(2) Whole embryonic rat eyes can also be cultivated *in vitro*. Rosettes are formed in the retinae of the younger eyes but not in those of the older ones.

(3) Retinal rosettes can be produced *in vivo* by trephining the undeveloped eyes of young rats soon after birth.

(4) The connection between a lowered intra-ocular pressure and the production of rosettes in the retina is discussed.

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"WHITE RINGS" IN THE CORNEA

BY

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GLASGOW

IN the *Trans. of the Ophthal. Soc. U.K.* for 1912,¹ George Coats described two cases "showing a small superficial opaque white ring in the cornea," and in the *Proc. Roy. Soc. Med.* for 1913,² he published a third case. As I have seen no further detailed reference to this condition, and as I have observed four or five cases which belong to the same category, I thought it might be of interest to give a brief description of them.

Coats' description of the lesion as seen with the loupe is so complete and precise, that even with the advantage of the higher magnification available with the slit-lamp there is not a great deal to add. In his first case, a man, aged 18 years, the cornea presented, a little below its centre, a white ring, measuring about

0.75 mm. in diameter, the general outline circular, but with minor sinuosities, and the circumference a fine line varying a little in thickness and with several interruptions. At one point a little spot projected beyond the general contour and in the centre there were three minute dots. In the second case, a man, aged 65 years, the opacity had the form of an ellipse whose long axis was about 1 mm., the circumference formed by a very sharply defined uninterrupted white line, but with many fine dots on its inner aspect giving a somewhat furry appearance. There were also a few spots in the centre. In both cases the opacity had the staring white colour of white-lead paint. It was situated "in the most superficial layers of the cornea, perhaps in the membrane of Bowman, but causes no prominence of the surface epithelium."

In Coats' third case, a boy, aged 11 years, the right cornea presented two rings and a group of spots, and the left showed four rings and an incomplete one, none more than 0.5 mm. in diameter. No illustrations were published with these reports.

In the first and third cases vision was perfect in both eyes, in the second not stated.

My own cases are as follows:—

1. J. L., male, aged 43 years. Engine driver. Attended on account of mild conjunctivitis. R. V.=6/6. L. V.=6/6.

In the right eye (Fig. 1) were two white "rings." One, near the centre of the cornea, was of irregularly elliptical form, the long axis of the ellipse, nearly vertical, being about 0.5 mm., and the short axis about 0.25 mm. There was a short projection from the temporal side. The whole opacity was made up of numerous chalky-white globules and specks of varying sizes. The centre of the "ring" was only relatively clear, for in it were scattered a number of very fine specks. Rather more than midway from the centre to the lower border of the cornea there was a second, incomplete, white ring, made up of more or less confluent white dots, the diameter of the ring being about 0.12 mm.

In addition to these characteristic chalky-white opacities, the cornea presented several faint opacities such as are left by small corneal abrasions. In the course of his occupation he often got "fires" in his eyes.

Ophthalmoscopic examination was negative.

Two years after the first observation the condition is unchanged.

2. J. D., aged 45 years, a seaman. Complained of dimness of vision in the right eye, which he thought to be due to something striking the eye six weeks earlier while at sea; but ophthalmoscopic examination showed cloudiness of the vitreous, a patch of active exudative choroiditis and some choroidal atrophy and pigmentation. Vision at first visit was R.=6/12, L.=6/6, but a week later it was R.=6/24, L.=less than 6/60, and the left field showed

a large central scotoma, due to a large area of acute exudative choroiditis at the centre of the fundus. The Wassermann reaction was strongly positive.

FIG. 1.

FIG. 2.

In the course of the slit-lamp examination a small white ring, resembling those already described, was noted in the lower nasal quadrant of the right cornea. The patient was lost sight of after his second attendance.

3. A. B., a woman, aged 42 years. Complained of dimness of vision in the right eye, of five years' duration. Vision was R.= Light perception, L.=6/6, and the right eye was in a state of

acute glaucoma. The left eye was normal. A slit-lamp examination of the right eye revealed, among other changes, a superficial white ring, composed of numerous chalky-white spots, in the lower central area of the cornea. Palliative treatment for the glaucoma was prescribed and the patient did not attend again.

4. J. B., male, aged 42 years, presented (Fig. 2) at a point somewhat down and out from the centre of the left cornea, not a ring, but a circular cluster of white dots, occupying an area about 0.3 mm. in diameter and, as in the other cases, quite superficial in situation. It gave the impression that the spots lined a very shallow saucer-shaped depression. The spots varied in size, but each was of definitely globular shape. There was no overlapping or coalescence. Some of the spots had a faintly blue or golden colour. An interesting point was that this patient had been seen 24 years earlier with a form of retino-choroiditis affecting both eyes, the special feature of which was that here and there the retinal vessels ran in front of elongated areas of pale choroid and in the same areas elongated strands of black pigment lay in front of the vessels. Refraction was a low mixed astigmatism and vision was R.=6/6 and L.=6/12. At that time the white opacity was not noted, but might easily have been present and escaped notice. The slit-lamp was not in use at that time, nor was it available when Coats' cases were recorded; hence it is necessary to modify his description of the lesion in this respect: that in none of the cases is the ring composed of a continuous white line; it always consists of a number of closely-set specks or globules.

The records in these cases are incomplete, and do not justify any positive conclusions as to the nature of the opacities or as to their cause. George Coats had found no references to similar cases in the literature, and my own search since the date of his papers has discovered very little that is helpful.

Fig. 176 in the first volume of Vogt's Atlas of the Slit-Lamp³ shows a corneal opacity consisting of a series of small chalky-white rods arranged as a rather oval ring, the individual rods being radially disposed. The diameter of the ring is about 0.5 mm. The condition was found in a female patient, aged 34 years, and Vogt dismisses it in a few words as an opacity following an old corneal injury.

Although in my cases the white particles were globular in form and thus differed from those shown in Vogt's illustration, I think the chalky colour, the superficial situation, the generally circular arrangement and the similarity in diameter of the opacities place Vogt's case in the same group. Vogt (*loc. cit.* Fig. 603a) has another illustration of a small irregular cluster of whitish spots in the cornea of a man employed in a cement factory. The spots do not form a circular group, and are not of chalky-white

colour, but they may represent an earlier phase of the same condition.

Gallemaerts⁴ also gives an illustration (Fig. 28, Pl. IV) of a corneal opacity consisting of an outer ring made up of numerous fine powdery specks, and within this a loose ring or spiral composed of about 24 larger discrete white spots. The spots are of the same chalky-white colour as in the cases under consideration, and the size of the "ring" also corresponds closely. The patient was a male, aged 17 years. The description attached to the illustration reads: "A round cicatrix with white points in the centre, following a traumatism many years earlier," and in the letterpress referring to "Lesions due to trauma" Gallemaerts seems to imply that such opacities can be caused by "Contusion of the cornea whether direct or due to an explosion" and as "Sequel of a foreign body." He states that these lesions have been studied by Caspar,⁵ Meller,⁶ Pichler,⁷ Palich-Szanto,⁸ Lampert^{9,10} and Vogt,¹¹ and I have referred to those publications, but, with the possible exception of Lampert's, the lesions described have no resemblance to the white rings described by Coats and illustrated by Gallemaerts, Vogt and myself. The ring-shaped opacities referred to by Caspar and Pichler are of much larger diameter, are delicate grey rings and disappear in the course of clinical observation. There is nothing to suggest that they are succeeded by the chalky-white opacities now under discussion.

No histological examination of the lesion has been made, and its nature is therefore a matter of speculation. Coats discussed the possibility of a microbic or mycelial origin, hyaline degeneration, calcareous degeneration and lead deposit and dismissed these for various reasons.

Rindfleisch¹² and Elschnig¹³ have described "drusen" of Bowman's membrane. In the latter the small elevations did not give the reactions of either hyaline or colloid, and their homogeneity distinguished them from coagulated protein. In their refractility they most closely resembled hyaline, and Elschnig supposed them to be deposited by the epithelial cells. I mention these findings because it seems possible that the spots which compose the white rings we are discussing, and appear to be situated on the surface of Bowman's membrane, could arise from a degenerative change, calcareous or otherwise, in such *drusen*.

The cause of the white rings seems to me to be equally obscure. Coats concluded that they might be congenital, but apparently for no other reason than that other causes seemed to be excluded. Meissner¹⁴ and Seefelder¹⁵ do not mention them among the congenital corneal opacities. Gallemaerts and Vogt look upon them as the result of injury by a small foreign body, but this assumption seems to me to have no direct evidence to support it. In no case

has the development of such an opacity been directly traced to a specific injury, and a history of injury by a foreign body at some past time is scarcely sufficient proof of the connection. As Vogt says, the condition is very rare, and Koeppel,¹⁶ in discussing the differential diagnosis of punctate white opacities in the cornea, does not refer to it. This rarity of its occurrence is a strong argument against its traumatic origin; for among the out-patients at the Glasgow Eye Infirmary, comprising thousands of coal miners and workers in stone and metal, corneal injuries by small foreign bodies are common, and the resulting corneal opacities are very familiar, while apparently this particular type of opacity is very rare:

One of Coats' cases had a vague history of a foreign body in his eye several years before observation, and another worked with pitch. One of mine was an engine driver who often got foreign bodies in his eyes, and remembered a particularly bad one 20 years earlier, removal of which had been attempted by several people. Another patient was a seaman, who might presumably be subject to eye injuries, and, indeed, attributed his visual defect to an undefined injury a few weeks earlier, but it was found to be due to disease of the choroid. Moreover, it will be noticed that in Coats' cases the one in which the opacities were multiple and bilateral, was a boy, aged 11 years, without any traumatic history.

If we were to base a theory on my four cases alone, we would rather be justified in tracing these opacities to an intra-ocular disease. For in one there was a chronic type of retino-choroiditis, in another, an acute exudative choroiditis superposed on an older choroidal affection, and in a third, there was an acute glaucoma which might conceivably be secondary to a uveal inflammation. In my fourth case the fundi were normal. The results of ophthalmoscopic examination are not stated in the cases of Coats and Vogt.

Of the eight cases herein referred to, six were males, aged 11, 18, 42, 43, 45 and 65, and two females, aged 34 and 42. In only one is the Wassermann result stated, and it was strongly positive.

Postscript

Since writing the above, notes of two other cases have been found and the details are briefly as follows:—

A. R., male, aged 27 years. A goods guard. Seen in 1926. No history of injury. Left cornea presents, to the nasal side of the centre, a ring, 0.5 mm. in diameter, composed of minute porcelain-white spots. At one margin a cluster of similar spots projects from the ring towards its centre.

J. W., male, aged 55 years. A factory worker. Seen in November, 1930. Right eye injured by gunpowder explosion in childhood. Left eye never injured and not subject to foreign bodies in his occupation. This eye presents a small white ring in the lower nasal quadrant of the cornea, diameter about 0.5 mm. O.E., left eye, normal. Corrected V.A. 6/6 and Jaeger No. 1.

No further notes were available in either case.

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"WHITE RINGS" IN THE CORNEA

BY

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A. J. BALLANTYNE in the current number of the *Brit. Jl. of Ophthal.* writes on some cases of "white rings" in the cornea, a condition originally described by Coats. This is of such rarity that the following case is of interest:—

E. C. P., male, aged 50 years. Seen on March 21, 1933, suffering from mild keratitis profunda. An interstitial opacity, which amounted to little more than a haze, was situated in the deepest layers of the cornea. There was no keratitis punctata, the Wassermann Reaction was negative and the condition was apparently due to a septic condition of the antrum and ethmoidal sinuses.

On examining the cornea with a slit-lamp, down and in could be seen a ring of white dots situated immediately beneath the epithelium, which was perfectly smooth over it. The dots were discrete, sharply defined and brilliant white in appearance. They