None No Filter	+⅓ stop 20B	+⅓ stop 20B+20M	+1 stop 20B+30M
H.S. Ektachr. Type B	None No Filter	+⅓ stop 05G	+1 stop 10G	+2 stops 05Y

NOTE: Factors for the recommended filters are NOT calculated into the exposure compensation figures. Cameras with through-the-lens metering systems will automatically take the filter factor into account when the meter reading is taken.

To calculate exposure increases in time instead of f/stops, multiply the original exposure as follows:

For ⅓ stop increase, multiply exposure by 1.3

For ⅔ stop increase, multiply exposure by 1.6

For 1 stop increase, multiply exposure by 2

For 1⅓ stops increase, multiply exposure by 2.6

For 1⅔ stops increase, multiply exposure by 3.3

For 2 stops increase, multiply exposure by 4

For 2⅓ stops increase, multiply exposure by 5

For 2⅔ stops increase, multiply exposure by 6.3

For 3 stops increase, multiply exposure by 8.

Canon systems equipment

for Photomacrography and Photomicrography

The equipment listed below is illustrated throughout this booklet and is the same equipment used to take the photomacrographs and photomicrographs illustrated.

Catalog No.	Description
33C	Canon FT-QL Camera Body
33CX	Canon FT-QL Camera Body (Black)
33CA	Canon FT-QL Camera with 50mm f/1.8 Lens
33CB	Canon FT-QL Camera with 50mm f/1.4 Lens
33CC	Canon FT-QL Camera with 58mm f/1.2 Lens
112169	FL 50mm f/3.5 Macro Lens Set (includes lens, case, and 1:1 adapter)
112143	Bellows FL
112665	Booster for FT-QL and Pellix QL Cameras
112685	Copy Stand 3F
112549	Photomicrographic Hood
112559	Photomicrographic Unit CM-IIA
112135	Lens Mount Converter A (must be used with 112549 and 112559 equipment)
112242	Macro Photo Coupler FL (58mm)
112629	Waist-Level Viewer
112214	Extension Ring RL Set (includes one 5mm, one 10mm, and two 20mm rings)
112240	Extension Tube FL (15mm)
112178	Extension Tube FL (25mm)
112502	Locking Cable Release

See your local Canon Systems Equipment dealer for equipment prices. For further information on the complete line of fine Canon photographic equipment, see your dealer or write to Customer Relations, Bell & Howell Co., Department 8625, 7100 McCormick Road, Chicago, Illinois 60645.

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