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Contributors

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Collier, James.
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BRAIN.

PART II., 1904.

Original Articles and Clinical Cases.

A CONTRIBUTION TO THE STUDY OF THE
CORTICAL LOCALISATION OF VISION. A
CASE OF QUADRANTIC HEMIANOPIA WITH
PATHOLOGICAL EXAMINATION.

BY C. E. BEEVOR, M.D., F.R.C.P.,

Physician to the National Hospital and to the Great Northern Hospital.

AND

JAMES COLLIER, M.D., B.Sc., F.R.C.P.,

Assistant Physician and late Pathologist to the National Hospital.

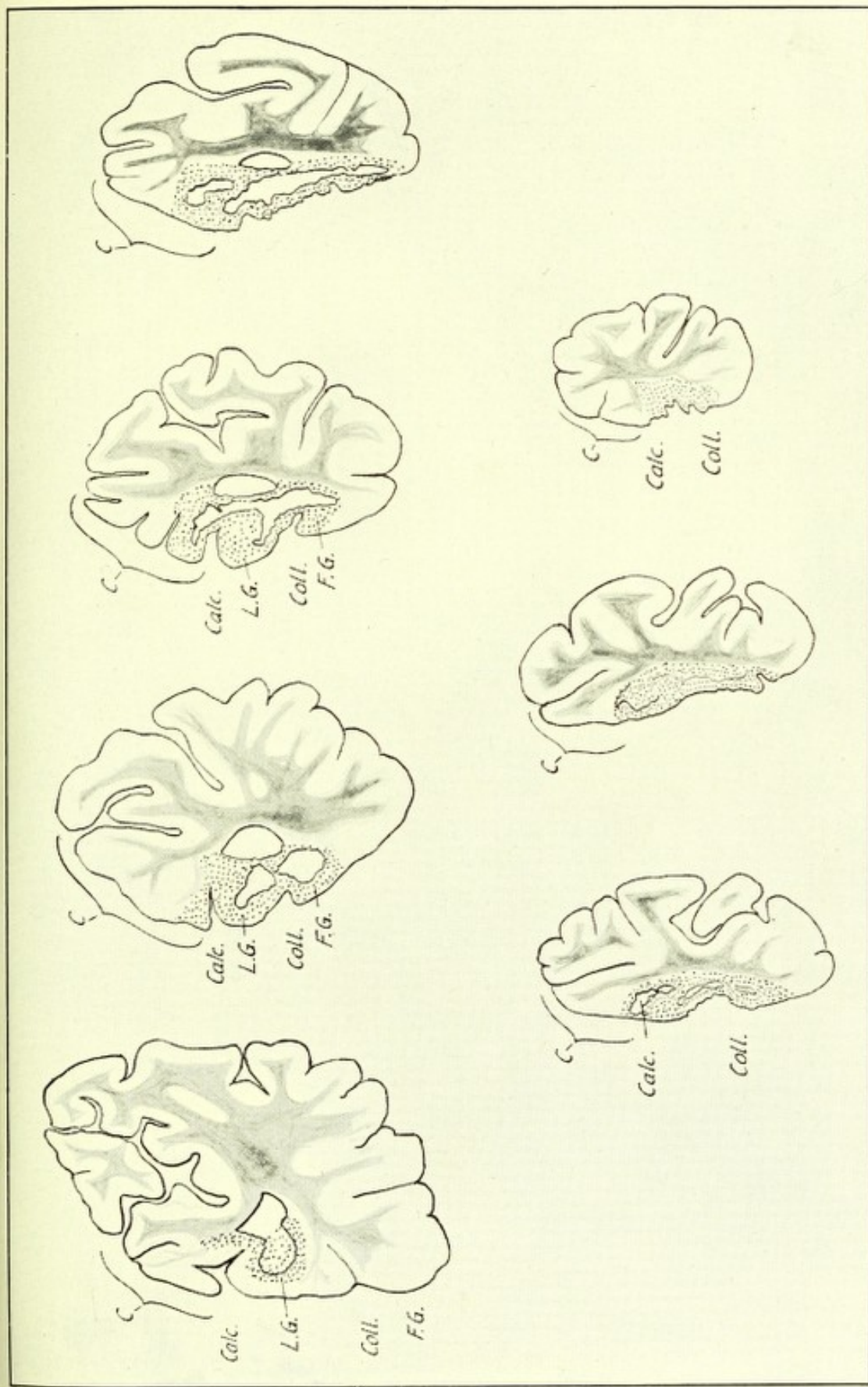
WHILE the investigations of recent years have definitely proved that the cortical half-vision centre is situated mainly if not exclusively upon the mesial aspect of the occipital lobes, the exact limitations of this centre is still a matter of debate. There has been but little evidence recorded as to the limits of the cortical representation of the quadrants of the visual field, and we have been able to find one recorded case only of quadrant hemianopia resulting from a cortical lesion in which there has been a pathological examination, and in this case, which was recorded by Hun, there was unfortunately no microscopical examination.

Cases of quadrant hemianopia and of partial hemianopia, with detailed pathological examination, have been recorded by Henschen (5 cases), Harris (2 cases), Anderson, Bruns, Reinhard, Förster, Lavista and Wilbrand, but none of these

cases afford evidence as to the cortical representation of the quadrants further than that the dorsal part of the visual cortex and the dorsal portion of the optic radiation between this and the external geniculate body are concerned with the lower quadrants, and that the ventral portions of both visual cortex and optic radiations are concerned with the upper quadrants. In none of these cases was the lesion confined to the cortex, and in several of them the lesion was limited to some part of the optic radiation.

The case which we report is of especial interest, since it was under our clinical observation for a long period, and careful perimetric examinations were made by several skilled observers. After the autopsy the brain was hardened in formalin, and subsequently photographs and casts of the occipital lobes were made. The occipital lobes were cut by vertical coronal sections into slices, and the posterior surface of each slice was photographed. The slices were then further hardened in Weigert's chrome alum fluid, and serial sections were prepared by Weigert's method, and projection drawings of the sections were made. These procedures allowed of the exact determination of the limitations of the lesion. The patient during the greater part of the period that he was under our observation presented, as the sole manifestation of gross nervous disease, blindness of the left upper quadrants of both visual fields, the fixation point escaping. The condition of the visual fields remained constant during a period of nearly two years. An occlusive lesion of the right posterior calcarine artery had caused destruction of the cortex (1) of the right fusiform lobe for its posterior two centimetres, (2) of the right lingual lobe from the junction of the calcarine and parieto-occipital fissures to the pole of the hemisphere, (3) of the whole cortex in the depth of the calcarine fissure, (4) of the greater part of the inferior cuneal gyrus, small areas only at the anterior and posterior limits of this gyrus being free. The necrosis did not involve the optic radiation at any point.

The only parts of the cortex of the mesial aspect of the occipital lobe which had escaped destruction were the upper two-thirds of the cuneus and the anterior and ventral



The right occipital lobe of D.C. Projection drawings of Weigert sections.

C. = cuneus. *L.G.* = lingual gyrus. *F.G.* = fusiform gyrus. *Calc.* = calcarine gyrus. *Coll.* = collateral fissure.

portion of the fusiform lobe. The lower quadrants of the visual fields were entirely unaffected, and, until it was pointed out to him, the patient was unaware of the visual defect. We submit therefore that this case affords conclusive evidence that the cortex of the upper two-thirds of the cuneus is the primary visual centre for the lower quadrants.

The primary half-vision centre is considered by von Monakow to occupy the cortex of (1) the entire lingual lobe behind the junction of the calcarine and parieto-occipital fissures, (2) the entire cuneus and extending for some half an inch or more on to the external aspect of the occipital lobe. He thinks that the calcarine fissure probably forms the line of separation of the representation of upper and lower quadrants.

It must be borne in mind in connection with Monakow's localisation of the half-vision centre that Ramón y Cajal traced the axons of the neurons of the external geniculate body to a corresponding area of the cortex in mammals. Further, the fibres of the optic radiation have been proved to form the layer of Gennari, which is a peculiarity of the cortex of the mesial aspect of the occipital lobe. Dejerine figures the layer of Gennari as having almost the same limits as von Monakow's half-vision centre. It is found throughout the cuneus and the corresponding portion of the lingualis, ceases abruptly below at the collateral fissure, and extends from the cuneus for some little distance onto the convexity of the occipital lobe. Brodmann gives much the same limits to Gennari's layer; Bolton, on the other hand, considers that it is absent from the upper convolution of the cuneus. Henschen finds that this layer is much more marked in the cortex lining the calcarine fissure, where it is divided into two separate layers.

In the case here recorded Gennari's layer was well marked in the upper two-thirds of the cuneus on the side of the lesion, and in the left occipital lobe it had such limits as Brodmann has described. Further, we have examined the occipital lobes of several normal brains, and have found this layer constantly present both in the upper part of the

cuneus and in the whole of that part of the lingual lobe which lies below the cuneus.

Monakow's conception of the limits of the half-vision centre is opposed by Henschen, who considers that, while the bulk of the cuneus and lingualis are doubtless concerned with half vision as secondary centres, the primary half-vision centre is located in the cortex of the lips and depth of the posterior calcarine fissure. The depth of the calcarine fissure is so close to the optic radiation that necrosis of the former is apt to involve the latter directly, and since in our case the whole of this cortex was destroyed and yet the lower fields were unaffected, it seems possible that direct involvement of the optic radiation is accountable for the homonymous hemianopia which has been reported in cases of necrosis confined to the region of the calcarine fissures.

We wish to draw especial attention to the following points in our case, and to submit these inferences.

(1) The larger part of the lesion was situated below the calcarine fissure. (The upper quadrant is chiefly if not entirely represented below the calcarine fissure.)

(2) The cortex lining the calcarine fissure was completely necrotic. (The primary half-vision centre cannot therefore be limited to the calcarine cortex nor the macula exclusively represented in the anterior part of this region.)

(3) The portion of the half-vision centre, as limited by von Monakow, which was not involved, was the upper two-thirds of the cuneus.

(4) The visual defect was blindness of both left and upper quadrants. (The lower quadrants are represented to a great extent in the upper two-thirds of the cuneus.)

(5) The lower quadrants of the visual fields were not affected, and the patient was not himself aware of any visual defect.

Deductions from these facts strongly support von Monakow's localisation of the half-vision centre, since the supply of the lower quadrants in our case was certainly from the upper two-thirds of the cuneus. The calcarine cortex to which Henschen limits the half-vision centre was entirely destroyed, and according to his localisation there should have been homonymous hemianopia.

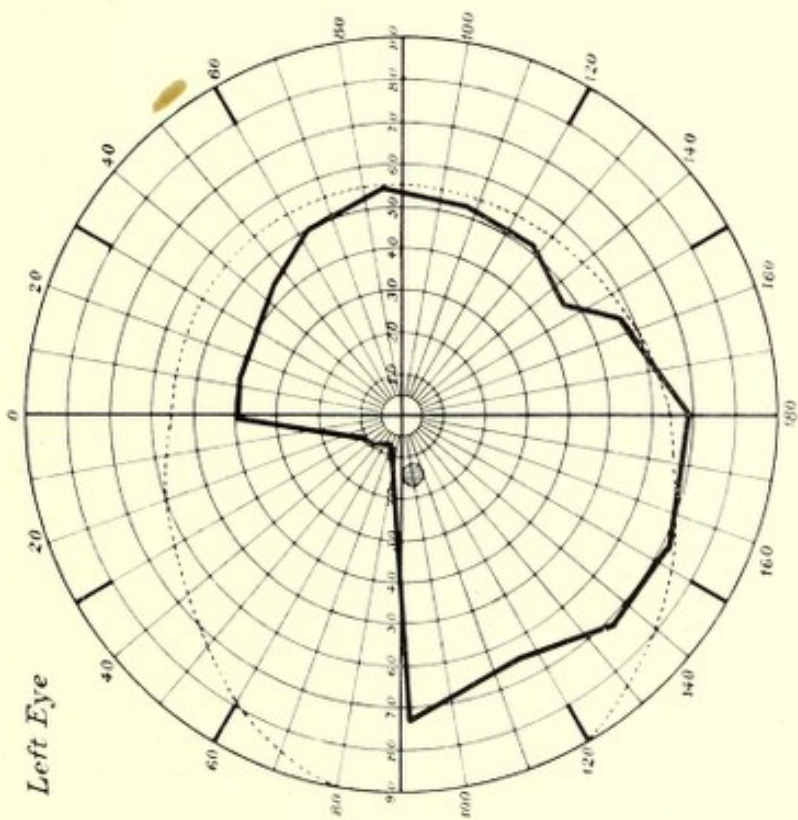
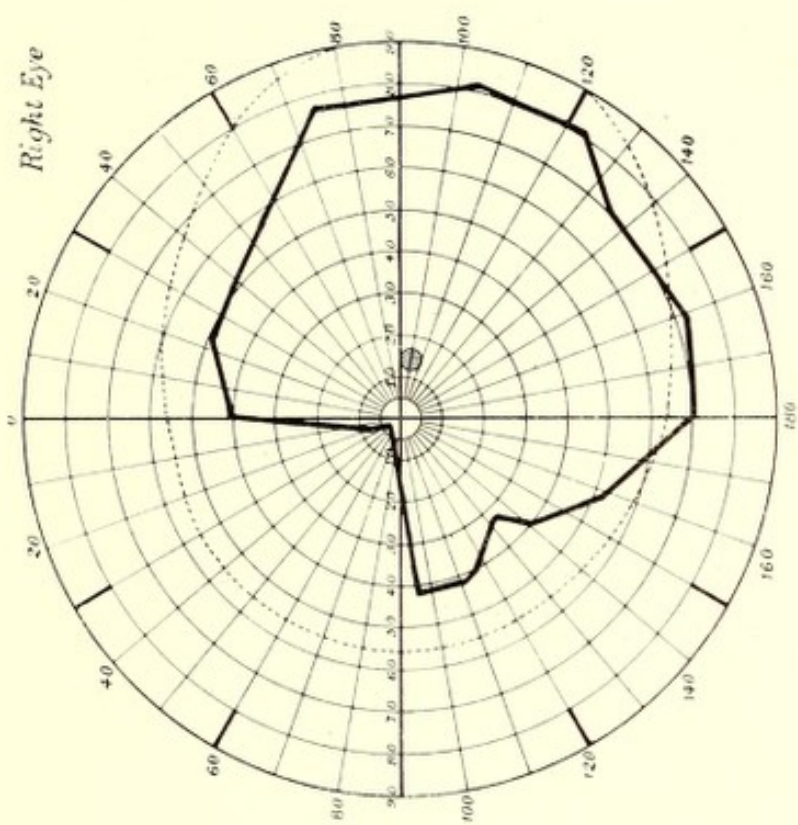


Chart of the visual fields of D.C., taken on May 25, 1900.



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According to Bolton, who excludes the upper part of the cuneus and restricts the half-vision centre to a pear-shaped area tailing off in front and occupying the lingualis and inferior cuneal gyrus, there should have been hemianopia, for the limits of the lesion in our case corresponded almost precisely to the limits of his half-vision centre. There is some difficulty in reconciling our results with those found in the only other case of quadrantic hemianopia with a pathological examination, and which was published by Hun. In this case the left lower quadrants were lost and the lesion upon the surface involved the inferior cuneal gyrus alone. In our case the inferior cuneal gyrus was almost entirely necrosed and the lower quadrants were not affected.

Hun made no microscopic examination, and his case is open to the judgment which has been expressed by Bolton and many others, and which our case fully confirms, that the extent of a lesion cannot be judged from its surface appearance and that the lesion as found by microscopic examination is invariably of greater extent than it appears upon macroscopic examination. The probable explanation of Hun's case is that the necrosis of the inferior cuneal gyrus extended somewhat deeply so as to cut off the radiation of the whole cuneus. We think, further, that cases of hemianopia with the lesion confined to the calcarine cortex are to be explained on the same grounds, that the lesion involves the optic radiation.

It would seem from our case that the line of separation between the visual centres corresponding with the upper and lower quadrants is at the upper limit of the inferior cuneal gyrus, but in this connection a most important consideration arises. In the only two cases of quadrantic hemianopia which to our knowledge have been examined, the case here reported and that of Hun, there has been complete or nearly complete destruction of the inferior cuneal gyrus. In the one case the upper quadrant was lost, the lower intact; in the other case the lower quadrant was lost and the upper was intact. The limits of the quadrants in the two cases corresponded. In our case we argue that the loss of the upper quadrant was due to the

lesion of the lingualis and of the calcarine cortex, while in Hun's case we argue that the loss of the lower quadrant was the result of involvement of fibres of the optic radiation coming from the upper cuneus. But, though the inferior gyrus of the cuneus was destroyed in each case, there was no blind area of the field common to the two cases. The only explanation which we can suggest of this remarkable fact is that there may be both considerable overlapping in the cortical supply of the various parts of the retina, and considerable power of compensation for local damage in the cortex limiting the lesion.

If this hypothesis be correct, the limit between the cortical representations of the upper and lower quadrants is probably the calcarine fissure. We would draw attention to the greater size of the supra-calcarine visual area, when compared with the infra-calcarine visual area, as corresponding with the greater physiological value of the lower visual field as compared with the upper visual field.

CLINICAL ABSTRACT.

D.C., aged 55 years, was admitted into the National Hospital under the care of Dr. Beevor on May 22, 1900, complaining of headache, difficulty with vision and attacks of "pins and needles" in the left arm. His symptoms had been present four months. The family history was unimportant. Thirty-six years before admission he had three fits in the space of a few months. Another fit occurred a year before admission. Otherwise his health had been very good.

His illness began in December, 1899, when, as he was at work, he noticed that the feeling was going out of his left hand and he dropped his tools. His hand was quite strong, but it was numbed and there was a constant feeling of "pins and needles" in the left upper limb. There was no impairment of consciousness and he went on with his work. From this time he suffered with severe pains in the head and his eyesight gradually failed so that he had to wear glasses for reading. The "pins and needles" in the left

upper limb lasted two days and then ceased, but sudden attacks of a similar sensation commencing in the fingers and running up the arm to the face occurred from time to time. There was no impairment of consciousness and no twitching of the muscles in these attacks.

He was never aware of any defect in the visual field.

When admitted the only abnormalities detectable were that he was blind in the upper left quadrant of the field of both eyes. The pupils reacted well to light and equally from the blind and seeing areas of the field. His vision was $\frac{6}{9}$ in either eye, and he could read J2 when he was wearing his reading glasses. There was no subjective sensory disorder. He complained at times of severe occipital headache.

There was some arterio-sclerosis and some signs of cardiac hypertrophy, but no albumen in the urine.

The optic discs were pale. The retinal arteries showed marked "silver wire" change.

There was no alteration in the appearance of the blind quadrants upon ophthalmoscopic examination as compared with that of the seeing quadrants. He was discharged in July, 1900.

He remained in much the same condition till August 18, 1901, when his sight became much worse. Details of this visual affection were not obtainable, presumably it was the result of the recent softening found *post mortem* in the region of the chiasma and right optic tract.

He became queer in his head and had three attacks of sudden unconsciousness without convulsion. Great physical feebleness came on and he was re-admitted in August, 1901. He was very restless and delirious, and difficult to examine. There was no motor or sensory paralysis. The optic discs seemed normal. The following day the respirations became grouped and he died on September 12, 1901.

PATHOLOGICAL ABSTRACT.

The convexity of the brain showed no peculiarity. There was much patchy thickening of the internal carotid arteries and basilar artery, and of their branches.

After hardening in formalin the cerebellum was removed, revealing a patch of old softening much sunk below the level of the surrounding convolutions, and occupying the mesial aspect of the right occipital lobe. A small recent patch of softening was present at about the middle of the left occipito-temporal (fusiform) convolution, while a quite recent thrombosis of fine vessels had caused some softening of the right optic tract, just behind the chiasma of some of the underlying gray matter.

Measured antero-posteriorly the right hemisphere was 4 centimetres shorter than the left. The scar on the mesial aspect of the right occipital lobe involved upon the surface:—

(1) The posterior two-thirds of the lower convolution of the cuneus, the larger upper convolution of the cuneus being entirely uninvolved.

(2) The posterior extremity of the lingual lobe for 2·5 centimetres.

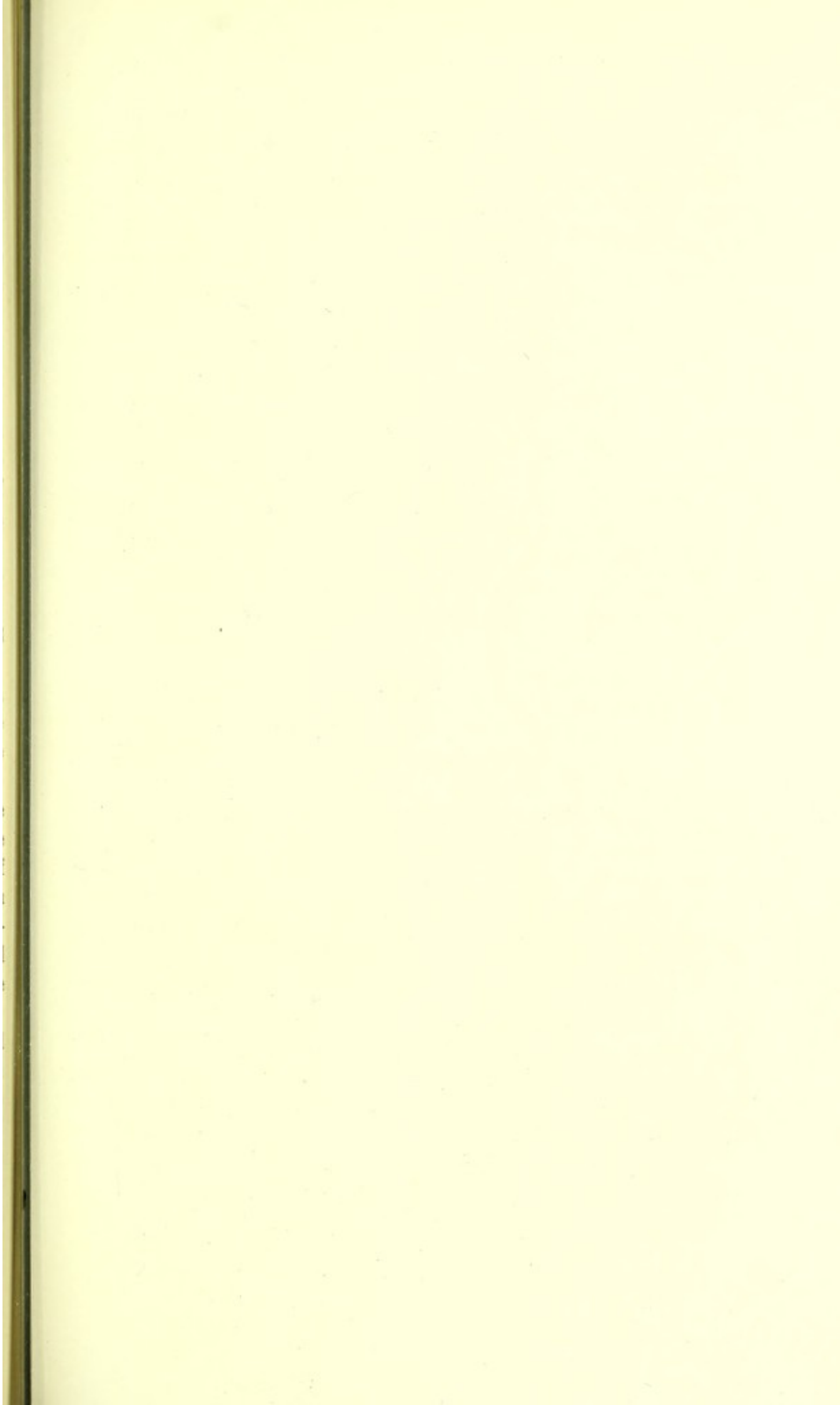
(3) The posterior extremity of the fusiform lobe for 2 centimetres.

Vertical sections through the occipital lobes were made, the photographs of which are shown on the plate. The pieces were then hardened; fluid and serial sections were prepared by the Weigert-Pal method.

These sections showed that the softening was more extensive than could be judged from the surface appearance of the lesion. It reached to and involved the inner wall of the posterior horn of the lateral ventricle, and extended in this position as far forwards as the splenium callosi, gradually tapering, and being last visible at that level as a small patch inferior and mesial to, and in close contact with, the posterior horn.

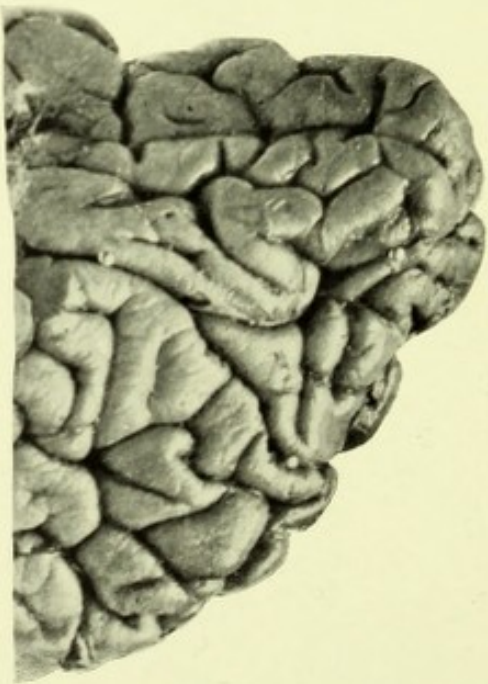
In sections through the cuneus the softening involved the lower one-half of the inner wall of the posterior horn of the ventricle. At its upper limit it involved most of the medulla of the lower convolution of the cuneus, but that of the upper convolution of the cuneus was not affected. It extended downwards as far as the inferior limit of the hemisphere in the subcortical white matter.

So far as the cuneus was concerned, the softening was entirely confined to the lower convolution.





The mesial aspects of the occipital lobes of D.C. The Chart shows the surface extent of the lesion as determined macroscopically.



At the posterior extremity of this convolution the gray matter bordering on the calcarine fissure alone was affected. For its middle two-thirds the whole of the convolution was involved, while in front of this the lesion became limited again to the lower part of the convolution, and at the junction of the calcarine and parieto-occipital fissures it involved the depths of the calcarine fissure only.

In front of the internal parieto-occipital fissure the softening extended into the lower and posterior part of the gyrus fornicatus.

The optic radiation, lying close to the outer wall of the posterior horn of the lateral ventricle, showed marked degeneration by the Weigert-Pal method. Between this region and the external geniculate body the regeneration was apparent in the ventral portion of the optic radiation.

The superior colliculus of the right side was slightly smaller than that of the left side, but it presented no other peculiarity. The mesial geniculate bodies of the two sides appeared of equal size. The right external geniculate body was smaller than the left. Very conspicuous was the difference in size and appearance between the pulvinars of the thalami upon the two sides. The posterior mesial projection of the thalamus was practically absent on the right side, and the superior brachium, markedly smaller than that of the left side, was uncovered by the pulvinar.

The right optic tract was much smaller than the left, and was soft and brown in colour from a recent local thrombosis just behind the chiasma. The right optic nerve was distinctly smaller than the left. The optic disc presented no peculiarity to the naked eye, nor on microscopic examination.

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CONTENTS.

ORIGINAL ARTICLES AND CLINICAL CASES:—

	PAGE
A CONTRIBUTION TO THE STUDY OF THE CORTICAL LOCALISATION OF VISION. A CASE OF QUADRANTIC HEMIANOPIA WITH PATHOLOGICAL EXAMINATION. BY C. E. BEEVOR, M.D., F.R.C.P., AND JAMES COLLIER, M.D., B.Sc., F.R.C.P.	153
SOME CASES OF FAMILY DISSEMINATED SCLEROSIS. BY ERNEST S. REYNOLDS, M.D. (LOND.), F.R.C.P.	163
FÆCAL VOMITING AND REVERSED PERISTALSIS IN FUNCTIONAL NERVOUS (CEREBRAL) DISEASE: A SUMMARY OF CASES AND CONCLUSIONS. BY F. PARKES WEBER, M.D., F.R.C.P.	170
INTRAMEDULLARY ABSCESS OF THE SPINAL CORD. AN ACCOUNT OF THREE CASES. BY WM. ALDREN TURNER, M.D., F.R.C.P., AND JAMES COLLIER, M.D., B.Sc., F.R.C.P.	199
BILATERAL LOSS OF POSTCENTRAL CORTEX, APPARENTLY CONGENITAL, IN AN ADULT. BY HUBERT M. TURNBULL, M.A., M.B. (OXON.)	209

REVIEWS:—

DR. O. CROUZON. DES SCLÉROSIS COMBINÉES DE LA MOËLLE. JAMES COLLIER	252
DR. P. J. MÖBIUS. DIE MIGRÄNE. PURVES STEWART	255
SIR WILLIAM R. GOWERS, M.D., F.R.C.P., F.R.S. LECTURES ON DISEASES OF THE NERVOUS SYSTEM. H. CAMPBELL THOMSON	256
T. CLIFFORD ALBUTT, M.A., M.D., LL.D., D.Sc., F.R.C.P., F.R.S., F.L.S., F.S.A. NOTES ON THE COMPOSITION OF SCIENTIFIC PAPERS. CHAS. MERCIER	258
C. A. STRONG. WHY THE MIND HAS A BODY. CHAS. MERCIER	270
ARCHIBALD CHURCH, M.D., AND FREDERICK PETERSON, M.D. NERVOUS AND MENTAL DISEASES. F. E. BATTEN AND R. PERCY SMITH	276
J. HERBERT FISHER, M.B., B.S.LOND., F.R.C.S.ENG. OPHTHALMOLOGICAL ANATOMY, WITH SOME ILLUSTRATED CASES. JAMES COLLIER	279

PROCEEDINGS OF THE NEUROLOGICAL SOCIETY OF THE UNITED KINGDOM 281