A STANDARDIZED LABORATORY APPARATUS FOR USING THE SPEEDLIGHT IN PHOTOGRAPHY OF INSECTS AND OTHER SMALL OBJECTS*

by LELAND R. BROWN

Since a colored photograph offers a unique and rapid means of communication, many entomologists desire to use photographs of insects and insect damage in teaching, extension work and in publication. However, many of these entomologists are deterred from making such photographic records because of certain difficulties, such as the proficiency required, the time required and possibly the cost. One objective of this paper is to indicate how these items can be minimized.

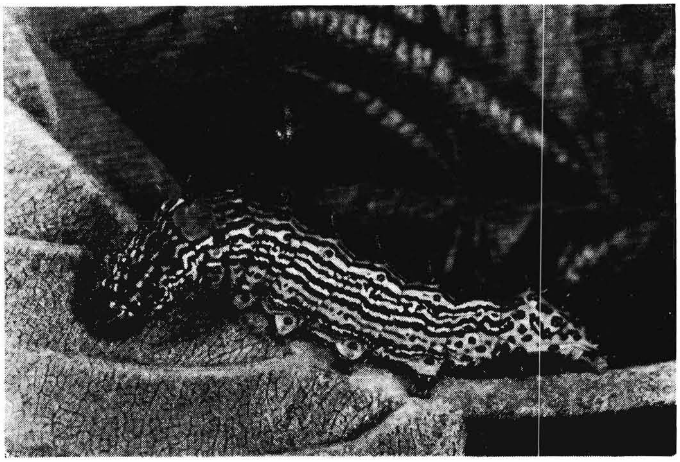

FIG. 1.
A living and moving larva of *Schizura concinna* (J.E. Smith) on Apple leaf. Photographed at 0.88× magnification on the original 35 mm. Kodachrome. Black-and-white reproduction cannot do justice to this beautifully marked insect.

A number of entomology departments or agricultural colleges employ a professional photographer, which is quite satisfactory on the whole and especially so if the photographic budget is large enough to allow such an expenditure. However, some departments cannot afford such an item in their budget and, more important, many entomologists, including the writer, want to have complete control over what appears on the film, and at the time needed, which can be suddenly and frequently. If such is the case, then the entomologist must obviously familiarize himself with the few facts and techniques necessary for

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this type of photography. The logic for this is the same as for any other technique of recording he may employ, such as the use of the pencil, typewriter, camera lucida, micro projector, and sound recorder. If the entomologist decides that photographic records are needed in his field, then it is helpful and sometimes necessary that he standardize his photographic technique so that these duties do not interfere unduly with his other responsibilities. Standardization not only enables the entomologist to make high quality photographic records quickly and at the time needed, but can also reduce costs of the photographic effort by saving time and film in making every exposure effective.

There is considerable literature on photomicrography, *i.e.,* photography with the compound microscope by transmitted light. Likewise the literature is quite extensive on conventional photography, *i.e.,* reflected light photography of objects at a distance from the camera of 2 feet to infinity. Also there is much fine equipment available for making photographs in these two categories. But relatively speaking there are very few authoritative articles on reflected and transmitted light photography between the two types, that is, in the range of low power photomicrography, or an arbitrary range of 0.1 to 20 linear magnifications. Likewise there are very few pieces of equipment with camera and lights as an integral unit for photography in this range of magnifications (see last section).

The main purpose of this paper is to summarize briefly from the great body of photographic literature those few facts, formulæ and techniques found useful to the writer in his insect photography and to describe an integrated photographic device, utilizing speedlights, as constructed and used by the writer. Not the least of the purposes of this paper is to stimulate manufacturers of photographic equipment to produce a simple but effective and integrated apparatus for the use of persons like the writer, who are not engineers or professional photographers, but who would like to obtain accurate photographic records quickly. Such a device need not be expensive or complicated, and this writer feels it would have a considerable market.

It seems logical to discuss first the component parts of this device and their calibration, and then the device as a whole and its operation.

THE CAMERA AND ITS ACCESSORIES

For low power photomicrography, a camera with a ground glass for focusing and composing is very desirable — indeed, it is a necessity at the higher magnifications of this range. For recording living and active insect specimens, a synchronized and automatic (in the sense of coupled film advance and shutter wind) ground glass camera of single lens reflex design is much superior to others. Because of the low cost of 35 mm. Kodachrome film (relative to larger sizes of color film) and other factors (see below), the writer chose the 35 mm. Exakta, (Exakta Camera Co., Distributors, 705 Bronx River Rd., Bronxville 8, N. Y.), a 35 mm. single lens reflex camera. This German-made camera has given excellent service. One feature of the 35 mm. Exakta that is disconcerting, until recognized and allowed for, is the fact that, in low power photomicrography (from approximately 2.0 X magnifications upward), about one-fifth of the ground glass image along the top edge is cut off. Possibly this is a result of the mirror being shortened to keep the camera compact. The writer does not know whether or not other cameras of this design have this fault. There are other 35 mm. single lens reflex cameras available today, some less and some more expensive than the Exakta. These include: the Exa, Practica, Practiflex, Pentacon (or Contax S), (all made in Germany), Alpa (made in Switzerland), and Rectaflex (made in Italy). Brief descriptions, prices and photographs of these cameras can be found in the May 1953 issue of *Photography* magazine. The writer has had experience only with the Exakta, so is not competent to evaluate these other apparently fine precision cameras.

In order to use speedlight, of course, the camera shutter must be synchronized for that type of flash, *i.e.,* no-delay or "O" or "X" setting ("E" contacts in the Exakta V). All currently produced models of the cameras mentioned above are synchronized for speedlight, and all have interchangeable lenses. With lenses of shorter focal length than normal, it is desirable to have a clear spot and cross in the center of the ground glass. For a large number of photographs, the Penta Prism viewing device for the Exakta is a definite advantage.

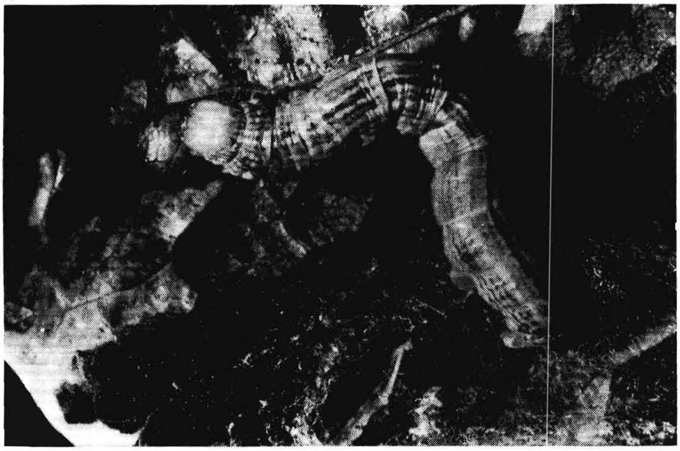

FIG. 2.
A living, moving mature larva of the geometrid, *Sabulodes caberata* Guenée, on a leaf of variegated ivy. Photographed at 0.59× magnification on the original 35 mm. Kodachrome with one speedlight lamp.

In order to obtain a larger image on the film one must either (1) use a lens of focal length longer than the normal lens, and keep the camera in the same position, or (2) extend the normal lens (or shorter focal length lens) from the film, and move the camera closer to the subject. The former case is needed infrequently in the laboratory (the formulæ stated in this paper apply in this case also, however). The latter case is more commonly used in low power photomicrography.

Extending the lens is accomplished by means of extension tubes or bellows extension attachments. Extension tubes have the advantages of being relatively inexpensive, sturdy, and, when combined properly, a given magnification can be duplicated with little difficulty. They have the disadvantage of taking some time to change to another magnification. A bellows extension is useful in that

Table 1. Adjustments for a standardized low power photomicrographic technique.*

1. Size of subject (cm.)	2. Magnification	3. Lens (focal length in cm.)	4. Marked f/no.	5. Portra lens	6. Extension tubes (length in cm.)	7. Lamp-to-subject distance (cm.)
76.2 x 50.8	0.05X	5(4')	8			R63
63.5 x 42	0.06X	5(3.25')	8			R62.5
50.8 x 33.8	0.07X	5(2.8')	8			R62
47.7 x 31.7	0.08X	5(2.6')	8			R61.5
38 x 25.4	0.10X	5(24")	8			R60.5
34.5 x 23.1	0.104X	5(20")	8			R60
31.7 x 21.1	0.11X	5(30')	11	+2		R44.1
29.2 x 19.6	0.12X	5(12')	11	+2		R44
25.7 x 17	0.14X	5(6')	11	+2		R43.9
23.6 x 15.8	0.15X	5(4.5')	11	+2		R43.8
21.6 x 14.5	0.17X	5(3.5')	11	+2		R43.7
19.1 x 12.7	0.19X	5(2.5')	11	+2		R43.6
16.5 x 10.9	0.22X	5(20")	11	+2		R43.5
12.4 x 8.3	0.29X	5	11		♀,♂	17.2
9 x 6	0.40X	5	11	+2	♀,♂	17.2
6.1 x 4.1	0.59X	5	11		♀,♂,1.5	14.0
4.1 x 2.7	0.88X	5	16		♀,♂,3	8.1
3.6 x 2.4	1.00X	5	16	+2	♀,♂,3	8.1
3 x 2	1.18X	5	16		♀,♂,1.5,3	7.0
2.54 x 1.69	1.42X	5(20")	16	+2	♀,♂,1.5,3	6.5
2.05 x 1.36	1.75X	3.5	8		♀,3	11.1
1.64 x 1.1	2.19X	3.5	8		♀,1.5,3	9.6
1.17 x 0.78	3.09X	3.5	8		♀,1.5,3,3	7.5
0.9 x 0.6	4.03X	3.5	8		♀,3,3,5	6.1
0.71 x 0.47	5.08X	3.5	8		♀,1.5,3,5,5	5.0
0.61 x 0.41	5.92X	3.5	8		♀,1.5,3,3,5,5	4.4
0.51 x 0.34	7.1X	1.5	5.6		♀,5	5.4
0.46 x 0.31	7.9X	1.5	5.6		♀,3,3	4.9
0.4 x 0.26	9.1X	1.5	5.6		♀,3,5	4.3
0.36 x 0.24	10.1X	1.5	5.6		♀,1.5,3,5	4.0
0.32 x 0.21	11.1X	1.5	5.6		♀,1.5,5,5	3.6
0.3 x 0.2	12.0X	1.5	5.6		♀,1.5,3,3,5	3.3
0.27 x 0.18	13.1X	1.5	5.6		♀,1.5,3,5,5	3.1
0.25 x 0.17	14.2X	1.5	5.6		♀,3,3,5,5	2.9
0.21 x 0.14	16.9X	1.5	5.6		♀,1.5,1.5,3,3,5,5	2.4

*Utilizing the following: 35 mm. daylight Kodachrome. Kine Exakta camera, model V, a 50 mm. f/3.5 Zeiss Tessar lens with focusing scale in feet (all settings at infinity unless otherwise specified); 35 mm. f/3.5 Fairchild type V lens; 15 mm. f/2.7 Zeiss Tessar lens; Kodak +2 Portra lens. Thriftlite speedlight, model AC-40, with an extension light, model EL-40, and an intensifier, model AD-15, on the powerpack. Each lamp at 45° from optical axis of camera, except at 25° for the range of magnifications of 0.05X to 0.104X ("R" indicates use of regular reflector). Male (♂) and female (♀) symbols refer to male and female adaptors for the extension tubes (♂ + ♀ = 1.5 cm., ♀ = 0.5 cm.).

changes of magnification can be made quite rapidly, but it has the disadvantages of higher cost and the possibility of slippage of the lens panel, unless one of highest quality is obtained. The bellows extension does not seem to be as sturdy as extension tubes. Also the bellows extension has a maximum and minimum limit to which it can be extended or retracted, whereas extension tubes can be added or deleted to the limit of practicality. However, with the proper lenses, the range of low power photomicrography can be covered with either method of extension. A disadvantage of some of the cheaper extension tubes is their less precise machining and the absence of sharp-edged baffle rings on their inner surface. In some cases thin rings of flat-black paper can be glued in these tubes to reduce light flare spots on the film. The bellows extension is free of this fault. Because of the initial cost the writer chose extension tubes.

According to authorities on lens construction (Greenleaf, 1950; Kingslake, 1939, 1951), lenses of decidedly asymmetrical construction (embraces many of the very fast lenses) should be avoided for low power photomicrography. Symmetrical or near symmetrical lenses are preferred, such as the Tessar types, the dialyte types (Dogmar, Unifocal, etc.), and the double anastigmats (Dagor, Protar, etc.). For the higher magnifications of this range, lenses of shorter focal length than the normal lens are useful in order to keep the lens extension within practical limits. Lenses designed for low power photomicrography are certainly to be preferred, good examples being the Micro Tessars of Bausch and Lomb, the Micro Luminars of Zeiss and the Micro Summars of Leitz. To date the writer has not been able to afford any of these lenses, so has had to be content with a 35 mm. and a 15 mm. focal length lenses, (see Table 1, column 3) from conventional movie cameras. Both of these lenses are mounted backwards in their mounts to improve resolution (see Figs. 6 and 7), *i.e.,* the normal film side of the lens toward the subject. On the whole, these used movie camera lenses are satisfactory, but lenses designed for the purpose would probably be better.

It will be noted in Table 1, column 5, that a 2-diopter positive supplementary lens is needed with the 35 mm. Exakta to bridge the gap between 0.1 and 0.3 magnifications and also in three other cases to obtain useful magnifications. The "2 in 1" Exakta adaptor extension ring can be used in place of the plus 2 diopter supplementary lens to cover the range of 0.1 X to 0.2 X magnifications.

In order to be certain of obtaining a given magnification it is most convenient to leave the lens-to-film distance fixed and focus by moving the camera and lens as a unit. Such an arrangement is a necessity for the higher magnifications of low power photomicrography. This usually involves some sort of rack and pinion arrangement for accurately controlled focussing. The writer has used a rack and pinion from a war-surplus microscope, which works very well (see Fig. 9). (It is well to note that by removing the optical parts of a dissecting microscope and replacing with the camera and extension tubes, a very fine, small, precision copying stand can be had.) There is a German rack and pinion now marketed for this purpose by Exakta under the trade name of "Novoflex" (code word CASTEL).

One reason was mentioned above for using the 35 mm. camera. Another reason should be discussed. An ever-present problem to contend with in low power photomicrography is the very shallow depth of field. Kingslake (1951) states: "For the same magnification on the film (not the same subject distance) and the same f/no., lenses of all focal lengths have the same depth of field."

This statement can be interpreted further. To fill the film area of a 35 mm. film obviously requires less magnification than to fill the film area of a larger size film. Or it can be said that less depth of field will be obtained with larger film sizes, if the full film area is utilized, and at the same relative apertures as compared to 35 mm. film. This is an obvious advantage of using this small film size.

Occasionally when extension tubes or bellows are purchased, a table of magnifications is also included. Such a table may not cover the complete range of magnifications desired, as when two or three sets of tubes are needed, or when shorter-than-normal focal length lenses are used. In this case a magnification is easily determined by observing on the long dimension of the ground glass the number of millimeters seen, on a meter stick focused upon, and dividing this number into the exact length (in millimeters) of the ground glass. With a ground glass camera this seems more simple than, and as accurate as, trying to determine the difficult-to-measure lens-to-film distance and using a more complicated formula to calculate magnification. Before determining the magnifications it is helpful to list all possible combinations of extension tubes and lenses. After determining the magnifications with these various combinations, the most useful magnifications can be arranged as in columns 2 and 6 of Table 1. At the same time the magnifications are determined, it is convenient to note the length and width of the field covered at a given magnification, as this will save time in the daily routine of photographic recording (see Table 1, column 1).

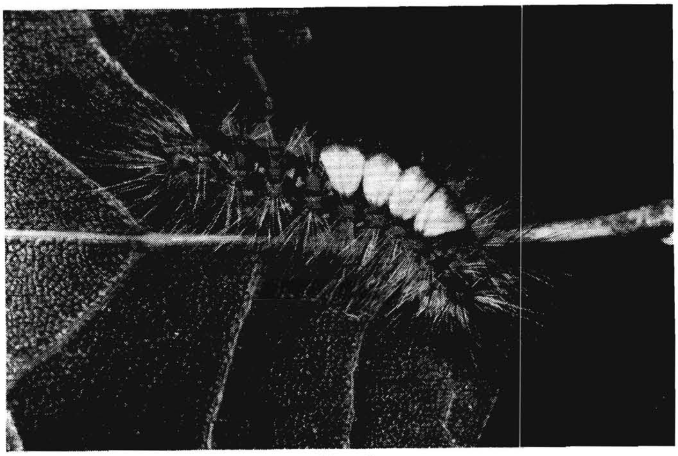

FIG. 3.
A living and moving larva of the Tussock Moth, *Hemerocampa vetusta* (Bdv.), on a leaf of Coast Live Oak. Photographed at 1.00 magnification on the original 35 mm. Kodachrome.

It was necessary to compromise on a given marked f/number, or relative aperture, for each magnification to make the photographic effort more rapid. The objective was to obtain as much depth of field as possible without having a noticeable loss of resolution in the plane focused upon from the effects of diffraction (scattering of light around the edges of the iris blades). At a given magnification (and at all magnifications listed in column 2, Table 1) the proper aperture was determined by stopping down a given lens to the f/no. at which the image just began to show a very slight unsharpness. This was simple to do by observing, on the clear spot of the ground glass, the image of a brightly illuminated object, such as a white celluloid ruler with much fine detail. These marked apertures are indicated in Table 1, column 4. These correspond to effective apertures of f/8.4 to f/100.4. Effective f/no. equals the magnification plus one, multiplied by the marked f/no., as for example at 1.18 X with a marked f/no. of 16, effective f/no. = (1.18 + 1) (16) = 34.9. It is interesting to note that the effective aperture is not changed when a Portra lens is used (Kingslake, 1951).

It will be noted in the range of magnifications from 0.05 X to 0.59 X (see column 4 of Table 1) that these apertures are not as small as indicated in the foregoing. In these cases it was necessary to open the lens aperture somewhat so the speedlight lamps could be placed further from the subject to achieve more even illumination (see the next section). Even at the indicated distances, only two lamps are not ideally suited for even illumination at the lower magnifications (0.05 X to 0.1 X). Raising the lamps to 25° from the optical axis helps somewhat.

LIGHTING EQUIPMENT

Proper illumination in low power photomicrography is just as important in making the photograph as the camera itself, but this is the phase most often neglected in papers on this branch of photography. This section is concerned with a new type of lighting and its adjustment for low power photomicrography, especially reflected light (as contrasted to transmitted light).

The invention and development of the speedlight has been traced in several publications, one of the most appropriate being that of Van Riper, *et al* (1952). Most of the currently made speedlights are listed by Lipton (1953), who also gives an excellent account of this type of lighting. *Photography* for May 1953 lists most of the speedlights available in the United States and has photographs of many of them. The speedlight is also known as high-speed flash, electronic flash, and strobelight. The light produced by one of these units is characterized by being a cool, very brilliant flash of very brief duration, and having a color range somewhat comparable to average daylight.

As compared to usual sources of illumination, the advantages of the speedlight for use in low power photomicrography, particularly of insects, can be listed as: (a) elimination of the effects of whatever vibration may be present in the photographic set-up; (b) elimination of the effects of movement of the living specimen; (c) elimination of prolonged exposures; (d) when desirable, elimination of killing, deep anesthesia or cooling of the specimen; and (e) elimination of hot sources of illumination. In regard to point (d) it should be mentioned that if the specimen is so active that it will not remain in the photographic field, slight anesthesia with carbon dioxide or chloroform is necessary.

With conventional sources of artificial illumination (incandescent or combustible sources such as photoflood or flash bulbs), the photographer has three variables he can control readily: lamp-to-subject distance, f/no., and shutter speed. However, with a speedlight the effective exposure time is so brief (1/500 to 1/50,000 of a second for most units) that shutter speed has no effect on the exposure. This leaves the photographer with only two variables he can control: lamp-to-subject distance and f/no. With the 35 mm. Exakta camera used by the writer (model V), the shutter speed is set at 1/50 of a second and left there when using the speedlight; at this shutter speed the complete film area is said to be open for 6 milliseconds by the focal plane shutter (Berkowitz, 1951). At faster shutter speeds with this camera the film area is never completely open, so the speedlight cannot be used with these faster shutter speeds. This is generally true of all 35 mm. cameras with focal plane shutters.

The Kelvin rating of most speedlights is listed as 6000° to 7500° or even 8000°, depending upon the unit. The lower Kelvin rating of certain speedlights, such as the "Thriftlite" (Pho-Tak Corporation, 15-21 N. Loomis Street, Chicago 7, Illinois) allows daylight Kodachrome to be used without filters. Higher Kelvin ratings of some speedlights require slight compensating filters, either on the camera lens or on the lights.

The principal disadvantage of the speedlight is its relatively high initial cost. For low power photomicrography, however, low power speedlights, and consequently lower cost units, are sufficient. It should be noted also that low power speedlight units are produced currently that are less expensive than several conventional microscope illuminators.

The manufacturer usually supplies a "guide number" for various types of artificial photographic illumination, including the speedlight, of course. A guide number is a very simple but extremely useful application of the inverse square law of illumination to allow the photographer to obtain a correctly exposed film. With a given film and shutter setting, the photographer divides the guide number by the lamp-to-subject distance to obtain the correct lens aperture (f/no.). Or, if a given f/no. is decided upon, the guide number is divided by the f/no. to obtain the correct lamp-to-subject distance. In low power photomicrography the formula should be modified to: lamp-to-subject distance equals the guide number (for centimeters) divided by the effective f/no.

For conventional photography it is sometimes necessary to check the guide number of the speedlight as stated by the manufacturer. In low power photomicrography the guide number should certainly be checked or determined, as the speedlight may frequently be used in a manner different than as originally purchased. The guide number supplied by the manufacturer is usually supplied for use in feet. For low power photomicrography this should be changed for use in centimeters. For example, suppose the manufacturer's guide number is 35 for use with feet (this is the manufacturer's guide number of the "Thriftlite" model AC-40 with Intensifier, with a single lamp and reflector and for Kodachrome daylight film; when converted for use in centimeters, it is essentially the same as the writer's determination of 1070; the guide number of the single lamp, with the intensifier and without the reflector, was determined to be 305 for use in centimeters). Multiply 35 by 30.48 (*i.e.,* the number of centimeters per foot) to obtain a guide number approximately 1067. The reason for this is that in low power photomicrography the speedlight lamp may be as close as 2 or 3 centimeters from the subject, and it is simpler to measure these distances in the metric system than in fractions of a foot or an inch.

To determine a guide number the writer has found it convenient to photograph a gray scale at various marked f/no.'s and keep the following factors constant: film, magnification, shutter speed, and lamp-to-gray-scale distance. When the film is returned from the processor, the various exposures are projected to the original dimensions of the gray scale, and the gray scale is compared, side by side, with its image. Then the guide number is determined practically by inspection.

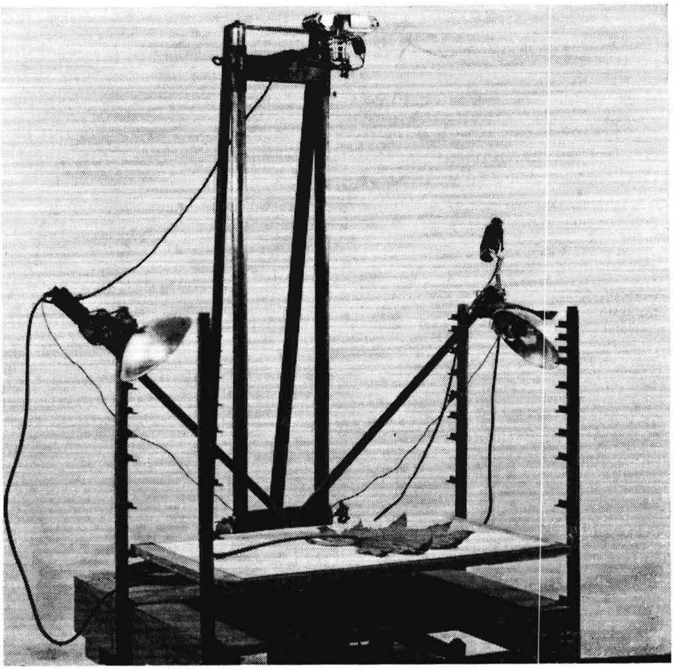

FIG. 4.
Photographic recording stand set up for 0.05× magnification; see Table.

For clarity this is best illustrated by an example (see Fig. 8). The problem was to determine the guide number of the Thriftlite, model AC-40 (with the intensifier on the power pack) and an extension light, model EL-40 (*i.e.*, the use of two lamps), with type A Kodachrome, with the type A filter for daylight. The camera was a Kine Exakta, model V, with the shutter set at 1/50 second and the synchronizer cord in the contacts for speedlight (*i.e.*, "E"). The camera lens was located at 20 inches (*i.e.*, magnification of 0.104 X) from the center of the gray scale with the long dimension of the gray scale and the camera set parallel to the speedlight lamps. Each lamp, in its regular reflector, was located 60 cm. from the center of the gray scale and on each side of the camera at 45 degrees from the optical axis of the camera lens. Six exposures were made under these conditions at the following relative apertures (f/no.'s): 4, 5.6, 8, 11, 16 and 22.

When the film was returned from the processing laboratory, each transparency was projected on a white matte surfaced screen to the original dimensions of the gray scale, that is, about 10 times magnification of the transparency. By holding the gray scale next to its projected image, and in a clear portion of the projected beam of light, it was obvious that the exposure at f/4 was overexposed and those at f/16 and f/22 were progessively underexposed. By closely inspecting the white end and first stage of gray of the f/5.6 exposure, both steps appeared white so the transparency was said to be overexposed. Likewise with the f/11 exposure the black end and first step of dark gray were indistinguishable, that is, both black, so this transparency was said to be underexposed. The image of the exposure at f/8 was almost identical with the gray scale, that is, all steps of the gray scale were distinct.

The effective aperture at 0.104 magnification and a marked aperture of f/8 is equal to 8.83. Thus the guide number for these conditions is (8.83) (60 cm.) or approximately 530. In Table 1, 530 is divided by each effective aperture in the range of 0.05 to 0.22 magnifications, inclusive, to obtain the lamp-to-subject distances in column 7. "R" indicates the use of the reflectors on the lamps.

Similarly and as shown in Fig. 9, a guide number of the bare lamps (without reflectors) was determined to be about 244. In Table 1, 244 is divided by each effective aperture in the range of 0.29 to 16.9 magnifications, inclusive, to obtain the lamp-to-subject distance in column 7.

As can be seen in Fig. 6, there is one-half of a frozen juice can over each lamp. The inside of each half-can is lined with shiny-surfaced aluminum foil. The use of this small reflector gives no increase in guide number over the bare lamps, contrary to what one would expect; that is, the guide number of the two lamps with the juice can reflectors is 244. The principle function of the cans then is to protect the lamps from falling objects.

There is a factor which must be recognized when working with some speedlights at very close subject distances, and that is the guide number becomes less as the subject is approached by the lamp in the reflector as supplied by the manufacturer. Quite possibly this is because the reflector is not designed for work at such close distances. If the speedlight is one in which the reflector can be detached, such as the "Thriftlite" and certain others, then the apparent radiating source more closely approaches that of a point source of illumination, upon which the inverse square law of illumination is based. If a guide number is determined for the lamp without the reflector, that guide number can be used accurately (on or near the optical axis of the camera) whether the lamp is 1 inch or 50 inches from the subject. However, in order to obtain more even illumination of larger subjects, it is practical to use the lamp with the reflector up to about 0.3 magnification, and from that to about 17 magnifications, using the bare lamp (or in its juice can protector).

This phenomenon of decreasing guide number, as the lamp in its regular reflector is brought nearer the subject, has been demonstrated several times by the writer with the Thriftlite, and he is satisfied that it is not due to variation in film processing or other variable. The reader should not construe this to mean that the speedlight with a non-detachable reflector cannot be used for low power photomicography. It is probable that any speedlight can be used in this type of photography, particularly at the lower magnifications. But with those speedlights having fixed reflectors, a guide number should be determined for each magnification contemplated, which amounts to the same thing as trial exposures. With a bare lamp this is not necessary. Unless one has a relatively powerful speedlight, it is not possible, at the higher magnifications, to get the lamp in its regular reflector close enough to the subject because of interference of the camera and extension tubes with the reflector.

Since by its nature the speedlight is not a continuous source of illumination (as compared to photoflood, for example), some means must be provided for light for focusing and composing the picture. For this a conventional microscope illuminator (Spencer No. 353 in Figs. 5 and 9) can be used, and this is left on during the preliminary and taking phases of the picture. The relatively dull light of this microscope illuminator (compared to the brilliant speedlight flash) offers sufficient light for focusing and composing but only 1/10 to 1/20 the amount of light (even at its brightest) necessary for recording the image on the film. With color film this gives no practical exposure whatever, and one need not fear ghost images appearing on the film.

THE PHOTOGRAPHIC STAND

The photographic stand is shown in Figs. 4 through 9, with the camera, speedlight, and lamps attached. The stand itself is like many other photographic copying stands noted in the literature, but has a few refinements to adapt it more conveniently to a standardized technique.

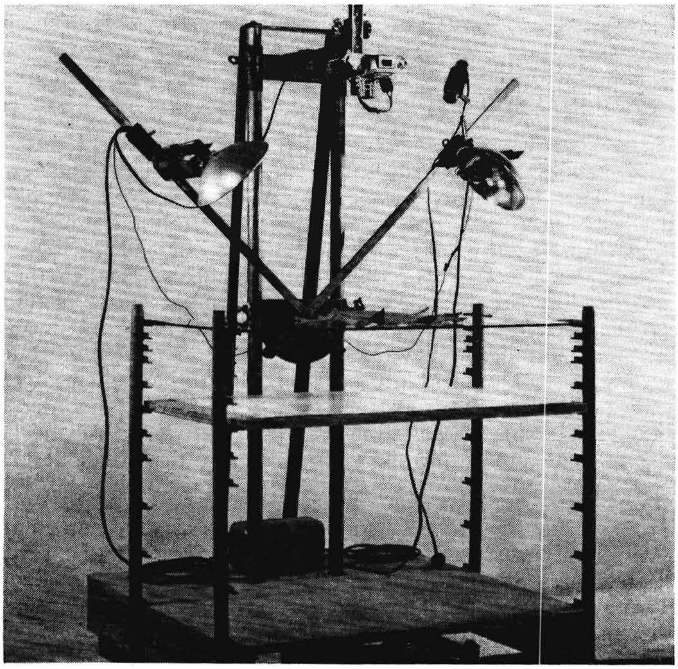

FIG. 5.
Photographic recording stand set up for 0.11× magnification with leaf subject on plate glass; see Table.

A piece of war-surplus equipment was found which had a cast-iron base with two hollow vertical steel pillars attached. The pillars are 4 feet long. A piece of ¾-inch thick 5-ply plyboard, 32 inches square, was fitted over the cast-iron base and attached to it, utilizing various pieces of wood and bolts. This arrangement left a space at the front approximately 20 by 30 inches, which is the maximum size this device can record. The 10 by 30 inch space behind is used for holding the speedlight powerpack and coiled cables. A rubber-tired caster is attached to each corner so the apparatus can be moved about.

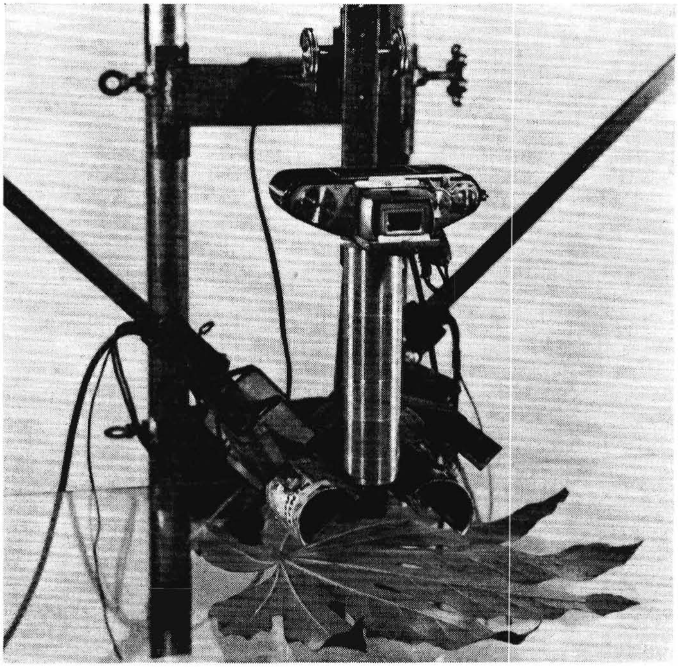

FIG. 6.
Photographic recording stand set up for 5.92× magnification; see Table. Note use of juice-can projectors on lamps.

The pillars are joined together at the top with a piece of strap iron. Extending down to the rear from the tops of the pillars are two pieces of angle iron which fasten through the plyboard and cast-iron base. Thus the pillars are very rigid and there is little or no angular movement possible between the pillars and baseboard. On each pillar there is a pair of close-fitting iron sleeves, which have set screws. The top sleeves are joined together by welding two pieces of cold rolled steel on the front and back. A piece of cold rolled steel is welded to this and extends out over the center of the baseboard to hold the camera and its accessory rack and pinion. This top member is for the rough and fine positioning of the camera.

The bottom sleeves are joined together in a similar manner. Welded to this bottom member is a semi-circular steel plate with the curved portion down; the curved portion is graduated in 5° increments. A bolt is located in the center of the semi-circle to act as a pivot for two steel bars, which are of rectangular cross section, and are approximately 3 feet long. Each bar extends slightly beyond the edge of the semi-circle with an arrangement for quickly clamping each bar at any angle from the optical axis of the camera. After the necessary guide number tests were made it was realized that, with a standardized apparatus, this complete adjustability of the angle of lighting is unnecessary. The most useful setting is with each lamp at 45° from the optical axis. Each lamp at 25° gives better illumination at the lower magnifications.

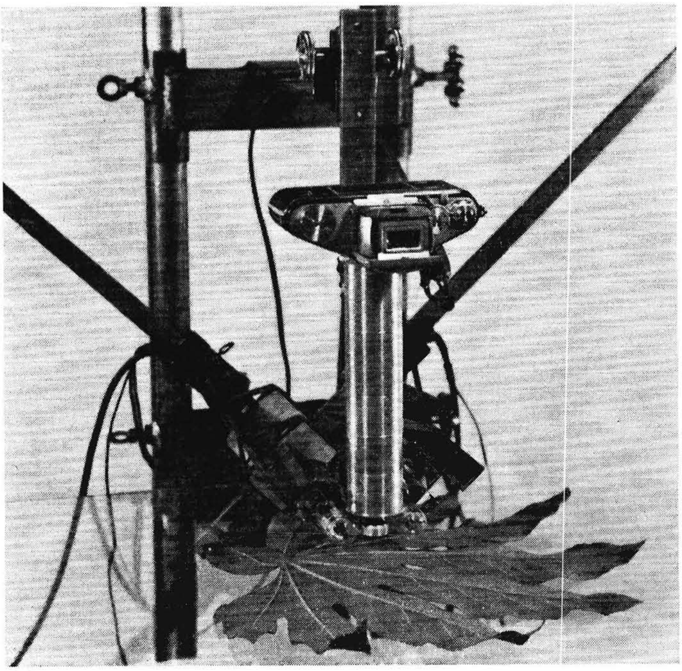

FIG. 7.
Photographic recording stand set up for 16.9× magnification; see Table. Note bare lamps.

Each bar is graduated in millimeters for 15 millimeters from the center of the pivot bolt and in 5-millimeter increments thereafter to the end of the bar. To each bar a closely fitted sliding member is attached, with a set screw for positioning at any distance from the pivot bolt. The reason for using a bar of rectangular cross section is that no rotation of the sliding member is possible, *i.e.,* motion is possible only along the bar. Each sliding member is constructed of pieces of flat and square steel stock, the latter of the same thickness as the bar, welded at the edges. To each sliding member a piece of angle iron is welded to extend out over the base board for holding a lamp of the speedlight.

The center of each lamp is located in the same plane as the optical axis of the camera lens.

At each corner of the 20 by 30 inch front space a vertical pipe 2 feet long is bolted to the wooden frame. At appropriate intervals along each pipe short sections of small angle iron are welded. The equal height of each angle iron on each pipe can be assured by laying the four pipes together on the welding bench and laying a piece of angle iron perpendicularly across the tops of the pipes and spot welding each pipe to the angle iron. The angle iron is then cut between the pipes to obtain the four pipes with equal spaces. These angle iron spacers are for the purpose of holding a 20 by 30 inch piece of plate glass with ground and polished edges, and a piece of ¾-inch 5-ply plyboard of similar dimensions. The plate glass is used for supporting the specimen at the higher magnifications while the background is supported on the movable plyboard beneath.

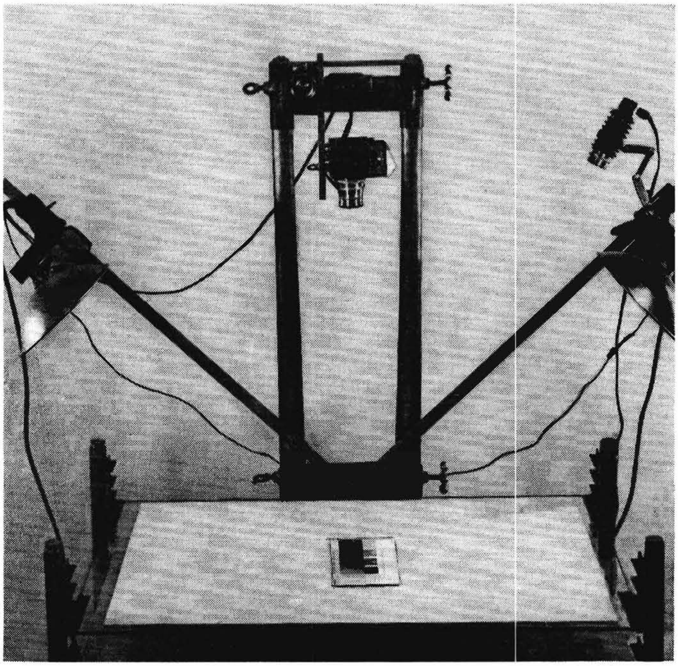

FIG. 8.
Set-up for photographing gray scale and color patches for guide number determination of speedlight with regular reflectors on lamps; see text.

It was learned to the dismay of the writer that any machine work or grinding necessary should be done after the pieces are welded together, as the welding process tends to deform the metal somewhat. This applies to the sliding sleeves on the vertical pillars and the sliding members on the steel bars. If these parts are a close fit before welding, they are almost certain to bind after welding, necessitating some laborious grinding to obtain freedom of movement.

A variety of backgrounds may be used. The specimen can be placed directly on black paper or cloth and this is often very pleasing. The specimen can be placed on the plate glass with a "physicist's black body" beneath for an absolutely black background (Pence, 1947). The black body in this case is a box, painted flat black, both inside and out, and with a hole in one side slightly larger than the area to be recorded. This amounts to photographing with a shadow for a background, that is, an absence of light in the background. In this case care must be exercised to keep the plate glass clean, as a particle of dust or the scale of a moth wing can be quite distracting. Also shiny surfaces on the camera front should be painted a flat black, as light can strike these surfaces, reflect to the plate glass and back into the camera, causing an out-of-focus light spot on the black background. Also the writer remembers

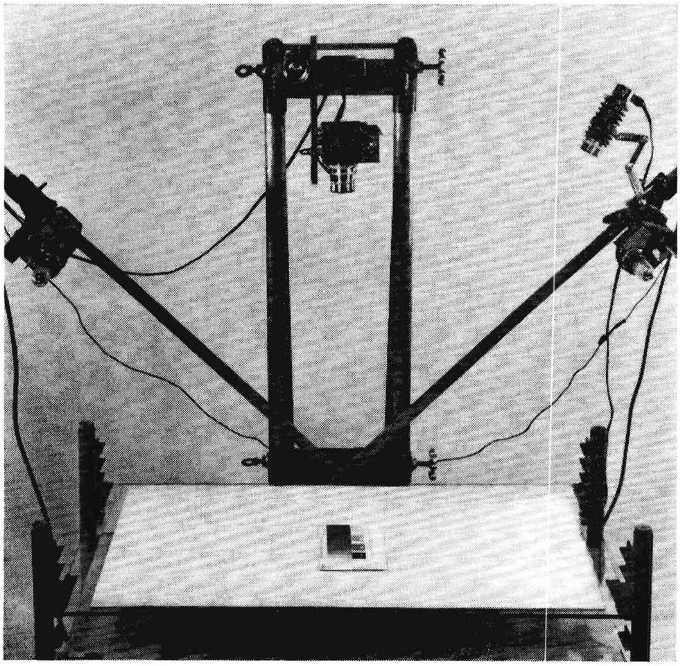

FIG. 9.
Set-up for photographing gray scale and color patches for guide number determination of speedlight with bare lamps; see text.

one disconcerting series of pictures with the black body in which a dim image of a red-checked shirt he was wearing appeared as a reflection in the background. Oftentimes these disadvantages can be overcome by dispensing with the plate glass and suspending the subject over the hole of the black body with a clamp or some such device.

Light backgrounds are desirable for many subjects. These are possible by placing the subject on the plate glass and white or colored blotters on the plyboard substage. Shadows of the subject can be cast outside of the picture area by lowering the background to the proper level. This level could be indicated in another column in the photographic chart (*i.e.,* in Table 1). It will be noted in Figs. 5 and 6 that the long dimension of the camera is placed parallel to the speedlight lamp. With this arrangement the shadows are cast out of the background with the background nearer the subject than when the long dimension of the camera (and picture area for 35 mm. film) is perpendicular to the lamp. This results in a brighter background. Note the use of the Penta Prism viewfinder in Figs. 5 and 6. In this position this viewfinder is much more convenient than the regular hooded finder.

Of course there are other means for obtaining a light, shadowless background, but other methods make the apparatus more complex. However, many entomologists would consider this additional control desirable. In such cases a single speedlight capable of operating possibly four lamps, two for illuminating the subject and two for the background, would be desirable. The background could be an opaque matte surface illuminated from above or a ground or opal glass illuminated from below.

Many times the whole picture area includes a leaf or portion of a leaf or twig. In these cases the leaf can be pinned or taped flat to a pinning block, and the choice of a background is not a problem.

MAKING THE PHOTOGRAPHIC RECORD

It saves time to make a rapid measurement of the length and width of the specimen or area to be included in the photograph. An estimate often suffices. Such a measurement gives the clue to all other operations to be performed to obtain the photograph (see column 1 of Table 1). With a standardized technique all that need be recorded on the record file cards or notes regarding the photographic technique is the magnification used.

The type of background is decided upon and adjusted. The specimen, or the area where the specimen will be, is placed temporarily near the back of the stage, and the center of the pivot bolt of the speedlight arms is brought to the same level. The lights are adjusted to the proper distance, as measured on the calibrated arms, and the reflectors are left on or removed as required. These directions from the photographic chart having been followed, the lighting equipment is now adjusted to give proper illumination at the desired magnification.

The focusing light is turned on, and the speedlight is allowed to develop a full charge with the synchronizer cord attached to the camera. The proper extension tubes and lenses are attached to the camera, shutter speed is set at 1/50 second, and with the lens at full aperture the subject is brought into rough focus by moving the member supporting the camera. The subject is composed on the ground glass and fine focus attained with the rack and pinion. The lens is adjusted to the proper f/no., and the picture is taken with the cable release. So adjusted, picture after picture of the subject can be taken, and they will all be of the same high quality as long as enough time is allowed for the condensers of the speedlight powerpack to develop a full charge (10 seconds between flashes with the "Thriftlite").

Such is the case with immobile or fairly placid insect subjects. With actively moving subjects slightly different techniques may be necessary, some of which involve a high degree of patience and manual dexterity. All adjustments can be made before the subject is placed under the lens, even to stopping down the lens. An adult insect that may fly can be placed on a supplementary piece of glass and beneath an inverted half of a petri dish. When the subject appears in suitable position by adjusting the piece of glass, the petri dish is carefully removed, slight adjustment made in the rack and pinion focusing, and the cable release pressed. With certain larvæ, such as tortricid larvæ, it is sometimes expedient to dissect the rolled leaf "nest" beneath the camera lens with all in readiness to photograph the larva when exposed. Another possibility, such as with certain tree-hoppers or leaf-hoppers that like to scurry to the lower surface, is to have the lens prefocused on the same horizontal plane as the pivot bolt of the speedlight arms. The plate glass stage is removed 2 or 3 inches below to act as a hand rest, and the host plant with the moving insect subject is manipulated into the field with one hand and the cable release operated with the other hand.

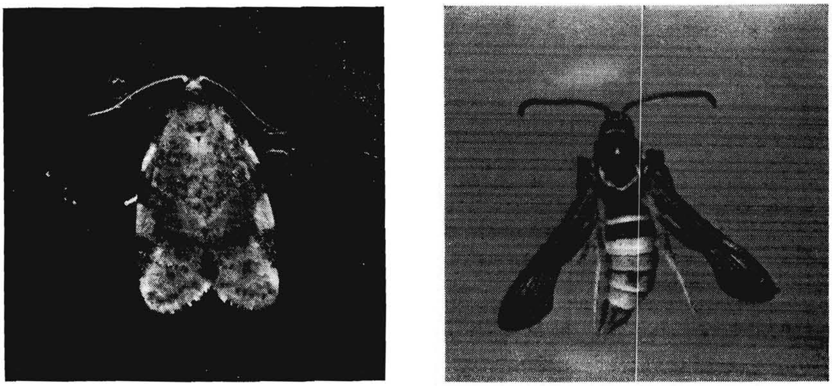

FIG. 10.

Left, a living, resting adult of the Fruit Tree Leafroller, *Archips argyrospila* Walker; reared from Coast Live Oak. Photographed at 1.18× magnification on the original 35 mm. Kodachrome. Illustrates the difficulty of keeping the plate glass stage clean when using the "black body" for a background. Right, a living and moving adult of the Hornet Moth, *Alcathœ apiformis* (Clerck); reared from Willow. Photographed at 2.88× magnification on the original 35 mm. Kodachrome.

As mentioned previously, it is sometimes necessary to inactivate the very active insects with carbon dioxide gas or chloroform if they cannot be induced to remain in the photographic field. Chloroform acts very quickly, but the writer prefers carbon dioxide, since it does not have the apparent ill effects on the insect specimen. It seems best to wait a few moments after removal from the carbon dioxide atmosphere so the insect can assume its most alert attitude prior to scurrying off again.

As would be expected such a standardized photographic device would have uses in addition to photographing insects. One use the writer has made of this device is the rapid microfilming of literature not always readily available, such as copying abstracts from various journals, entomological keys, etc.

In teaching, wall charts are useful but for newer fields these are not always available. In such cases drawings from various entomological texts often suffice. The writer had occasion to make 250 transparencies of textbook drawings on this photographic device to use as visual aids for his class.

The writer has made not less than 1000 Kodachrome transparencies on this photographic device by the technique outlined. The percentage of those improperly exposed was very low. In those cases of improper exposure the trouble was not with the device but almost exclusively with the writer, as for example: forgetting to set the f/no., failing to adjust the lamp-to-subject distance, failing to let the powerpack develop a full charge, etc. Thus it can be said, almost categorically, that by following rigidly such a technique of "cookbook photography" one can expect properly exposed low power photomicrographs every time the shutter is released.

INTEGRATED PHOTOGRAPHIC UNITS AVAILABLE COMMERCIALLY

Earlier it was mentioned that very few integrated photographic units were available for use in low power photomicrography. The writer knows of only two such units utilizing the speedlight. Apparently neither of these is particularly well adapted to making photographic records at magnifications greater than about 1.0 X. However it should be mentioned, at least in the writer's work, that a large percentage of photographs have been taken at 1.0 X magnification or less; that is, either of these units might be quite suitable for many entomologists. The writer has handled only one of these units, the "Photronic", and has seen only a brochure of the other. Both units appear well designed for clinical photography in hospitals. Both have built-in focusing lights, and both utilize 110 volt alternating current. Either unit can be attached to a tripod and aimed in any direction, such a feature being very desirable and a considerable advantage over the device described by the writer.

The "Photronic" (Photronic, Inc., 5662 S. E. 122nd Ave., Portland 66, Oregon) utilizes a speedlight with a circular flash tube fixed around the front of the lens of the 35 mm. Exakta or other 35 mm. single lens reflex camera. As one focuses on the ground glass a dial indicates automatically the proper f/no. The lens aperture is set by hand and the picture taken. Such an arrangement of the speedlight lamp gives a flat type of lighting, with little or no shadow around the edges of the subject, which is very effective on Kodachrome. This unit is well adapted for photographing into cavities.

The "Quick-clix" (Walden Industries, Inc., 350 W. 50th Street, New York 19, N. Y.) model A-300, utilizes what appear to be two conventional speedlight lamps and reflectors, fixed approximately 5 inches on each side of the camera lens. The camera can be, apparently, any 35 mm. single lens reflex camera or other type of camera. The "Quick-clix" does not have the automatic feature of the "Photronic" in which the light-to-subject distance is related to relative aperture. However, the "Quick-clix" does have an arrangement for pre-setting of the lens aperture whereby focusing is done on the ground glass with the lens at maximum aperture. As the shutter release is actuated, the aperture automatically stops down to the pre-set aperture.

A unit in which the good features of the "Photronic" and "Quick-clix" were combined would be a truly automatic recording device for the magnifications for which these units are designed.

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PERSONALIA

The death of Society member S. LEMARCHAND, of Paris, in November 1953, at the age of 77 years, has been reported by P. E. L. VIETTE. M. LEMARCHAND was a disciple of JOANNIS (see *Lepid. News* 3: p. 77) and specialized on the Microlepidoptera of the French fauna. He described several new species of *Lithocolletis, Scythris,* and *Stigmella* (= *Nepticula*) and took a large part in the Lhomme *Catalogue des Lépidoptères de France et de Belgique.* The collection was given by his family to the Paris Museum; it contains large series of French Microlepidoptera, with 13 LeMarchand types and 1 Meyrick type.

On 7 February 1953, MASAMI WATARI, a lifelong amateur lepidopterist, and a member of The Lepidopterists' Society, died in Tokyo, Japan. He was born there on 5 September 1897. Having finished the law course at the Tokyo Imperial University, he was commissioned to various government posts. Everywhere he was stationed he collected butterflies enthusiastically and named many forms, mostly aberrations.

At least one Hairstreak, from Formosa, was named after him: *Strymonidia watarii* (MATSUMURA), 1927.

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