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Ultra-Violet Photography of Lepidoptera

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The Editor asked one of us to contribute notes on a simple method of obtaining ultra-violet photographs of butterflies. Such pictures may reveal patterns concerned in their mutual recognition during courtship, and so interest both the ethologist and the taxonomist (Ferris 1973). The procedure originally employed by Bowden (1977) for set insects depended upon the availability of an ultra-violet discharge lamp (Allen 409) fitted with a Wood's glass filter to eliminate visible frequencies. This was used in a darkened room to illuminate the specimens, which could then be photographed using an ordinary camera (on a tripod or other stand) with „bulb" shutter setting, an auxiliary lamp being used for the preliminary focussing on the subject.

It happened that the authors met at the Annual Exhibition of the Botanical Society of the British Isles, and we compared our methods. In studies (1976) of flowercolour polymorphism in relation to pollination by insects, Kay had used a small electronic flash (such as is often carried by amateur photographers, e.g. Mirage 500, Speedtron II) as a source of UV, its coulour-temperature being high enough to include the required near-UV. After the single-lens reflex camera had been focussed on the subject, an optical filter of the type described below was placed in front of the lens, in contact with the lens-mounting, to exclude visible light. A fine-grained film of 125 ASA (Ilford FP4 or Kodak Tri-X) was used. If the subject was shaded from direct sunlight, an aperture of f2.8 to f4 was required for the UV exposure and one of f16 to f22 for the paired visible-light exposure (without the filter). UV exposures may also be made using sunlight as a supplementary or even sole source of UV; in bright sun 1/60 sec. at f8 may be a suitable exposure. The variation of UV in sunlight can be monitored, using the same UV filter over an exposure-meter. The general technique is similar to one described by Silberglied (1976).

The chief advantages of electronic flash are that it can be used in the field and that it freezes movement of either the subject or a hand-held camera; its chief disadvantages are the small depth of focus obtainable in the UV exposure and the difficulty of maintaining the focus while the optical filter is placed in front of the lens, unless a twin-lens reflex is used. UV photographs of pollinating insects visiting flowers have been obtained, but great patience and several exposures are needed; nor is it usually possible in this case to take paired UV and visible-light photographs, as can be done with flowers alone (to reveal UV honey-guides) and with set insects.

In UV photography of set specimens (also using a fine-grain film of 125 ASA), Bowden found that the Allen lamp at 1-metre distance allowed an exposure of about 15 sec. at f11, which is very convenient. However, with a small electronic flash (Sunpak GT 26), an aperture of f4 is required even at only 55-cm distance, at which it may not be easy to obtain even illumination. With many modern cameras it is awkward to arrange multiple consecutive flashes for a single exposure.

Bowden therefore experimented with a mercury-vapour moth-trap tube (Actinic-5, 15-watt), which many lepidopterists possess. The fluorescent inner coating of such a tube produces a band of radiation from 300 nm to 500 nm (Heath 1970), i.e. extending well into the visible. This light, run 75 cm from the subject, required 45 sec. exposure at f11, the visible frequencies being cut out by the filter over the camera-lens, as in the electronic-flash method. Bowden used a darkened room, but this is not strictly necessary if the filter is close to the lens.

All three methods are extremely easy for set specimens. Once suitable and convenient exposure-conditions have been chosen, the standardized light-sources permit fully comparable results at any time. Variation of results between methods or occasions is usually attributable to directional effects of the light, especially when structural reflection is occurring (as in *Gonepteryx rhamni*).

Use of the Allen lamp is simplest, but the lamp is expensive. The other two methods both require a filter costing less than £ 10 (see below); the Actinic-5 moth-lamp procedure may be the better, if such a lamp is available. A faster film (400 ASA) should preferably be chosen for the electronic-flash method, to allow the use of a smaller stop and greater flash-to-subject distance.

The filter employed is a Schott UG1 of 3-mm thickness, supplied in England by H.V. Skan Ltd. of 425 Stratford Road, Shirley, Solihull B90 4AE. Ours, costing £ 7,90, measures 75 mm x 75 mm; described modestly as „roughly polished, edges worked", it seems perfect. Held up to the sun, it shows a (negligible) transparency in the red (to which FP4 and Tri-X films are rather insensitive). In the field, the square filter can be held conveniently in the hand beside the flash, and placed in contact with the lens-mount just before making the UV exposure. In the laboratory, it can be supported immediately before the camera-lens on a retort-stand and bosshead, using an adjustable arrangement of a curved rod, a „Terry" clip and a spring clothes-peg. Other set-ups are of course possible. At some additional expense the UG1 filter can be cut to a circle and supported on the lens in a standard bayonet-fitting filter-holder. There is some advantage in using a twin-lens reflex camera, to permit visual focussing with the filter in place.

The accompanying plate shows a group of Pieridae photographed by visible light and by different UV arrangements. The images are determined by the varying absorption of UV light by different concentrations of pterin pigment on the wings, and its reflection by interference structures or scattering (Ghiradella *et al.* 1972). The butterflies figured are:

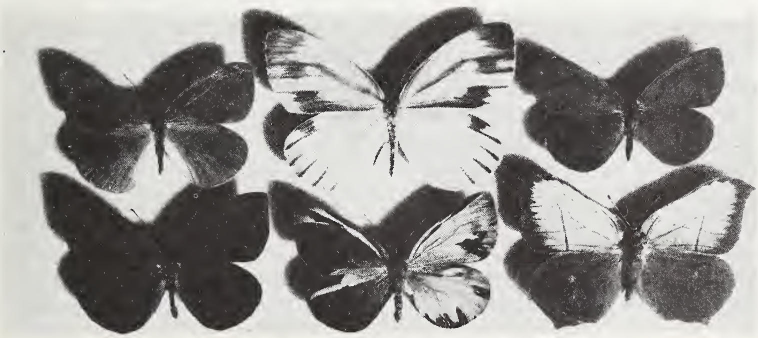
Artogeia rapae (L.) (Portugal)	*Artogeia melete* (Mén.) (Japan)	*Artogeia napi* (L.) (Cornwall)
Artogeia rapae (L.) (Spain)	B. BN X B. BN sex-mosaic (Swiss *A. bryoniae* X Brit. *A. napi*)	*Gonepteryx rhamni* (L.) (England)

Fig. 1 (p. 29). A group of pierids (see text on p. 28) photographed 'A' by visible light, 'B' UV light (flash + UG1 filter), 'C' UV light (Allen 409 lamp) and 'D' UV light (Actinic moth-trap + UG1 filter).

A

B

C



D

For UV photography, insects should not be mounted on a background of modern white paper (which is generally fluorescent) unless the filter is used on the camera-lens.

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