THESIS

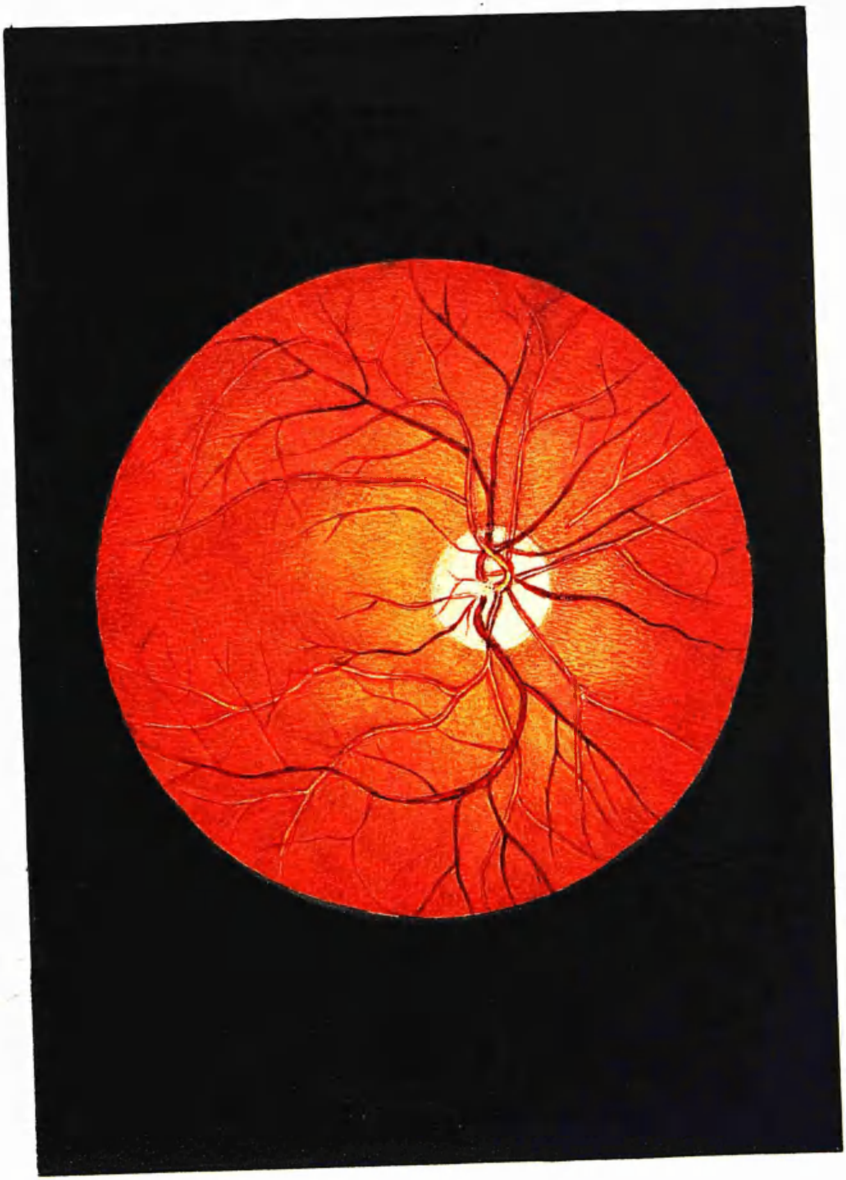
on the

OPHTHALMOSCOPE.

1860.

Brutus. No Cassius: for the eye sees not itself,
But by reflection.

Francis Henderson



The diseases of the Eye have long been recommended to the Student of General Pathology as a subject of study, because within the small compass of this perfect and beautiful organ, a great variety of the different structures of the body unite and further from the exposed situation of the Eye, and the transparency of certain of its parts, the behaviour of these several structures, under the influence of disease may be narrowly and accurately observed.

"Here" says Dr. Latham "are to be seen almost all diseases in miniature, and from the peculiar structure of the Eye, you see them as through a glass and may learn many little wonderful details in the nature of morbid processes, which but for the observa-tion of them in the Eye would not have been known at all."

From these peculiarities, the Eye has probab-ly contributed more to General Pathology and furnished more sure data for the in-duction of therapeutic principles than any other organ. For these reasons mainly — to illustrate Pathology and Therapeutics have Eye-diseases received so large a share of attention; Until very recently its Special Pathology — the diseases of those structures most immediately connected with vision — was but very imperfectly understood and Why? Because the very circumstances which make the investigation of its other diseases so satisfactory, were here awanting. The investigation did not rest upon the surest and most reliable basis — physical diagnosis.

Within the last few years, modern Science has supplied this deficiency, for by the aid of a simple, though ingenious instrument, called the "Ophthalmoscope", the interior of the Eye is revealed to the Oculist.

As a contribution of physical Science to Medicine, the Ophthalmoscope ranks only second to the Stethoscope.

The Stethoscope is the more important because it has to do with organs essential to life. But the Ophthalmoscope is likely to prove a still more perfect means of diagnosis, inasmuch as the sense of sight is more comprehensive and more to be relied upon than the sense of hearing.

No doubt difficulties are experienced at first, in the use of the Ophthalmoscope, but these serve only to invest the subject with deeper interest, and surround it with still greater fascination — 'What joy' says our Lord Rector — 'What joy equal to that of difficulties overcome.' The track is not a beaten one — few are far ahead and there is still a plausible hope of finding a shorter and a better path onward and of making new discoveries in a region little explored. These then are inducements, if such are needed, to prosecute the study of the Ophthalmoscope.

But we must remember, that the appearances seen by the Ophthalmoscope are not of themselves sufficient to furnish data for an accurate diagnosis, we must further understand by what conditions these appearances are produced.

This knowledge can only be attained by a careful post mortem examination of the actual changes.

Pathological anatomy has interpreted the signs of auscultation and Percussion, and it has the same duty to perform to the Ophthalmoscope. The concordance between what we see and the actual structural state, must be thoroughly established, otherwise, although all observers must see the same appearances, still they may read them differently. Even already however there are many signs, for which pathological anatomy, like the Rosetta stone, has furnished the key of interpretation.

Here then is another aspect of this new field of investigation. For although elaborate works have been written, upon the post mortem appearances of diseases of the deep structures of the Eye yet how these changes appear when viewed through its transparent media has still to be made out.

Having now indicated the value of the Ophthalmoscope and the manner in which its study is to be conducted, we shall without further preface begin our subject.

I The History of the Ophthalmoscope

II The Optical principles involved in the construction and use of the Instrument

III The application of these principles to practice

IV The appearances seen in the Healthy Eye.

I The History of the Ophthalmoscope.

The History of the Ophthalmoscope is both curious and interesting. Discoveries are made in various ways. Some rise into existence at the call of genius; for others materials are collected, and some one either by the force of reason, or by happy accident, finds out the correlation of these materials, draws from them general principles, and thus phenomena previously isolated are made to explain each other, and form the basis of a science.

To this latter class, the discovery of the Ophthalmoscope belongs. The honor is undoubtedly due to Professor Helmholtz of Heidelberg and to explain his share in the discovery, let us rapidly review the materials prepared for him.

For long it had been observed that the

eyes of some animals gleam brilliantly in the dark, and the ancients fancied this was owing to a power these animals possessed of generating light. In 1810 Prevost of Geneva established that this luminosity was produced, not by light originating within – but by light from without, reflected from the bottom of the eye! The eye gives back only that which it receives, for there is no reflection in absolute darkness.

In the beginning of the last century (1704) a physiologist of the name of Mery placed the head of a cat under water, and thus by refracting the rays issuing from the eye, succeeded in seeing not only a reflexion from the eye, but also the vessels of the retina! This was a very curious observation and was repeated with like success by others.

These results however do not bear very directly upon the examination of the human eye, because from the eyes of those animals experimented on, there is a reflection, now from the healthy human eye, there is no reflection

Beer the famous oculist, has recorded a case, where the iris was congenitally wanting and from this eye there was a reflection to see which, the observer had to place his eye nearly parallel to the entering rays

In 1846. Mr Cumming added another step by showing how a reflection may be seen. In the 29 volume of the Medico-chirurgical Transactions - Mr Cumming says 'there are three circumstances necessary for observing the interior of the eye'.

1st That the eye must be at some distance from the source of light

2nd That the light diffused round the patient be excluded

3rd That the observer occupy a position as near as possible in a direct line between the source of light and the eye examined.

Further Mr Cumming observed that the brilliancy of the reflection was in proportion to the amount of pigment in the eye

Kussmaul a German was the first who attempted to answer the question. Why does the bottom of the eye ordinarily appear black? and though he did not succeed very satis-

-factorily, yet he made some interesting experiments to demonstrate the influence of the refracting media of the eye, upon the visibility of the retina. He found that when the Cornea and lens were both removed he could see the vessels of the retina, but when either remained the bottom of the eye appeared black.

A simple but very striking observation was made by D^r. Von Erlach. This physician wore spectacles and he often remarked, that he saw a rosy reflection from the bottom of the eyes, of persons near him, when they looked at the image of a flame, reflected from his spectacles.

Here were all the conditions essential to explore the interior of the eye, and if Erlach had only analysed them, his name would have been handed down to posterity as the discoverer of the Ophthalmoscope.

But this honor was reserved for Professor Helmholtz of Heidelberg. He commenced the study in a most philo-sophic spirit. Instead of seeking to il-luminate the eye, he first set himself to explain why there was no reflection from the bottom of the eye in the normal state? And he arrived at the conclusion, that there were several causes for this, but that these causes had not by any means an equal influence.

Helmholtz argued, that if he could find the true reason, why there was no reflection from the eye, then he would be in the best possible position to solve the problem of its illumination.

He distinguished the following causes.

1st The contractile iris allows of few rays entering the eye at all.

2nd The pigmentary layers of the choroid and iris absorb some of the rays that do enter. But these causes are not sufficient, because when the pigment is absent, as in an albino, and the pupil is artificially dilated and fixed, no doubt the colour of the pupil is altered, but the bottom of the eye is still invisible

The main cause why we see no reflection and one, which Helmholtz first pointed out, may be thus shortly explained

If the eye is focussed for a luminous object, then the rays coming from it which enter the eye are reflected and issue from the eye, in exactly the same position and direction as that in which they entered. In short in this case (when the eye is focussed for the source of light) the incident and the reflected rays follow the same track, but they travel in opposite directions. Now that the fact has been pointed out, it is easy to explain it.

The curvature of the retina is so exactly adapted to the power of the refracting media that all rays, which come to a focus upon the retina, strike that surface at right angles - or more correctly at right angles to the tangent, passing through the point upon which each ray falls. And hence as the angle of incidence is equal to the angle of reflection - the reflected rays leave the surface at right angles -

In order to see the image which we know the reflected rays carry with them, on their mysterious waves it is obvious that the observer's eye must be in the course of the incident rays. In ordinary circumstances, he could see nothing thus, because his own eye would intercept the incident rays, and then of course there would be no reflected rays.

The conditions necessary to see the reflection from the eye being ascertained, it was a matter of no great difficulty to fulfil them.

The essential condition was met by making use of a reflector, which admitted of the observer seeing through its centre.

Another obstacle - the contraction of the pupil when light is thrown upon the eye - was overcome by mydriatic preparations as Belladonna. And lastly, the absorbing power of the black pigment was counterbalanced by throwing additional light into the eye.

The Ophthalmoscope which Helmholtz constructed upon these principles, consisted of a small metallic tube, blackened in its interior. One of its ends, was cut obliquely and supported three plates of transparent glass placed one against another.

The other end of the tube was provided

with a diaphragm, arranged so as to receive convex or concave glasses.

In exploring the eye with this instrument the glass plates were directed toward the source of light, which was placed near and at the level of the patient's eye. The rays which fell upon the glass, were reflected into the interior of the eye examined, returning thence, they passed through the transparent reflector and entered the observer's eye, which was placed at the opposite end of the tube.

The three plates of glass were intended to increase the reflecting power, but at the same time, they obstructed the passage of the returning rays into the eye of the observer. The illumination which this Ophthalmoscope gives, is found to be too feeble to reveal distinctly the details of the retina, and it is not used now, except when the eye is very sensitive to light, or when it is not advisable to dilate the pupil by Belladonna.

Many Ophthalmoscopes have been subsequently constructed, differing in the arrangement of the reflector - in the employment of lenses, to modify the course of the rays and in the addition of accessory apparatus - to secure steadiness - to measure objects seen on the retina etc.

The following varieties of reflectors have been employed.

1°. The three plates of glass, already described.
2°. A plane mirror, perforated at the centre.
3°. The hypotenusal surface of a perforated prism
4th. A Convex mirror
5th. A concave mirror, having a central or two lateral apertures.

It will be sufficient at present to explain the manner of using concave mirrors as they are most generally employed a proof in itself of their practical superiority.

Obviously the first point to be attended to, in an examination by the Ophthalmoscope is the satisfactory illumination of the interior of the eye. In order to succeed in this, without loss of time it must be clearly understood, how the rays of light ought to strike the eye, and how this again is modified, on the one hand, by the focus of the patient's eye and on the other, by the distance of the patient and of the source of light.

When rays strike the eye in such a manner, that they come to an exact focus on the retina, then the illumination is brightest. But this is not the most suitable arrangement, because supposing the flame of a candle or lamp, was the source of light, then an exact image of the flame would be thrown on the retina. Now in the centre of such a flame there is a dark cone, which would correspond to the centre of the retina, and so an important part of the surface would be left in comparative darkness. Another objection is that the field illuminated is very small.

The best illumination is obtained when the rays come to a focus a little in front of the retina, which is then lighted by a circle of dispersion.

to come to a focus a little in front of the retina, the rays falling upon the eye must be either nearly parallel - or slightly convergent according to the focus of the eye at the time. Thus, if the eye is focussed for distant objects, slightly convergent rays must fall upon it - if for near objects, then they must be nearly parallel. We shall see afterwards that this is of considerable practical importance, because the focus of the eye must be differently adjusted, according as we wish to examine the 'direct' or the 'inverted' image.

The next question is, by what means are parallel or slightly convergent rays to be thrown into the eye?

If rays coming from a luminous point as a candle, fall upon a plane mirror, their direction is altered, but not their divergency. If they fall on a slightly concave mirror, the reflected rays are rendered less divergent. A deeper concave mirror might be selected, which would render them parallel - and by a still deeper, they are