more species together under one name. On the other hand, to one of a more analytical bent of mind, the difference between members of a single species may appear so marked that he will be under constant temptation to separate them into still smaller subdivisions and to give to each specific rank. But, whichever course we follow, the different groups into which the genus, or a species, may be divided represent little more than particular tendencies or directions of variation, and the members of each make up a series illustrating the different stages. The word "species," as applied to our North American asters, can hardly be said to have any other significance than this.

It will startle some old-fashioned taxonomists to read the next sentence:

> It does not seem a valid objection that under such a definition a single plant might be conceived as belonging to more than one species.

Notes are made of ten previous lists of Wisconsin asters, and then follows a systematic and critical discussion of the species recognized by the author. This latter is so well done that one is tempted to wish that it might be used as a model by other local botanists.

SHORT NOTES

IMPORTANT phytopathological papers by G. G. Hedgcock have appeared as follows: "Notes on Some Western Uredineae which attack Forest Trees" (*Phytopath.*, III.); "Notes on Some Diseases of Trees in our National Forests" (*Phytopath.*, III.); "Injury by Smelter Smoke in Southeastern Tennessee" (*Jour. Wash. Ac. Sci.*, IV.); "The Alternate Stage of *Peridermium pyriforme*" (privately printed June 12, 1914). In the latter the conclusion is reached that the alternate stage occurs on *Comandra umbellata*.

B. F. LUTMAN contributes an interesting paper on "The Pathological Anatomy of Potato Scab" accompanied with ten text figures, in which he concludes that "The scab is due to the hypertrophy of the cells of the cork cambium" (*Phytopath.*, III.). The same author's "Studies on Club-root" (Bull. 175, Vt. Agr'l Expt. Sta.) will be suggestive to those who are interested in the organisms usually known as slime molds (Myxomycetes). The one here under consideration is *Plasmodiophora brassicae*, and it infests the root cells of cabbages and other cruciferous plants. It gains entrance either through the epidermis or the root-hairs, and produces cellular hypertrophy, especially of the cortical tissues.

> Nuclear divisions in the plasmodium are of two types—vegetative and reduction. The vegetative divisions are peculiar in that a spireme is not formed. . . . The reduction division is one of those preceding spore formation, probably the first.

Six text figures and four plates (with 52 figures) accompany the twenty-seven pages of text.

A SIGNIFICANT feature of the new edition of the "Genera of British Plants," by H. G. Carter (Cambridge, 1913), is the adoption of Engler's system. At the outset it must be remembered that the "plants" referred to in the title are the ferns and flowering plants. The little book (of 139 pages)

> is intended to familiarize students of British vascular plants with Engler's system in its latest form, and thus to habituate British floristic students to the use of a more natural system than that to which they have been accustomed in the British floras that have hitherto appeared.

In carrying out this plan the class, ordinal and family characters are clearly given, while the genera are briefly characterized by means of analytic keys. A similar book for North America would be very useful. However, we can not approve of the use of the terms "apopetalous" and "apochlamydeous" as defined by the author (petals, or perianth "absent by reduction") even though sanctioned by Engler. Certainly "apetalous" and "achlamydeous" are sufficiently definite for the conditions of *no petals*, and *no perianth*, leaving "apopetalous," and "apochlamydeous" for the conditions of *separate petals*, and *separate perianth segments*.

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SPECIAL ARTICLES

THE ALLEGED DANGERS TO THE EYE FROM ULTRA-VIOLET RADIATION

DURING recent years there have been not a few sensational attacks upon modern illu-

minants as dangerous by reason of injurious effects of the ultra-violet radiation delivered by them. The literature of the subject is large, but unhappily most of the investigations have entirely neglected any quantitative relation between the radiation and its supposed pathological effects. One can not stigmatize an illuminant which emits ultra-violet as dangerous for this reason any more than one can declare a stove unfit for use because it is possible to burn the finger by deliberately touching it. The vital question is not whether a light source gives ultra-violet radiations, but whether it gives them of such kind, and in sufficient quantity, as to make any injury to the eye possible under practical conditions. A second point frequently neglected in the discussion of this subject has been the action of the eye itself in focusing radiation falling upon it, with the resulting effects upon the intensity of the radiation in the media of the eye. Finally a great many errors have been made and unwarrantable conclusions reached owing to the fact that in the solar spectrum the maximum intensity of radiation is in the brilliantly luminous part of the spectrum, where in addition the so-called actinic power is considerable, so that phenomena possibly having their origin in specific effects of radiation of particular wave-length become difficult to separate from those of purely thermic origin.

During more than two years past the writers have spent a large amount of their time in an investigation from a quantitative standpoint of the effects of radiation on the various media of the eye from the corneal epithelium back to the retina, and have investigated with considerable care the maladies reputed by one writer or another to be due to the specific effects of radiation. Broadly we have found that no artificial source of light used for illuminating purposes contains enough ultra-violet radiation to involve the slightest danger to the eye from its effects under any readily conceivable conditions of use, and that such pathological action as can be obtained experimentally from the ultra-violet is confined to a strictly limited region of the spectrum and obeys perfectly definite quantitative laws in its action. Incidentally we have found most extraordinary resisting power of the eye as respects radiations outside this particular range, which is in fact the whole body of radiation present in any material quantity in the energy normally received from the sun at the surface of the earth.

Our conclusions regarding these fundamental matters and respecting the various alleged pathological effects which have been charged up against radiation are appended as preliminary to the more complete publication of the methods and results of our investigations. Most of the experiments were made upon the eyes of rabbits and monkeys. An especially noteworthy experiment, however, relating to the possibility of abiotic action on the retina, was made upon a human patient affected with cancer of the eye-lids, twenty-four hours before the eye was removed. A number of crucial experiments were also made upon our own eyes. It should be especially noted that while the abiotic effects of the extreme ultra-violet on the outer eye are well defined, they are limited to a particular region and their extent in case of exposure to any given radiant can be definitely predicted and effectively guarded against.

Conclusions

The liminal exposure capable of producing photophthalmia to the extent of conjunctivitis accompanied by stippling of the cornea, is in terms of energy 2×10^6 erg seconds per square cm. of abiotic radiation of the character derived, for example, from the quartz lamp or the magnetite arc. About two and a half times this exposure, *i. e.*, 5×10^6 erg seconds per square cm., is required to produce loss of corneal epithelium.

The abiotic action on the cornea and conjunctiva produced by any radiating source follows the law of inverse squares and is directly proportional to the total abiotic energy received. It can therefore be definitely predicted from the physical properties of the source.

After exposure of the eye to abiotic radiations there is a latent period before any effects,

clinical or histological, become perceptible. This period of latency in a general way varies inversely with the severity of the exposure, but a theoretical latency of 24 hours or more corresponds to an exposure entirely subliminal.

The combined effect of repeated exposures to abiotic radiations is equivalent to that of a continuous exposure of the same total length, provided the intermissions are not long enough to establish reparative effects. Approximately, the exposures are additive for intermissions of somewhat less than 24 hours. Exposures of one third the liminal given daily begin to show perceptible effect only after about six exposures. Daily exposures of one sixth the liminal repeated over long periods produce no effect whatever, except to give the external eye a degree of immunity against severer exposures. Actual abiotic damage to the external eye renders it temporarily more sensitive to abiotic action.

Abiotic action for living tissues is confined to wave-lengths shorter than 305 $\mu\mu$, at which length abiotic effects are evanescent, while for shorter wave-lengths they increase with considerable rapidity.

For the quartz arc and the magnetite arc the abiotic activity of the rays absorbed by the cornea is eighteen times greater than those which are transmitted by it. To effect the media back of the cornea requires, therefore, at least eighteen times the liminal exposure heretofore mentioned.

Even with exposures as great as one hundred and fifty times the liminal for photophthalmia the lens substance is affected to a depth of less than 20 μ, and this superficial effect undergoes in the rabbit complete repair. Such enormously intensive exposures, which we obtain with the magnetite arc and double quartz lens system may completely destroy the corneal epithelium, corpuscles and endothelium. The corneal stroma may be strongly affected by waves shorter than 295 $\mu\mu$, which it completely absorbs, but is very slightly affected by the remaining abiotic radiation.

The histological changes produced by abiotic radiation are radically different from those produced by heat, and the cell changes are best seen in flat preparations of the lens capsule. The most characteristic change is the breaking up of the cytoplasm into eosinophilic and basophilic granules.

Changes in the lens epithelium like those following abiotic action, including the formation of a "wall" beneath the pupillary margin, are not exclusively characteristic of abiotic action, but may be produced by ordinary chemical reagents. They are, therefore, characteristic not of abiotic action alone, but of chemical action in general.

Abiotic radiations certainly do not directly stimulate, but, on the contrary apparently depress mitosis. Their action in this respect also is materially different from that of heat.

The lens protects completely the retina of the normal eye even from the small proportion of feebly abiotic rays which can penetrate the cornea and vitreous.

Experiments on rabbits, monkeys and the human subject prove that the retina may be flooded for an hour or more with light of extreme intensity (not less than 50,000 lux), without any sign of permanent injury. The resulting scotoma disappears within a few hours. Only when the concentration of light involves enough heat energy to produce definite thermic lesions is the retina likely to be injured.

The retina of the aphakic eye, owing to the specific and general absorption of abiotic radiations by the cornea and the vitreous body, is adequately protected from injury from any exposures possible under the ordinary conditions of life, even without the added protection of the glasses necessary for aphakic patients.

To injure the cornea, iris, or lens, by the thermic effects of radiation, requires a concentration of energy obtainable only under extreme experimental conditions.

Infra-red rays have no specific action on the tissues analogous to that of abiotic rays. Any effect due to them is simply a matter of thermic action, and such rays are in the main absorbed by the media of the eye before reaching the retina.

Actual experiments made on the human eye

show conclusively that no concentration of radiation on the retina from any artificial illuminant is sufficient to produce injury thereto under any practical conditions.

Eclipse blindness, the only thermic effect on the retina of common occurrence clinically, is due to the action of the concentrated heat on the pigment epithelium and chorioid, this heat being almost wholly due to radiations of the visible spectrum, within which the maximum solar energy lies.

The abiotic energy in the solar spectrum is a meager remnant between wave-lengths 295 $\mu\mu$ and 305 $\mu\mu$, aggregating hardly a quarter of one per cent. of the total. At high altitudes and in clear air it is sufficient to produce slight abiotic effects such as are noted in snow blindness and solar erythema, the former only occurring with long exposures under very favorable circumstances and the latter being in ordinary cases complicated by an erythema due to heat alone. The amount of abiotic energy required to produce a specific effect in solar erythema is substantially the same as that required for mild photophthalmia.

Erythropsia is not in any way connected with the exposure of the eye to ultra-violet radiations, but is merely a special case of color fatigue temporary and without pathological significance.

Vernal catarrh and senile cataract we can find no evidence for considering as due to radiations of any kind.

Glass blowers' cataract, often charged to specific radiation, ultra-violet or other, we regard as probably due to the overheating of the eye as a whole with consequent disturbed nutrition of the lens.

Commercial illuminants we find to be entirely free of danger under the ordinary conditions of their use. The abiotic radiations, furnished by even the most powerful of them, are too small in amount to produce danger of photophthalmia under ordinary working conditions even when accidentally used without their globes. The glass enclosing globes used with all practical commercial illuminants are amply sufficient to reduce any abiotic radiations very far below the danger point.

Under ordinary conditions no glasses of any kind are required as protection against abiotic radiations. The chief usefulness of protective glasses lies not so much in their absorption of any specific radiations, as in their reducing the total amount of light to a point where it ceases to be psychologically disagreeable or to be inconveniently dazzling. Glasses which cut off both ends of the spectrum and transmit chiefly only rays of relatively high luminosity, give the maximum visibility with the minimum reception of energy. For protection against abiotic action in experimentation, or in the snow fields, ordinary colored glasses are quite sufficient.

So far as direct destruction of bacteria within the cornea or any other tissues of the body is concerned, abiotic radiations possess no therapeutic value. This is due to the fact that abiotic radiations that are able to penetrate the tissues are more destructive to the latter than to bacteria.

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SOCIETIES AND ACADEMIES

THE AMERICAN MATHEMATICAL SOCIETY

BY invitation of Brown University, the twenty-first summer meeting of the society was held at that institution on Tuesday and Wednesday, September 8–9, in connection with the celebration of the one hundred and fiftieth anniversary of the founding of the university. Two sessions were held on Tuesday and a morning session on Wednesday, the attendance including fifty-two members. President Van Vleck occupied the chair at the morning sessions, being relieved by Vice-president L. P. Eisenhart at the Tuesday afternoon session. New members were elected as follows: Mr. L. K. Adkins, University of Minnesota; Dr. Lennie P. Copeland, Wellesley College; Mr. J. W. Cromwell, Jr., Washington, D. C., High Schools; Professor Tsuruichi Hayashi, Tôhoku Imperial University, Sendai, Japan; Professor C. I. Palmer, Armour Institute of Technology; Mr. G. A. Pfeiffer, Columbia University; Mr. P. R. Rider, Yale University; Dr. Alfred Rosenblatt, University of Cracow; Miss Caroline E. Seely, Columbia University. Eleven applications for membership were received. It was decided to hold the annual meeting about January 1, the exact date to be so fixed that those who wish