Extreme accuracy of measurement was not possible, but the result indicates that the particle size is roughly a little smaller than a normal epithelial cell. The usual angular diameter of the haloes in glaucoma is 7° — 12° and here we know that the size of the droplets causing them is that of a swollen oedematous epithelial cell. Haloes due to mucus on the corneal surface are larger still (up to 14°).

An attempt was also made to calculate the actual particle size by measuring the haloes seen with monochromatic filters (5500 Å and 5400 Å) and using the formula

$$d = 1.22 \times \frac{\lambda l}{r}$$

where d = diameter of particle

r = radius of first dark ring in cm.

l = distance of eye from screen

λ = wave-length in μ

the actual measurements were difficult to do accurately and the results of a number of trials gave values for d varying between 7μ and 11μ . This, though not conclusive, points to an intra-cellular cause for the diffraction effect and would seem to correspond with the massed amorphous particles.

The investigation of this new industrial disease is chiefly of interest from the physico-chemical point of view and from the importance of the differential diagnosis of glaucoma which its history suggests.

Summary

A new industrial disease of the cornea is described in atebtrin workers. It appears to be caused by an intra-cellular deposit of an insoluble derivative of atebtrin.

Its only symptom is the seeing of coloured haloes (mostly blue) round lights. Its prognosis is excellent on removal from contact with atebtrin dust.

SUBJECTIVE "LIGHTNING STREAKS"*

BY

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IN the October, 1935 number of this Journal I published a series of cases of a symptom complex under the above title (p. 545), and later, an additional series in *The American Journal of Ophthalmology*

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(November, 1940, Vol. XXIII, p. 1255). Professor F. H. Verhoeff has published an excellent account of them in *The American Journal of Ophthalmology* (March, 1942, Vol. XXV, p. 265).

My reason for reverting to the subject is, that I am now able to add the personal experiences of the symptoms in three ophthalmic surgeons, which may, on this account, be thought to have particular value; they compel me to modify, and enable me to amplify my former description in several prominent particulars.

Professor Verhoeff has been good enough to send me a detailed and lucid account of his experiences, and to make suggestions which, coming from him, have unusual authority; Dr. J. Rutter Williamson sends me an excellent description of his observations, and these have a value of their own from the fact that he sees with one eye only; and since my last paper I have myself become a subject of the "Streaks." I propose to describe the condition in the light of the above additional evidence.

This is a symptom complex which occurs after middle age—the youngest of my patients was 42—most usually in myopes, and perhaps more commonly in women.

It consists in the association of the development of flashes of light with the simultaneous appearance of spots before the eyes. I previously expressed surprise that patients should be sufficiently concerned to seek advice on account of these symptoms alone, as they sometimes will, but having experienced them myself, I can understand that they should arouse a degree of curiosity, if not of actual anxiety as to their significance, for the phenomenon is quite a striking one.

The most conspicuous feature is the sudden appearance, without obvious cause, of bright or brilliant flashes of light.

Various similes have been made use of in describing them, but as "lightning" is the most usual I adopted it.

Amongst other similes are the following:

J. R. W. says "On the evening of November 25, 1942, I noticed flashes after switching off the light to go to bed. I thought there must be a defect in the "black-out" showing searchlights, but investigation proved negative."

F. H. V. says "I have found on close questioning that patients all agree that what they see are streaks."

For myself, were I experiencing the phenomenon as a quite unfamiliar sight, I feel no doubt that I should have compared the streaks to lightning.

Others have suggested "shooting stars"; "fireworks"; "headlights," etc.

Few have commented upon the colour, but J. R. W. describes a "bright bluish yellow" flash: one person spoke of "silver lightning,"

and one compared the flashes to fire-flies, but said they were too silvery in colour.

They are of momentary duration so that detailed analysis of them is not possible; they are very bright and travel from above down. They are curved as, I fancy, lightning never is; they do not exhibit the zig-zag feature of lightning.

J. R. W. says "It commenced in the upper part and ran downwards, always in a perfectly true semi-circle"; this too is true of what I see. They may be seen at any time, though naturally they are more conspicuous in the dark; they occur whether the eyes are open or closed.

Position of the streaks.—My original statement as to the part of the field in which the streaks are seen, was that they were "almost always to the outer side of the eyes" and whilst this is an accurate statement they certainly do occur at other positions.

F. H. V. says:—"The streaks in my left eye began about October 30, 1937. For a short time they occurred in all quadrants. In 1939 I could elicit them only in the outer quadrant. On October 19, 1942, I first observed the streaks in the right eye; at first here too they were in all quadrants and I could sometimes get an almost complete circle of light; all but the lateral streaks, however, ceased to occur in about a month. At the present time (May 24, 1946), I can still elicit a temporal streak in either eye."

J. R. W. says:—"It was situated to the outer part of the field (he having only one seeing eye, the left). On its disappearance there swept in from the right, *i.e.* from the nasal side, a sort of secondary flash, a wavy cloud of pearly colour, very like what is seen with the ophthalmoscope sometimes, in a detached retina. This wavy appearance was trembling, as if a very thin cloud disturbed by a current of air; the whole was of course of extremely brief duration. Very rarely did one see a straight flash, and then it was very small and appeared on the nasal side of the field of vision.

My own experience is that the streaks are seen only on the rather extreme temporal side, and do not transgress a central vertical limiting line, but at times I have seen what I can only describe as faintly luminous circular areas to the nasal side.

It can be said that the streaks may be seen in any quadrant of the field, but that they are much more often referred to the temporal side, and that here they persist much longer than elsewhere.

Movement of the eyes. I am surprised that in my former account I had not elicited that the flashes are only seen on movement of the head or eyes, a fact which is pointed out by Prof. Verhoeff. Had I at that time been the subject of them, I could not have overlooked the fact; most folk are agreed that they can produce them at will by sudden movement of the eyes.

Verhoeff says:—"I can elicit both streaks by quick rotation of

my head. This of course causes an ocular rotation to the opposite side, so that the resultant is simply a sideways motion of the eye as a whole."

J. R. W. says—"I could produce it at will by moving the eye quickly to the left."

For myself I can say that while the eyes are at rest the flashes are never seen, and that I can elicit them, not with certainty but quite frequently, by sudden movement of the eyes.

It is unnecessary to labour the fact that movement is necessary for their production, the only point upon which I have some doubt is as to whether movement of the head will do so; I think it likely that it will, though I have not been able to satisfy myself as to this.

Verhoeff's explanation (referred to later) of the method of production of the streaks clearly calls for movement, whether of the head or eyes or both.

It is quite clear that the streaks do not occur with the eyes at rest.

Unilaterality. I find that in three cases only of my first twenty-six was the condition bilateral. In Verhoeff's case streaks appeared in the second eye about five years after the first; he says, with true prescience, "probably you will later get streaks in your other eye," this occurred just a year later.

I think it likely that most cases become bilateral in time.

Persistence. My original statement that the streaks persisted for "varying periods up to two or three months" needs revision.

Of the present three observers F. H. V. tells me (May 24, 1946), "The streaks have persisted about nine years in my left eye, and about four in my right; I still can produce them at will in both eyes, but only in the outer field of each."

J. R. W. says—"They only lasted in their original brilliance for six weeks or so; after two months I occasionally see the semi-circular flashes but not brilliantly illuminated as before."

For myself, they first appeared in the right eye on October 17, 1943, and in the left eye on October 20, 1944; I still see them in the temporal field of each eye, *i.e.*, after three years in the right and two in the left eye; they are less obtrusive than formerly and I think occur less frequently, though no doubt one has got used to them and notices them less.

In view of the above it is clear that one can put no limit to the period for which they may occur, and it seems likely that, in some cases at least, they may persist indefinitely, especially in the temporal fields.

The association with vitreous opacities. Of the close relationship between the occurrence of these streaks and the simultaneous development of vitreous opacities I have no doubt.

It may well be that the patient has been familiar with opacities for many years, and in this case the development of streaks is

heralded by the sudden appearance of a fresh crop of them, or it may be that the two, the streaks and the opacities make their first appearance at the same time, *i.e.*, within a few hours of each other; in any case the association is very constant and I do not think these characteristic streaks occur without the development of a crop of opacities.

F. H. V. says:—"My vitreous opacities are much greater than they were before the streaks first appeared."

J. R. W. says "In daylight one was constantly seeing showers of black spots in a smoky environment and these moved across the page when reading."

For myself, as a low myope, I have been familiar with muscae for many years. On the evening of October 17, 1943, whilst out walking, I noticed a new, rather conspicuous unfamiliar spot, in the lower temporal field of the right eye, it was oat-shaped and of a rather golden colour; twenty four hours later I saw, for the first time, bright flashes, running from above down, curved, vertical in direction and well to the temporal side.

On October 20, 1944, flashes, having the same character, suddenly appeared to the temporal side of the left eye, and in the evening, a shower of dark opacities appeared.

The immediate cause of the streaks. I believe Verhoeff's explanation of the immediate cause of the streaks is probably the correct one; he attributes them to a shrinking and partial separation of the vitreous which then impinges upon the retina on movement, he says—

"To explain the more frequent occurrence of the streaks in the outer field, it is necessary to assume that the separated vitreous is more apt to strike the nasal retina, or that the sentient part of the retina extends further forward on the nasal side, or that both of these conditions obtain. Since the vitreous is asymmetrical, in the sense that the disc is nasal to the posterior pole of the eye, the separated vitreous would be nearer to the retina on the nasal side, and it is, of course, a known fact that the visual field extends furthest on the temporal side."

At a later date he writes:—"I can elicit both streaks by a quick rotation of my head—this fact confirms my view that a streak is due to the impingement of the separated vitreous upon the retina. You should try again to elicit the streak in your eye by a quick rotation of your head."

Up to date, I have come across no case which causes me to modify my belief that the streaks have no sinister meaning, either at the time, or, what is more important, ultimately.