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A CONTRIBUTION TO THE STUDY OF ANGIOSCOTOMETRY

BY

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THE very interesting phenomena disclosed by this branch of visual field study are so unusual as to need careful consideration at every step, and particular care must be taken not to attempt to draw conclusions from the findings thus far uncovered.

We cannot expect to find help through a review of the literature, because careful search shows that no more than stump-like processes have been previously demonstrated (see Chart I, Figs. 1, 2, and 3). To be sure, numerous papers have shown pathological charts from which a defect of vascular origin could be pointed out. But in such cases the relation could be arrived at mainly through inference from other forms of study.

The plan thus far adopted has been to present maps showing typical characteristics of the angioscotoma. The physiological experiments have been repeated many times, and the particular phenomena checked by a number of observers before the results have been accepted. Of course, this policy has been impossible in most of the pathological cases.

The word "Angioscotometry" was chosen only as a temporary means of denominating this work, as it was realized at the very beginning that it was probably not technically accurate and that, indeed, the various phenomena described might not be manifestations of vessel-shadow at all. It seems best, however,

to continue its use with the understanding that it is applied in a broad sense to mean that the plotting is *associated* with the retinal vessel tree rather than *caused* by it. The words "vessel shadow" and "vessel scotoma" are used in this same sense in these reports. In concrete form we may state the experimental matter in hand thus:

FIRST.—The *discovery of the angioscotoma* (see Chart II).^{*} The development of this technique may properly be called "perimetry with minute objects." In some instances the little spheres may be smaller than 1/8 mm. in diameter.

SECOND.—The *discovery of certain types* of characteristic distribution, particularly about the macular region and adjacent to the blind spot (see also Chart II).

THIRD.—The *discovery of certain physiological changes*, as—

I. Widening of the angioscotoma by:

1. Holding the head lower than the trunk (see Chart III, Fig. 1).
2. Holding the breath (see Chart III, Fig. 2).
3. Pressure on the eye which is being plotted (see Chart III, Fig. 3).
4. Pressure on the *opposite* eye (see Chart III, Fig. 4, *a* and *b*).

II. The *discovery that the scotoma seeks* to relocate itself if the head be rotated about the visual line of the eye examined (torsion).

To these three studies of the physiological series we may now add others:

FOURTH.—*This study has demonstrated* that the scotoma may be traced in every direction to at least 35 degrees from the nerve head. Such a study is possible only by making removable the dividing partition of the stereocampimeter. This means makes accessible much more of the nasal field. A characteristic arrangement of the scotoma is then noted in that region. Excentric fixation is also used to bring the more peripheral areas within the limits of the slate (see Chart IV).

FIFTH.—In the non-pathological case of L.S., *when frightened*, the vessel scotoma showed marked widening, as compared with the same scotoma taken a few minutes later when the patient was at ease. The patient was badly frightened and pallid because she was afraid the stereocampimeter would hurt her. She had been told that the test was very painful and she had recently undergone

^{*}Preliminary reports, with a detailed description of the technique appeared in the *Amer. Jl. of Ophthal.*⁴ (An abstract of this paper will be found on p. 407 of this number.—ED.)

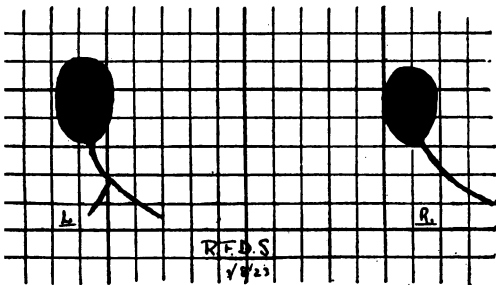
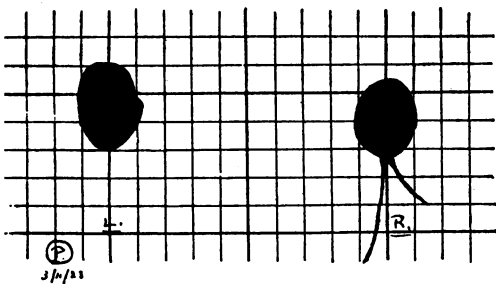
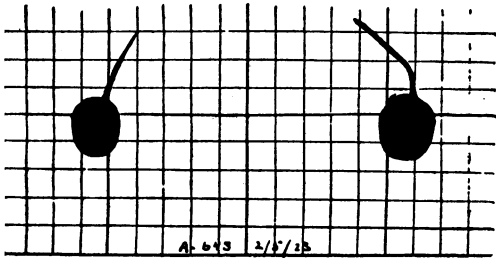
It seems better to allow the small sphere a longer protruding stem than in the original objects, so that the paper handle is more remote and is less apt to attract attention.



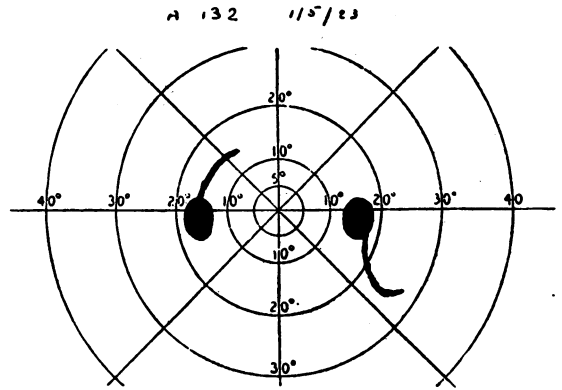
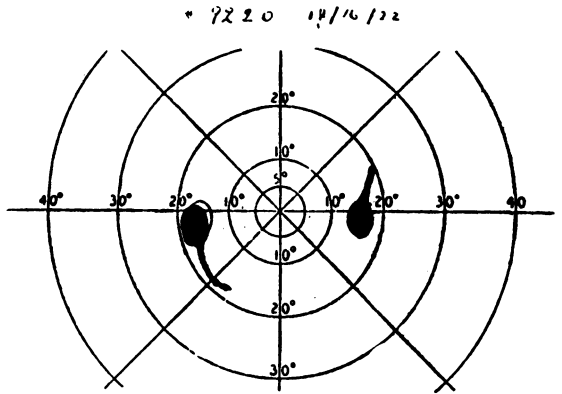
From Helmholtz.
CHART I. FIG. 1.



From Igersheimer.
CHART I. FIG. 2.



From S. B. Marlow.
CHART I. FIG. 3.



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From S. B. Marlow.
CHART I. FIG. 4.

a severe and painful operation. Perhaps we may term this phenomenon "widening by fright," or even, "psychological widening" (see Chart V, Fig. 1).*

SIXTH.—*It was discovered that* in 100 consecutive cases at least one small angioscotoma extended in the horizontal meridian from the blind spot towards the point of fixation. Ordinarily, this can be traced less than six degrees from the border of the blind spot (see Chart V, Figs. 2 and 3).

SEVENTH.—*It was discovered that* this scotoma could be traced all the way to the point of fixation; when an after-image had been created by gazing fixedly at a bright light for a few seconds. (The subject turns, from fixing the light, immediately to the campimeter and the outline of the after-image can be mapped by the same technique as is used for plotting the vessel scotoma.) The extension of the short vessel scotoma is not discoverable all the way to the after-image for an interval of 10-15 seconds, and persists a short time after that central scotoma fades (see Chart V, Figs. 2 and 3).

If desired the after-image, when projected as a *relative scotoma*, may be exaggerated, or even made absolute, by placing a red glass before the eye. It is well to place a green glass of the same brightness value before the fellow, or fixing eye, so that the red may not become gradually submerged and lose its colour value.† This arrangement also keeps one or the other eye from becoming continuously suppressed because of the difference in acuity. Stereoscopic vision is also enhanced by this method. Care must be taken to fix through the green glass a very white chalk circle about the fixation point, in order to discourage suppression through lack of stimulation of the fixing eye. The writer has not found this method previously described and therefore denominates it the "complementary colour" method.

EIGHTH.—*It has been discovered that* there is a widening of the entire scotoma tree for *both eyes* (see Chart VI, Fig. 1) after an after-image has been created by gazing at a bright light with *one eye* (see Chart VI, Fig. 2). This is so whether the light be gazed at by fixing with the macula or by *fixing excentrically* (see Chart VI, Fig. 3). The eye not in use for fixing the light is lightly covered by an opaque shield.

Two avenues are open for exploration in the study of the angioscotoma—the physiological and the pathological. Ideally, the former should be fully developed and established so that some sort of theory may be elaborated to aid in the explanation of the pathological. Such conditions are not afforded in the daily routine

*Once studied and not checked by other observers.

†This means of study by the "complementary colour method" is worth careful thought, as many very interesting problems are introduced. See Parsons⁹ and Helmholtz⁸ for other observations.

in the practice of ophthalmology. Moreover, certain pathological cases present themselves from time to time, which offer unusual and rare opportunities for studying the relation of the angioscotoma to disease conditions. It is, therefore, more practical to develop the two branches at the same time. By following this method of study

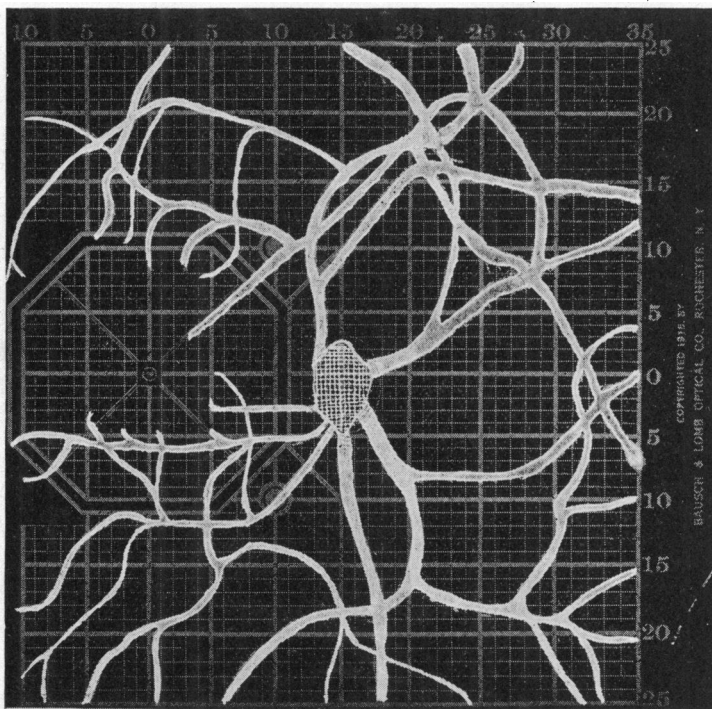


CHART II. FIG. 1.

A typical vessel scotoma 1 mm. white sphere used. Mapping time 2 hours. Simple hyperopia 1D.

it has been possible to show certain relations between angioscotomata and the following pathological conditions.

FIRST.—*There was discovered* a relation of the blood-vessel shadow to an enlarged blind spot in a case of pulsating exophthalmos. In this instance, the widened angioscotoma and enlarged blind spot became smaller when pressure was made over the carotid artery on the same side, though there was no apparent change in the fundus picture.*

* From a review of the literature this would seem to be the first case reported in which such a change in the blind spot had been demonstrated. See reference No. 1 in Bibliography. (Case of J.S.)

SECOND.—*A relation has been pointed out between the angioscotoma and enlarged blind spot in a case of toxic neuro-retinitis. (Case of E.S.)*

THIRD.—*A relation of the angioscotoma has been discovered in cases definitely recognized as being vascular in character. Of these there was a tuberculous periphlebitis; a pigmentary degenera-*

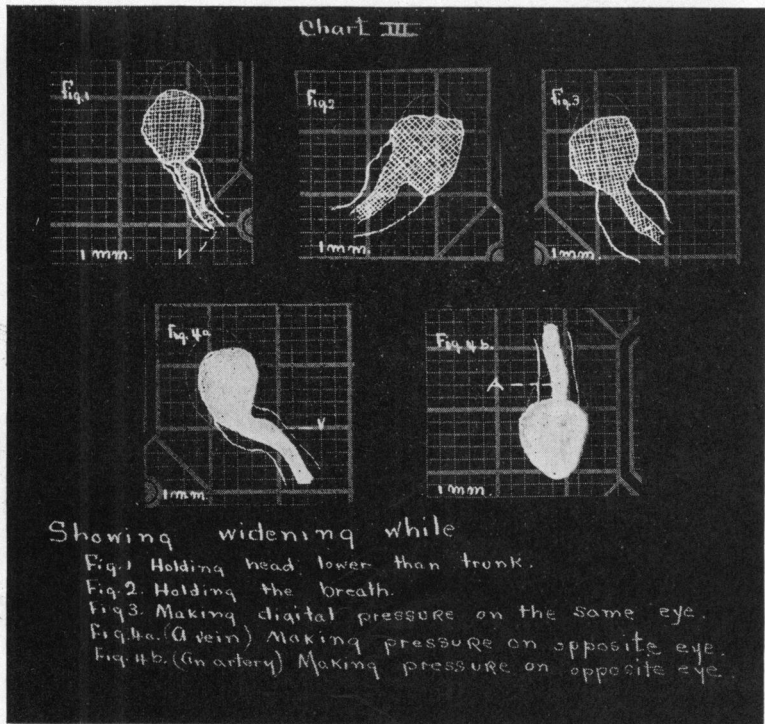


CHART III.

tion of the retina; a choroiditis, macular degeneration in a case of arterio-sclerosis and advanced chronic interstitial nephritis.

FOURTH.—*A relation of the vessel shadow has also been indicated in charts of patients suffering from chronic glaucoma.*

FIFTH.—*A relation has also been found in certain toxic cases, as alcoholic amblyopia and retrobulbar neuritis. (These charts are also presented in a previous paper.)**

There is strong temptation to try to draw deductions from each of these cases but as another is added, an apparent complication

* See these cases in author's paper, reference No. 4 Bibliography.

arises which emphasizes the danger of premature speculation in the presence of inadequate material!

The following cases show additional relations :

SIXTH.—H.M. This patient, a coloured woman, stated as aged 46 years, had been under observation for eight years. Three years previous to the present examination, a haemorrhagic glaucoma had developed in the left eye which necessitated enucleation. The condition leading up to this was a very rapidly advancing arterio-sclerosis of the generalized type in which numerous vessels had become apparently replaced by fibrous tissue. At the onset of the

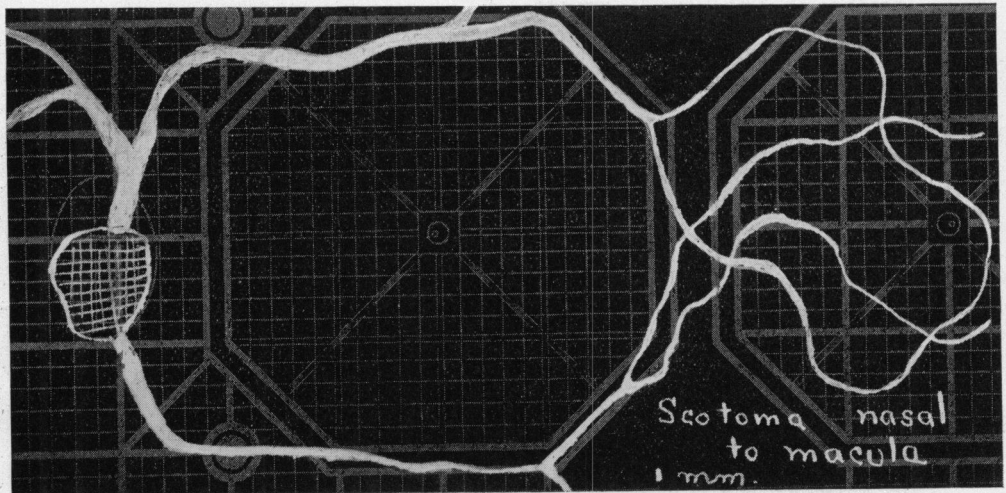


CHART IV. FIG. 1.

glaucoma all stages of sclerosis were present in the various vessels. The vessels here studied correspond as nearly as can be remembered to a group of nasal ascending ones which showed this same picture at the time of enucleation. The ophthalmoscope now shows a similar broadly blurred arterio-venous crossing, with pinched vein and wide central and peripheral light streaks on the artery. As will be seen from the chart there is no difference from the normal in the appearance of the angioscotoma either at the point of crossing, or elsewhere. Pressure on the same eye showed the usual widening effect and seemed to respond to the change in the same manner in every way as a healthy eye. The opposite eye being enucleated, heavy pressure was made directly on the artificial eye, and also through the closed lids, so as to cause deep orbital compression. There was, however, no widening of the scotoma under these conditions. Though very carefully and

repeatedly studied, the cause of this almost malignant sclerosis has not been discovered. The visual acuity is still 6/6 and there is no other pathological evidence in the eye (see Chart VII, Fig. 1).

SEVENTH.—L.K. This American woman, aged 54 years, showed a marked generalized arterio-sclerosis, apparently of a primary type. The vessels mapped (right eye) appeared ophthalmoscopically as white fibrous bands without evidence of a blood stream at any point. O.D.V.=3/30. It was noted that pressure on the same eye caused the usual prompt widening effect. Pressure on the

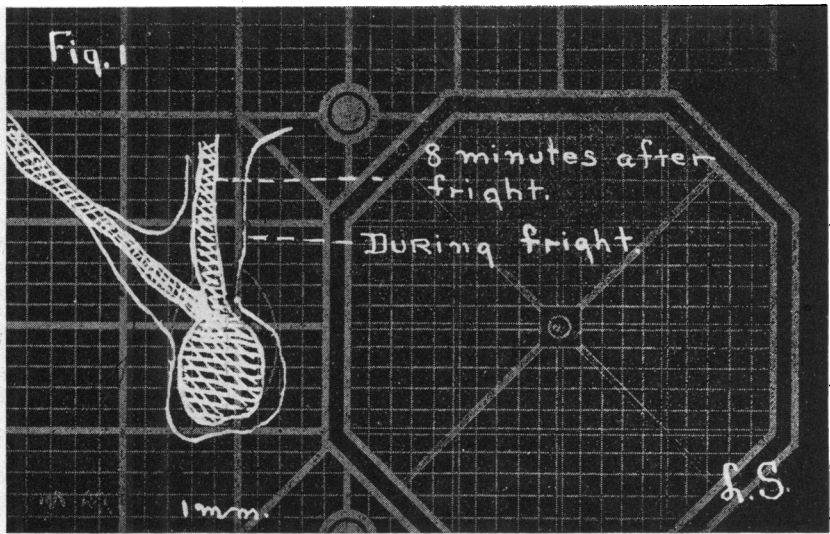


CHART V. FIG. 1.

opposite eye, however, did not produce this usual effect (see Chart VII, Fig. 2).

EIGHTH.—C. McF. An American man, aged 36 years, was under observation from August to October because of decrease of vision in the left eye. Though previously studied by three different physicians, no ophthalmoscopic evidence could be found. The *finally* visible detachment of the retina had become non-progressive by November. The relation of the vessel scotoma to the detachment was well shown months before the ophthalmoscope could identify the lesion. Vision dropped during the period of observation from 6/12 to 3/30+1 (see Chart VIII, Figs. 1-4).

NINTH.—J.L.M., aged 60 years. A physician complained of decreased vision in each eye which turned out to be a unocular diplopia, affecting each eye separately. The left eye got doubling

of a horizontal string in all positions of the head with a separation of apparently two inches at ten feet. The right eye got separation

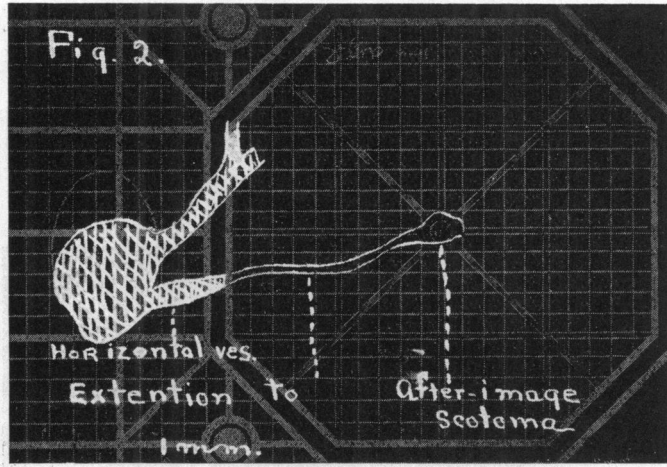


CHART V. FIG. 2.

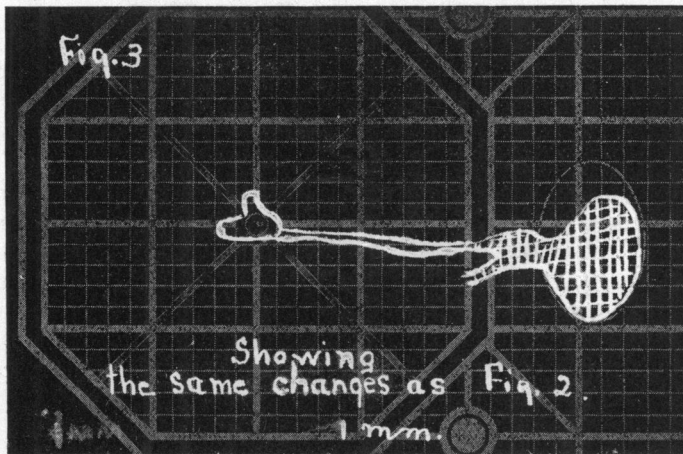


CHART V. FIG. 3.

of about one-half inch. (A pin-hole aperture did not relieve the diplopia.) Very small opacities of the lens could not be ruled out absolutely, as the cause, but arterio-sclerosis with nutritional disturbances at the macula were called the aetiological factors. Central

acuity with correction of a +3.0S. was constantly 6/4 in each eye. Both eyes showed the vessel scotoma running from the blind spot to a central scotoma. Mapping was accomplished by the "complementary colour method" (see Chart IX, Fig. 1).

TENTH.—*An additional relation which has to do with the problem of amblyopia ex anopsia has been discovered.* Out of twenty consecutive cases in which all other causes for the decreased vision were carefully ruled out, a central scotoma was outlined and at least one angioscotoma connected it to the blind spot. In some instances a number of these small vessel shadows were outlined radiating

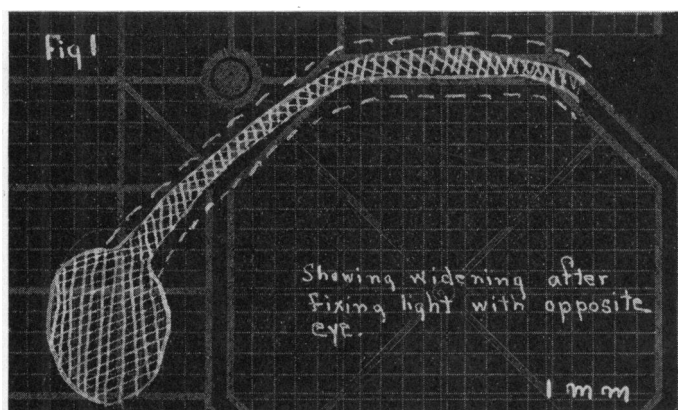


CHART VI. FIG. 1.

from the central defect (Chart IX, Fig. 2). The same widening effects could be produced on these angioscotomata as could be with other vessel shadows (Chart IX, Fig. 3), *i.e.*, to light, pressure, holding breath, etc. All of these twenty cases in which the scotomata were mapped, were not suitable for the more elaborate studies of widening, on account of the "wandering moments" which these eyes showed after protracted fixation. The "complementary colour method" was used.

In looking about for possible related factors and phenomena which may at some time be of assistance many points are of the utmost interest. Beside the possible influence of the perivascular lymph space and all those near and remote factors modifying intra-ocular pressure, certain circulatory responses, the influence of the sympathetic, etc., we must not forget the avascular zone of the retina following the arteries and veins. This region contains no capillaries, as was pointed out particularly by Parsons.⁽⁸⁾

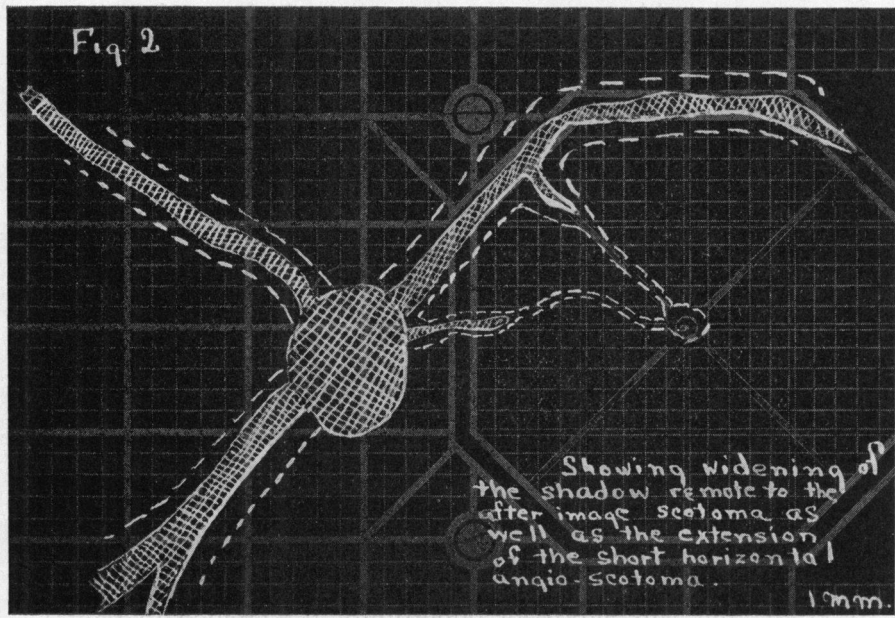


CHART VI. FIG. 2.

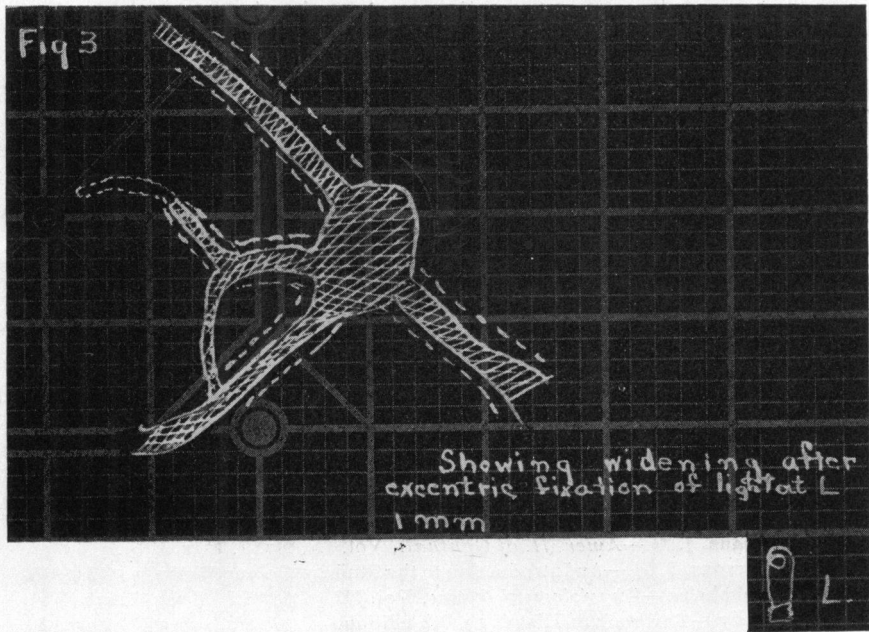


CHART VI. FIG. 3.

I may quote this same author on a point which may have some relation to the horizontally placed scotoma between the macula and the nerve head: "There are also two fine macular arteries which pass horizontally outward from the disc, usually arising from the central artery before it has reached the surface."⁽⁸⁾

The recent contributions coming from Cajal's⁽⁷⁾ workers, and corroborated by Penfield,⁽⁷⁾ on the neuroglia cells of the brain, and particularly those cells—the astrocytes—capable of motility and which in part, at least, seem to contribute to the formation of the perivascular lymph space must not be neglected in amassing possible factors likely to contribute to an explanation of the herein described phenomena. To be sure, there is still much to be learned about their relation to the retina, but our knowledge is expanding rapidly.

Remarks.—It is proposed to continue this policy in future communications of stating the features so far brought to light, both pathological and physiological, including any additions from the literature, supplying any points which may some day lend aid in evolving a theory and keeping up bibliographical references. In this way each communication will not only summarize the progress, but will afford an opportunity for anyone to offer a possible explanation of these very interesting and novel phenomena.

If the angioscotoma studies never develop any practical diagnostic points it is obvious that indirectly they will lead to more systematic and painstaking methods of searching for defects in the central and paracentral regions and in this way may already be said to have established their practical value.

NOTE.—Dr. Ralph I. Lloyd has suggested that it would be well to call attention to the difference between the "complementary Colour method," as described by Schloesser (*Vossiusche Abhandl.*, Bd. III, Heft 8, 1901) and the method detailed above.

Space does not permit of a comparison of these two procedures. Reference to Schloesser's work will, however, make it evident that the principles involved are quite different.

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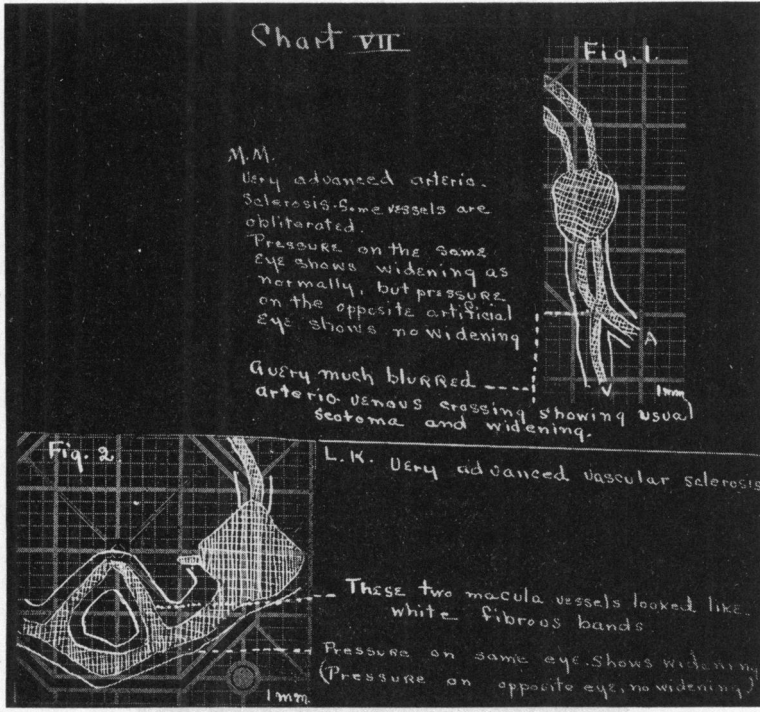


CHART VII.

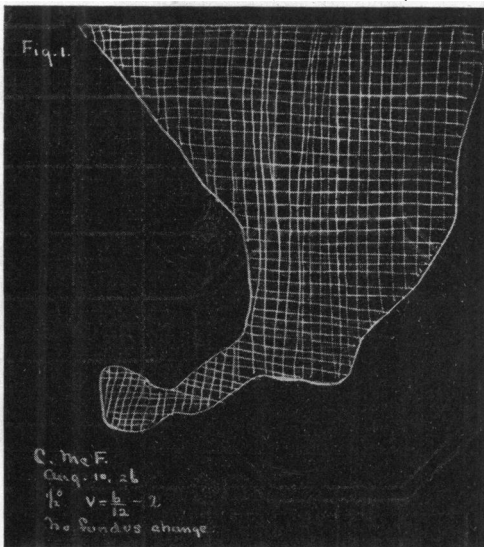


CHART VIII. FIG. 1.

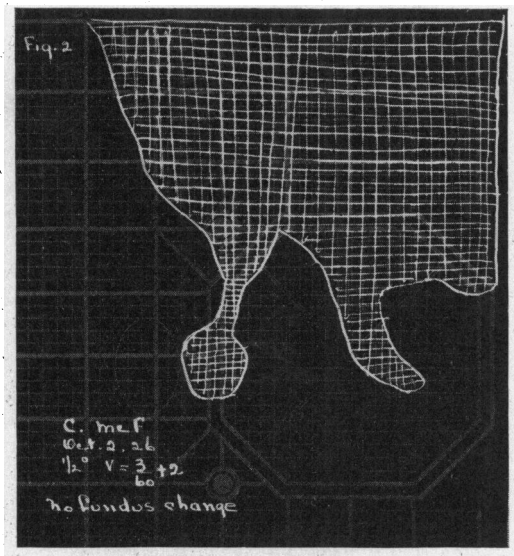


CHART VIII. FIG. 2.

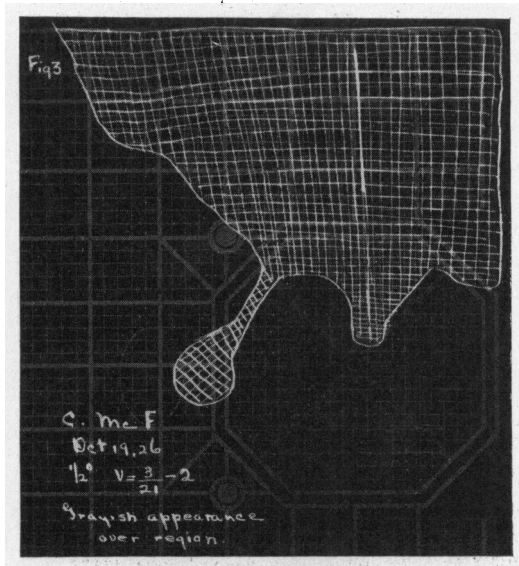


CHART VIII. FIG. 3.

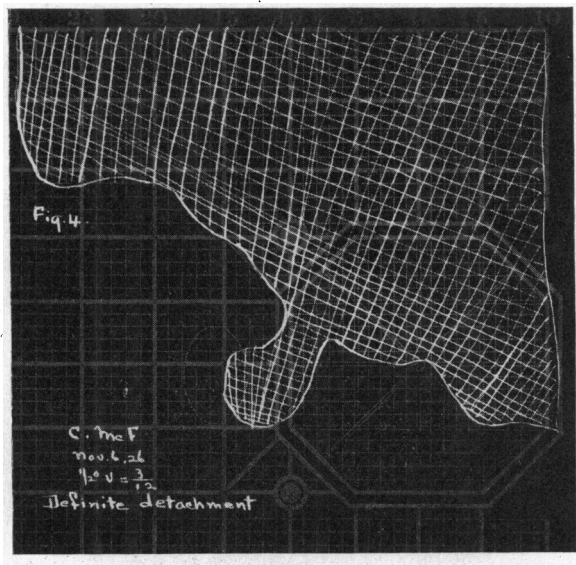


CHART VIII. FIG. 4.

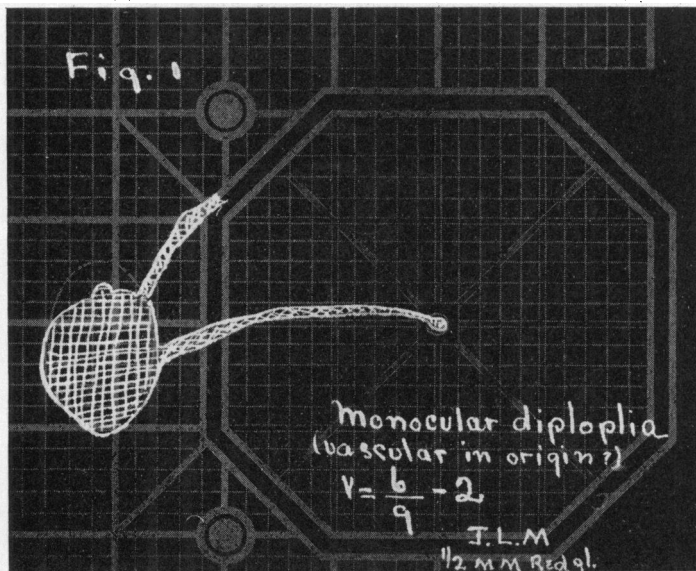


CHART IX. FIG. 1.

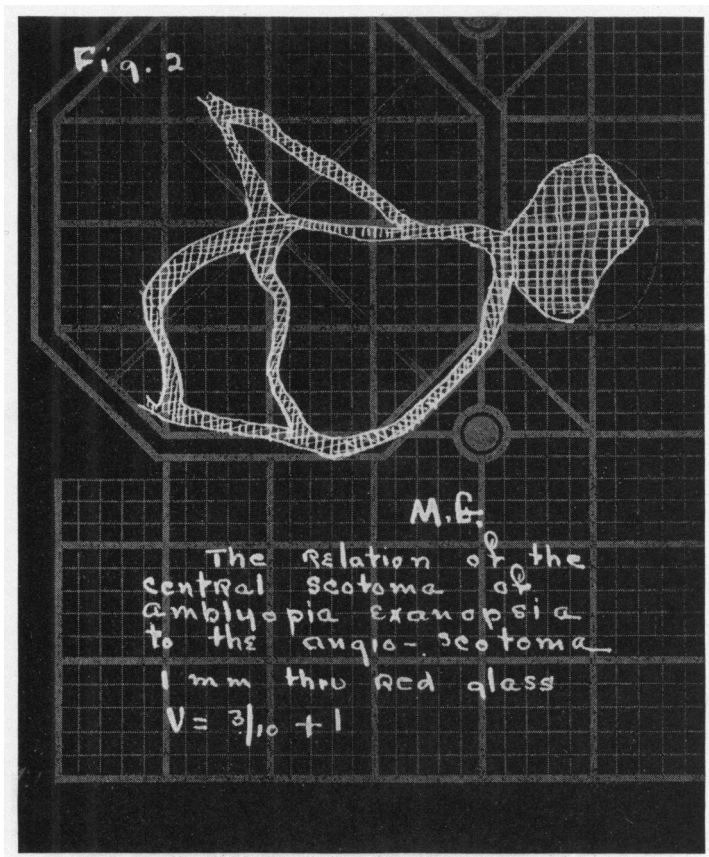


CHART IX. FIG. 2.

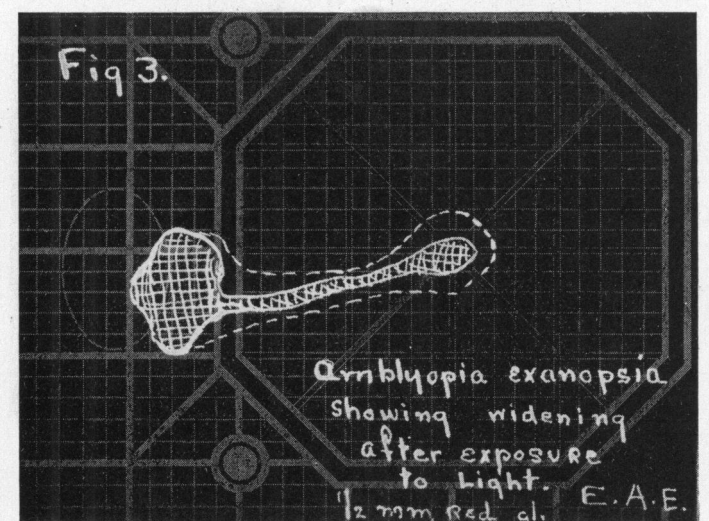


CHART IX. FIG. 3.