of an order $g = pg'$, $(p, g') = 1$ appear as special cases of properties of characters of blocks of defects 0 and 1.[7]

Finally, it may be mentioned as a conjecture that it appears probable that for a given p and d, only a finite number of matrices exist which can occur as Cartan matrices C_τ of blocks of defect d.

[1] The first part will be quoted as I.

[2] Cf. Brauer, R., *Ann. Math.*, **42**, 926–935 (1941).

[3] For the results quoted in this section, cf. the paper mentioned in [2].

[4] In the case that ρ belongs to the section of the 1-element, this result has already been obtained in Brauer, R., and Nesbitt, C., *University of Toronto Studies, Math. Ser.*, No. **4**, theorem VIII (1937).

[5] This generalizes a result obtained in Brauer, R., and Nesbitt, C., *Ann. Math.* **42**, 556–590 (1941) for blocks of defect 0.

[6] Cf. Brauer, R., these PROCEEDINGS, **30**, 109–114 (1944), in particular, equation (2).

[7] Cf. Brauer, R., these PROCEEDINGS, **25**, 290–295 (1939), and *Ann. Math.* **42**, 936–958 (1941).

I take this occasion to mention the following corrections in the first of these papers: In theorem III, the assumption should read $n < (2p + 7)/3$. The left side of equation (4) should read $r_\rho t_\mu + r_\mu t_\rho$. For the results of the last paragraph of section 3, it is necessary to assume that a suitable splitting field is used.

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*EFFECTS OF EXPOSURE TO ULTRA-VIOLET LIGHT ON HUMAN DARK ADAPTATION**

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Previously it has been shown that the course of dark adaptation of the eye of the baby chick can be altered by addition of ultra-violet radiation between 290 and 365 mμ to the visible white light of a mercury vapor lamp during preëxposure.[1] Exposure to wave-lengths longer than 365 mμ results in uniform dark adaptation curves, all curves reaching the same final threshold level. The addition of ultra-violet below 365 mμ retards complete adaptation, raising the final threshold considerably above the normal. Extension of the ultra-violet range to about 355 mμ causes an increase of 0.3 log unit, to 315 mμ an increase of 0.6 log unit, and to 290 mμ an increase of 1.1 log units in the final threshold level.

In the baby chick, as in all newly born animals, the absorption by the ocular media is small, therefore a considerable penetration of ultra-violet to the retina is expected. For the human eye the ultra-violet transmission is a function of age,[2] depending mainly upon the transparency of the lens;[3] it is maximal in infancy and thereafter decreases so that in the adult eye the lens transmission at 365 mμ is only 0.1 per cent.[4] In accordance with this fact one might assume *a priori* that wave-lengths shorter than 365 mμ can have practically no effect upon the retina. In subsequent tests it is demonstrated that addition of ultra-violet to the adapting light during preëxposure changes the course of human dark adaptation and raises the final level of adaptation, and thus decreases the sensitivity of the eye.

Light Exposure.—The observer must be fully light adapted before the course of dark adaptation can be studied. As light source, a 250-watt mercury vapor lamp (GE type H-5) is used. The lamp is mounted in a housing 50 cm. behind a finely ground round Pyrex plate (transmitting from 285 mμ up), 30 cm. in diameter, which acts as a diffusing screen. The observer views this evenly illuminated screen from a distance of 50 cm., securing uniform light exposure of a large retinal area. Between lamp and screen, filters of different transmissions can be inserted which provide for addition of smaller or larger portions of the ultra-violet part of the spectrum to the otherwise white exposure light. The filters used are: AO crown 1045, transmitting from 290 mμ up; ordinary plate glass, transmitting above 315 mμ; AO Cruxite 1794 transmitting above 355 mμ; and Corning 3389 (Noviol, shade A), which begins to transmit at about 410 mμ. All filters have practically the same transmission in the visible, therefore the color of the exposure light does not change. The brightness of the screen as measured with a Macbeth Illuminometer is 6250 millilamberts. To this illumination varying only in ultra-violet content the observer is exposed prior to test for a standard period of 10 minutes.

Measurements.—The course of dark adaptation is followed with the aid of a visual discriminometer,[5] an instrument of highest experimental rigidity, particularly in regard to fixation, retinal location of the test field, size of the field and control of threshold intensities of light. The instrument is calibrated by insertion of the illuminometer into one tube of the binocular head, after removal of the eyepiece. After completion of light exposure the observer views monocularly a red fixation point, representing the center of a square test field, subtending a visual angle of 12.5° on a side. With good fixation and the head securely on a chin rest, the test field is presented by means of a shutter for $^1/_{25}$ second, while by a neutral-tint wedge the operator of the instrument increases step by step the intensity of the field for each flash, until the critical point of first perception of the flash is reached. The time from cessation of light exposure and the wedge reading is recorded. This procedure is continued for 30 to 35 minutes, until there is no further increase in sensitivity at complete adaptation.

With exposure light free from ultra-violet (Noviol A in the light path) the ensuing dark adaptation curve is duplex, separating the process of adaptation into a cone and a rod component. The cone segment of the curve covers about 1.3 log units between the first reading, taken roughly at 1 minute, and the onset of the rod segment of the curve. The transition from cone to rod adaptation occurs after about 6.5 minutes. By adding to the exposure light ultra-violet down to 290 mμ by the insertion of crown glass into the light path instead of Noviol, the course of adaptation is modified. While the general level of the cone curve remains unchanged, it is extended up to 8 minutes, overshooting the previous onset of rod adaptation by $1^1/_2$ minutes. Rod adaptation then follows a course parallel to that obtained without the ultra-violet but on a higher intensity level, so that at complete adaptation the two curves are separated by 0.24 log unit which corresponds to an increase in threshold intensity by a factor of 1.74 for threshold recognition.

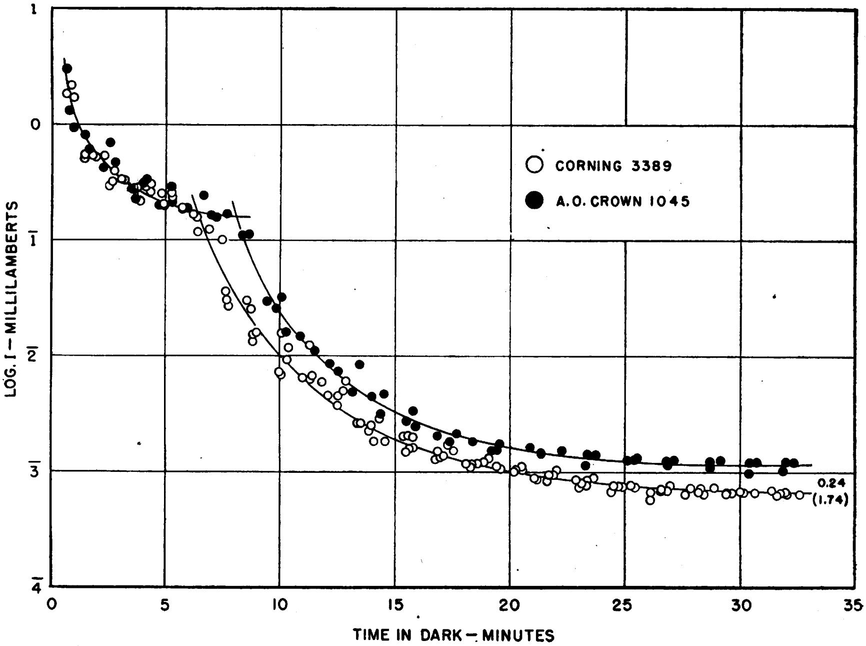

FIGURE 1

The course of dark adaptation of the human eye after preëxposure to light free from ultra-violet (Corning 3389, Noviol, shade A) in the light path (open circles) and light containing ultra-violet as low as 290 mμ (Crown in the light path), black circles. The ultra-violet produces a later onset of rod adaptation and raises the threshold levels for the rod segment.

In figure 1 summarized data on one observer are presented. There are plotted 6 runs with Noviol and 3 runs with crown in the path of the exposure light. The observations extend over several days. A run with crown may follow a run with Noviol immediately. After crown a minimum time of 5 hours was allowed so that no previous ultra-violet effects would interfere with a subsequent run. The data in figure 1 represent the prototype of the course of dark adaptation without and under the influence of ultra-violet in the exposure light. Altogether, measurements were taken on 6 observers which show in principle the same kind of phenomena. In each case a higher "final" threshold of the rod segment is found after preexposure to light filtered by crown only. The rise in "final" threshold varies between 0.21 and 0.29 log unit. The variation does not seem correlated to age, at least within the age range of the experimental group, nor to sex. In no case could any significant change in the level of the cone segment be observed. The overshooting of the cone part might vary from hardly detectable to 2 minutes. Also, the separation between the two curves over the steep part of the rod segment up to 20 minutes might be not as distinct as in figure 1. At 20 minutes and beyond the separation is, however, always clear and becomes increasingly greater, until the final level is reached. The final separation between the normal level of adaptation and the lowest level reached at termination of the experiment after exposure to ultra-violet, for all observers, is given below.

OBSERVER	AGE	SEX	MEAN SEPARATION IN LOG UNITS
T. H. C.	18	m	0.24
M. L.	19	f	0.24
E. E. F.	21	f	0.28
D. A. J.	25	f	0.24
G. A. B.	26	m	0.29
E. W.	43	m	0.23
		Mean =	0.253

The mean increase in light intensity for threshold recognition among 6 observers is 0.253 log unit. This indicates that roughly 1.8 times as much light is needed for threshold response at "complete" dark adaptation after preëxposure to light containing wave-lengths as low as 290 mμ.

Similar effects on final dark adaptation thresholds after prolonged exposure to sunlight, moderately rich in ultra-violet, have been described recently.[6] An overshooting of the cone segment and a temporary rise of final thresholds of the same order of magnitude as described here are noticed. Ultra-violet as a cause is not mentioned. It seems probable, however, according to some of our tests with preëxposure to light reflected from snow, that the changes in final level are not due to glare, but rather to the ultra-violet.

On two observers tests were made comparing the effects of light filtered by Noviol with those of light filtered by plate glass, which excludes the strong mercury lines at 297, 302 and 313 mμ, but transmits the 365 mμ band at full strength. The data are given in figure 2. Besides a difference in the onset of rod adaptation for the two observers, both show an overshooting of the cone segment for the plate glass curves of about 1 minute. The mean final threshold difference is 0.15 log unit, 0.1 log unit less than with crown glass, due to the reduction in effective ultra-violet radiation.

Comparing AO Cruxite which transmits about 20 per cent at 365 mμ with Noviol, the ensuing dark adaptation curves are practically identical. At least no final threshold differences can be noticed. There are, however, slight irregularities at the cone-rod transition which suggest overshooting of the Cruxite curve. Also the initial steepness of the rod segment might be less for Cruxite. From 15 minutes onward the normal and the Cruxite curves are, however, identical, indicating that any small ultra-violet effect produced by the reduced transmission at 365 mμ, recognizable at the beginning of rod adaptation, has disappeared at a time when previously the effect of exposure to ultra-violet was most pronounced.

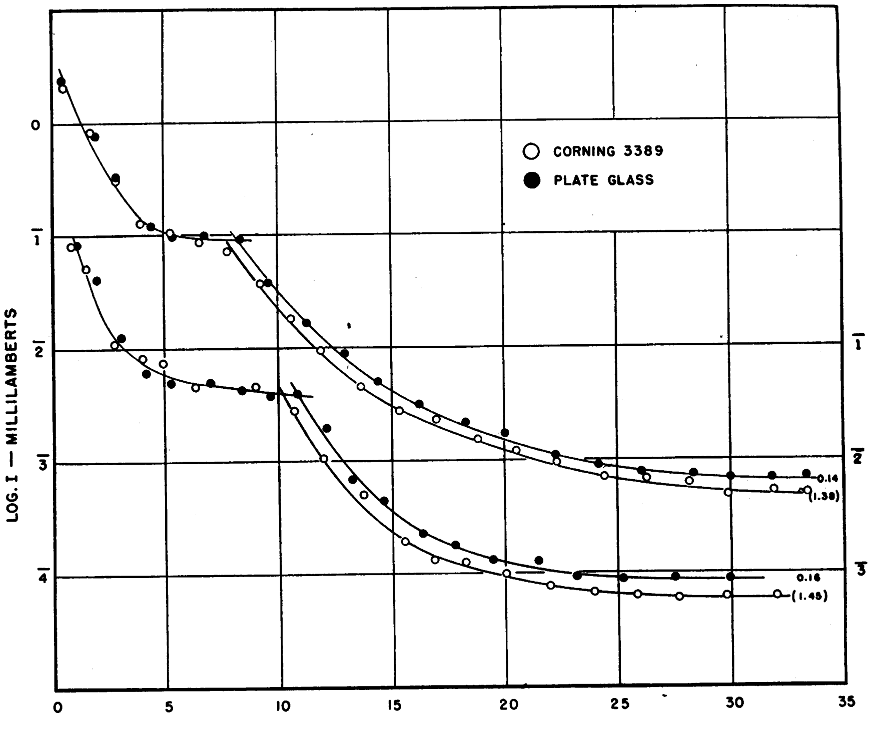

FIGURE 2

The course of dark adaptation after preëxposure to light free of ultra-violet (open circles) and light filtered by plate glass (black circles). Due to the ultra-violet, the rod adaptation begins later and the thresholds are higher.

Compared with the results on the eyes of baby chicks the effect on human dark adaptation is considerably smaller. In the chick an intensity increase by a factor of 12.5 was necessary (crown vs. Noviol) as against 1.8 for the human eye, a ratio of 6.6:1. Assuming that most of the effective ultra-violet is absorbed by the lens, one should expect a considerably greater effect in aphakics. Two observers were available. J. W., age 26, had the lens of his right eye removed several years ago, the left eye having normal vision. His normal eye gives a final threshold separation of 0.20

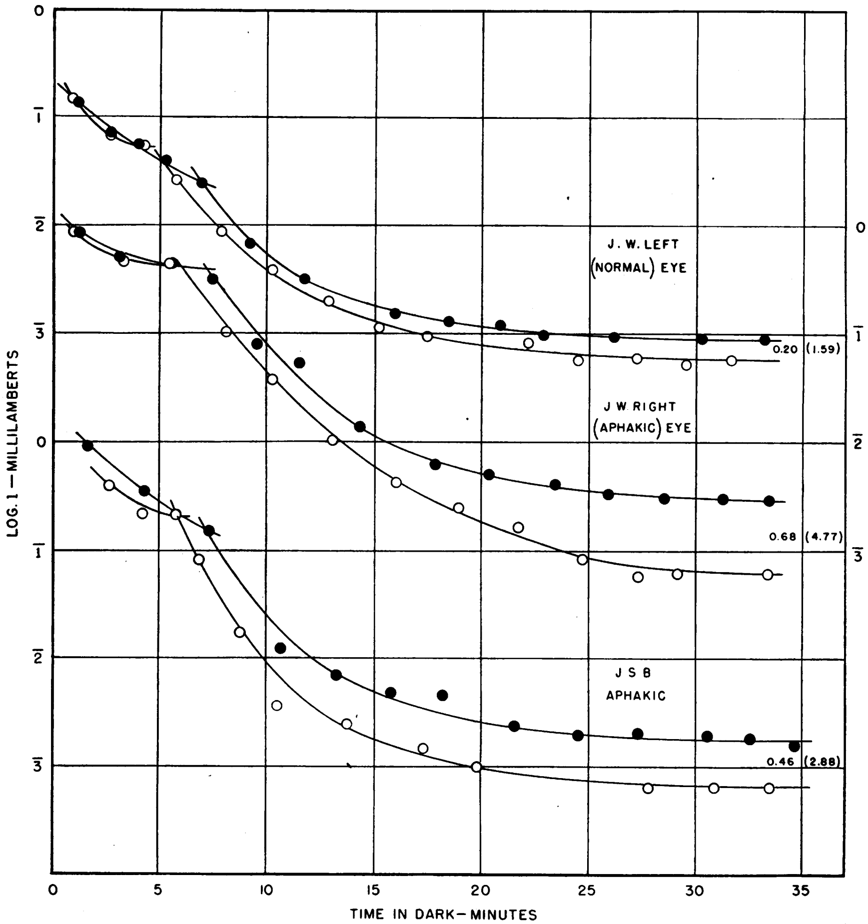

FIGURE 3

Dark adaptation in aphakics: The normal (left) eye of J. W. gives curves similar to those presented in figure 1. For the aphakic eye the separation between the normal and the ultra-violet curve is considerably increased, due to more effective action of ultra-violet upon the retina. The same conditions are found in J. S. B.

log unit which is slightly below the average of the group of 6 mentioned previously. For the aphakic eye the separation between the Noviol and the crown curves becomes increasingly greater after the cone-rod transition, until a final separation of 0.68 log unit is reached, corresponding to an increase in light intensity by a factor of 4.77 for threshold recognition. In J. S. B., 30 years, both eyes are aphakic; one eye having better vision is used for test. The results are similar to those for J. W. with the exception that the final separation is only 0.46 log unit, or a factor of 2.88. Even while there is a difference of 0.22 log unit between the two aphakics, the final threshold levels for both are so much higher than previously found that it becomes evident that much of the ultra-violet is normally absorbed by the lens which otherwise would reach the retina. The data on the aphakic observers are presented in figure 3.

With only 0.1 per cent transmission at 365 mμ, there is no doubt that the small amount of ultra-violet reaching the retina produces considerable physiolgical effects in proportion to its intensity. In the human eye, as well as in the chick, the ultra-violet effect seems entirely on the rod thresholds, whereas the cones remain unaffected. For both types of eyes it may be assumed that an effect on the cones is prevented by their dense filter pigments, while the ultra-violet can act upon the pigment-free rods.[7] The action of the ultra-violet might be directly upon the photosensitive material of the rods, or it might be due to desensitization caused by fluorescence of the ocular media during preëxposure. In both cases a longer recovery time would be needed to regain maximal sensitivity. At present it can only be pointed out that ultra-violet radiation has peculiar effects upon the sensitivity thresholds of the rods, disregarding the locus and mode of action.

Summary.—The course of dark adaptation of the human eye is studied after preëxposure to the radiation of a mercury vapor lamp, filtering out the ultra-violet between 290 mμ and the visible to various extents. Exposure to light free from ultra-violet results in uniform dark adaptation curves. Addition of ultra-violet below 365 mμ affects rod adaptation by causing a later onset of rod adaptation and raising the final thresholds appreciably above the normal level. The cone adaptation is not affected. The final level reached is a function of the extent of the ultra-violet spectrum. The lens, having a high ultra-violet absorption, reduces the ultra-violet action upon the retina which can be demonstrated on aphakic eyes in which the ultra-violet action on dark adaptation is considerably increased.

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[†] The experiments were carried out with a visual discriminometer at the Laboratory of Industrial Physiology, Harvard School of Business Administration, which kindly was

made available for the purpose. I feel particularly indebted to Miss D. A. Jameson for her generous help in these experiments.

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EXPERIMENTS ON SEXUAL ISOLATION IN DROSOPHILA. VIII. INFLUENCE OF LIGHT ON THE MATING BEHAVIOR OF DROSOPHILA SUBOBSCURA, DROSOPHILA PERSIMILIS AND DROSOPHILA PSEUDOOBSCURA

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Philip, Rendel, Spurway and Haldane[1] and Rendel[2] found that cultures of *Drosophila subobscura* Collin cannot be kept permanently in a dark room because no matings take place in this species in the absence of light. Furthermore, several mutant types with abnormal eye colors proved to be male sterile; for example, white eyed males, although they are positively phototropic like the wild type, do not respond to moving contours and produce no offspring. Rendel[2] also points out that the males of the mutant yellow (yellow body color) are discriminated against in mating by the females of some, but not all, wild type strains. Yellow females produce offspring easily when placed with wild type males. These findings are the more interesting and unexpected since Mayr and Dobzhansky[3] found that in *D. persimilis* Dobzhansky and Epling and in *D. pseudoobscura* Frolova mating and insemination occur freely in the presence or absence of light. Cultures of these species can be kept in a dark room generation after generation. Furthermore, when females of these two species are placed together with males of one of them, a significantly greater proportion of conspecific than of foreign females are inseminated and this selectivity of mating is not affected by light or by darkness. It follows that representatives of these species are able to discriminate between conspecific and foreign mates in the absence of light.