Pl. 1.

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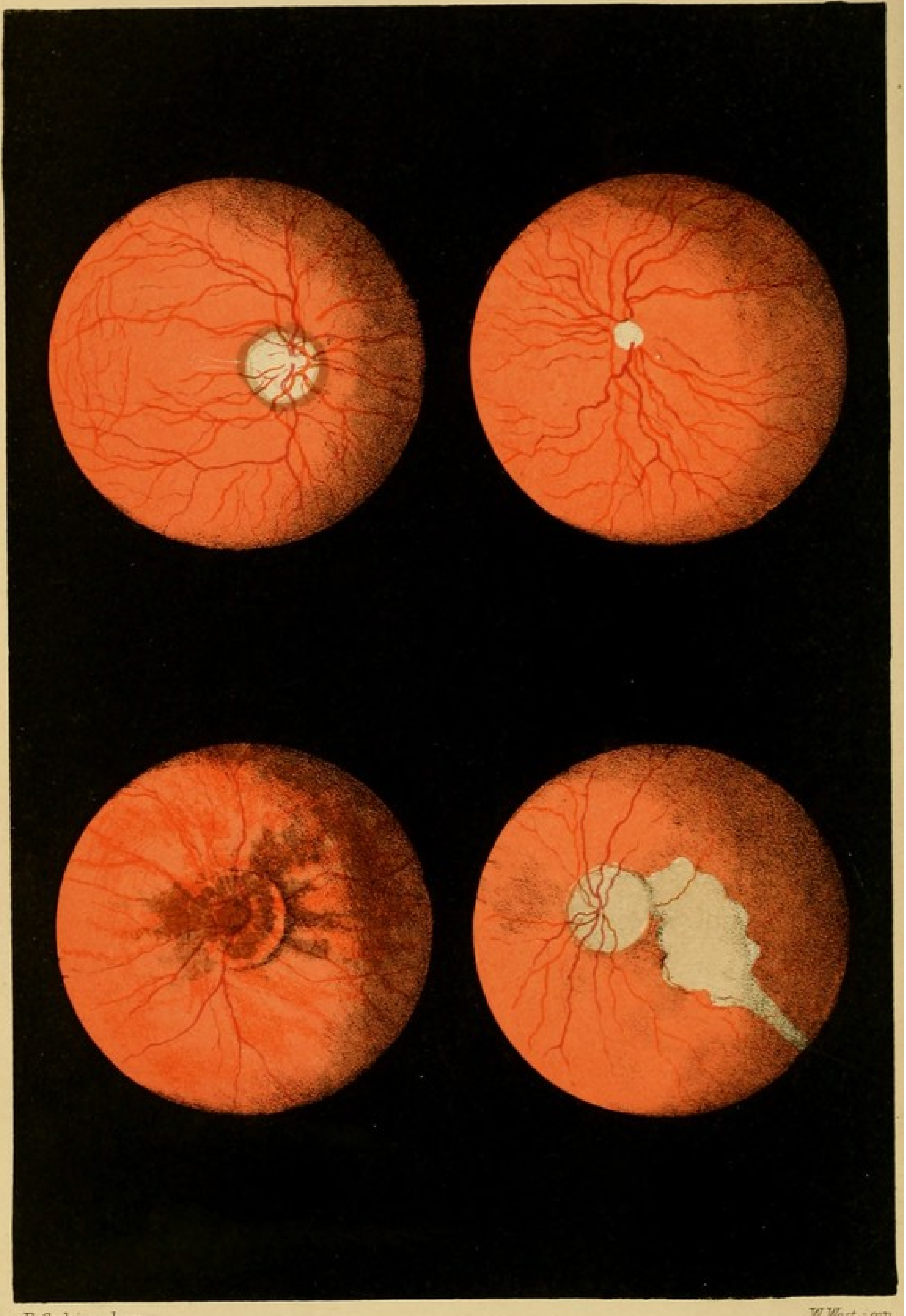

E. Cocking chroms. W. West imp.

A MANUAL

OF

OPHTHALMOSCOPIC SURGERY;

BEING

A PRACTICAL TREATISE

ON

THE USE OF THE OPHTHALMOSCOPE

IN

DISEASES OF THE EYE;

BY

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AUTHOR OF
THE MICROSCOPE, ITS HISTORY, CONSTRUCTION, AND APPLICATIONS;
ELEMENTS OF NATURAL PHILOSOPHY; ETC.

"These eyes, though clear
To outward view of blemish or of spot,
Bereft of light, their seeing have forgot."

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TO THE

PRESIDENT,

THE MOST NOBLE THE MARQUIS OF WESTMINSTER, K.G.

VICE-PRESIDENTS,

DUKE OF CLEVELAND, K.G.
DUKE OF RUTLAND
EARL OF SHAFTESBURY
EARL OF STRATFORD
EARL OF ENNISKILLEN
LORD DYNEVOR
FIELD MARSHAL VISCOUNT COMBERMERE, G.C.B.
SIR HENRY HOLLAND, BART.
THE VERY REVEREND THE DEAN OF HEREFORD
MAJOR-GENERAL WOOD
LEWIS POWELL, ESQ.

AND THE

COMMITTEE OF MANAGEMENT,

OF THE

ROYAL WESTMINSTER OPHTHALMIC HOSPITAL,

In grateful recollection of early kindness and encouragement received from the Author's first connection with that invaluable Institution;

AND TO

HIS FRIEND AND COLLEAGUE,

HENRY HANCOCK, ESQ.

AS A TOKEN OF SINCERE RESPECT AND ESTEEM,

THIS TREATISE ON

OPHTHALMOSCOPIC SURGERY IS

DEDICATED.

EXPLANATION OF THE PLATES.

PLATE 1.

NO.

1.—The healthy fundus; the vessels of the retina, the optic nerve entrance, and the relative situation of the macula lutea.

2.—Retinitis; the optic nerve entrance being reduced to a very small point by the chorio-capillary injection.

3.—Capillary apoplexy of the retina: the papilla optica in this case being completely covered over by the hæmorrhagic effusion.

4.—Detachment of the retina, extending to the optic nerve, which is seen considerably dilated, and the vessels very small. This drawing was made a month after the accident occurred.

PLATE 2.

5.—Atrophy of the optic nerve, with anæmia of retina, showing the saucer-like depression of the optic papilla.

6.—Syphilitic retinitis: the condition of the optic nerve and retina at the end of the second month, the sight being then very imperfect.

7.—Retinitis from albuminuria, with considerable disorganization of the retinal vessels.

8.—Softening of the retina: in this case cupping of the optic nerve was associated with the disease.

PLATE 3.

9.—Glaucoma: considerable excavation of the optic nerve and irregularity of the vessels.

10.—Exudation between retina and choroid, believed to be fatty degeneration of the retina; probably colloid disease of the choroid.

11.—Choroiditis pigmentosa and posterior staphyloma, with deposits of pigment over the macula lutea.

12.—Choroiditis pigmentosa; saucer-like depression of the optic nerve; vessels atrophied and irregular.

PLATE 4.

13.—Hyperæmia of choroid, with capillary congestion.

14.—Choroiditis pigmentosa. In this case there was considerable capillary congestion, which, with the enormous quantities of pigment, covered the white spaces in the choroid coat, so that they were very faintly seen.

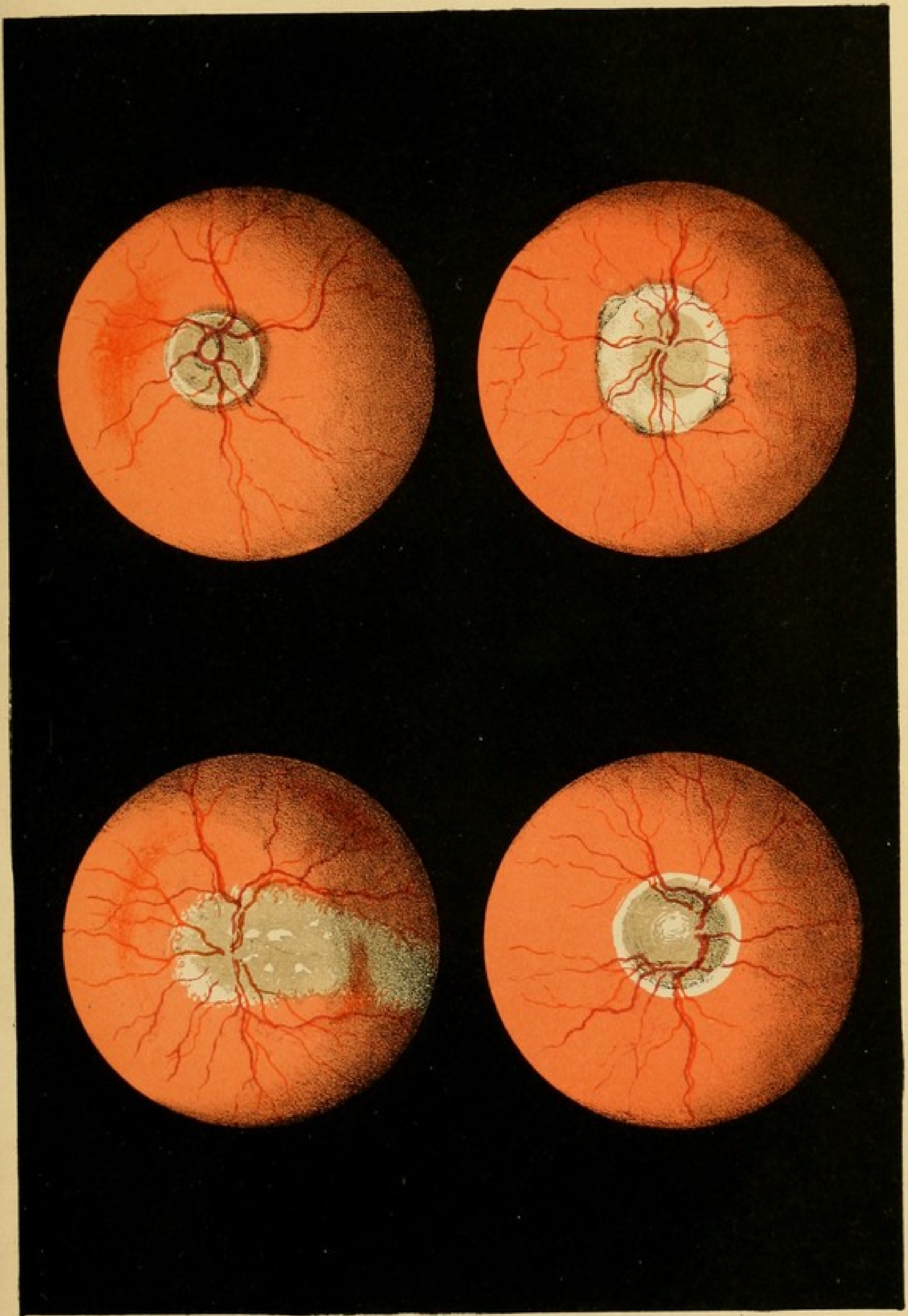
15.—The fundus of a myopic eye, showing a crescentic depression at the outer periphery of the optic nerve; the latter being pale and considerably dilated.

16.—Sclero-choroiditis pigmentosa: the vessels on the same side appear to have been either removed, or obscured by some exudation.

Pl. 2.

5.

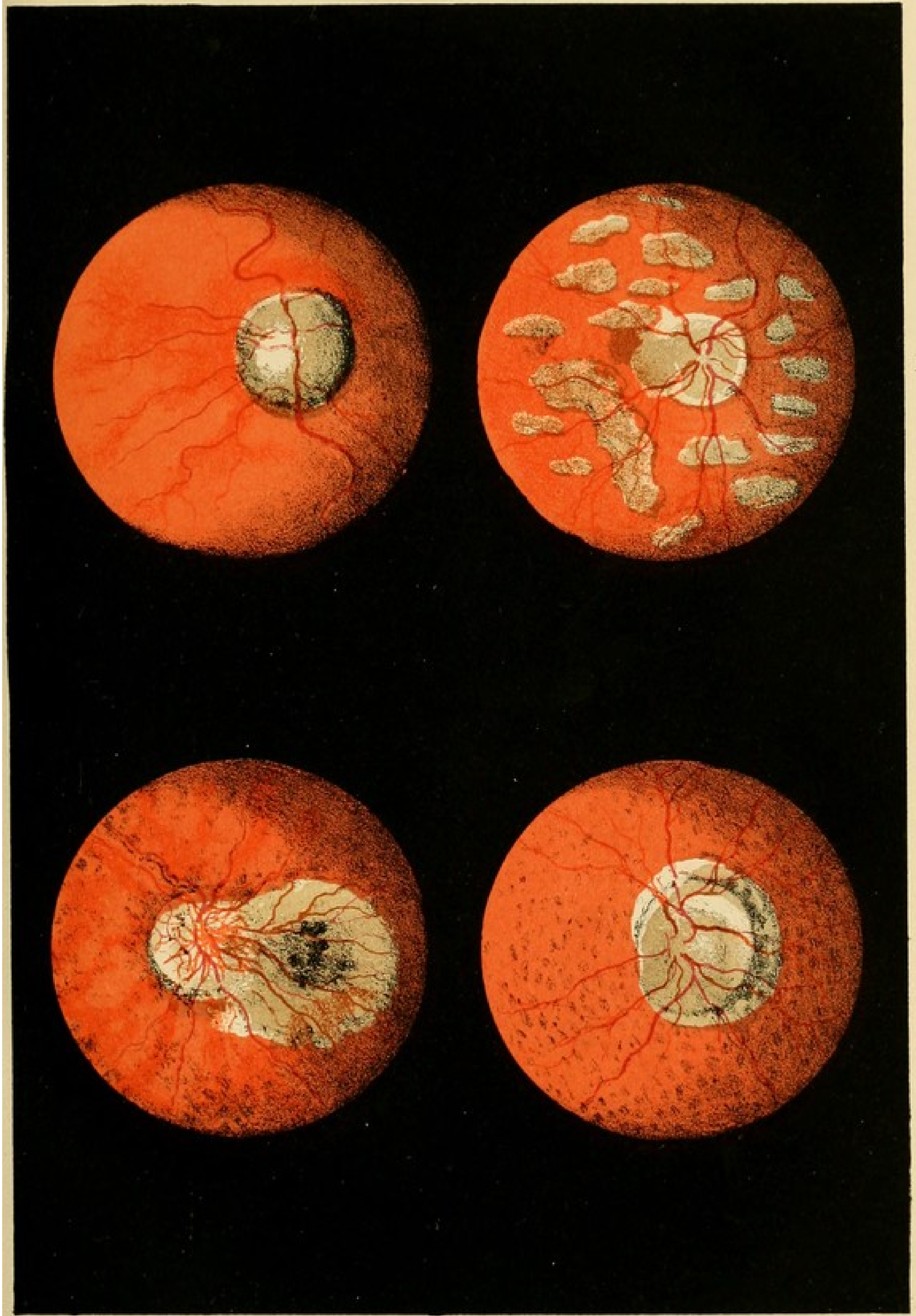
7.



E. Cocking chromo.

W. West imp.

Pl 3.



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E Cocking chromo. W. West imp.

Pl. 4.

E. Cocking chromo

W. West imp.

PREFACE.

The confident opinion I entertained, when the first edition of this work appeared, in 1857, of the value and importance of the ophthalmoscope as an unerring guide in the previously obscure pathology of the eye, and the great popularity which I also anticipated it would achieve, have been fully realized by the results of the past five years' experience. That its introduction would form a new era in scientific investigation, I felt assured, from the advance of special knowledge when aided by proper methods of investigation, and the wide field afforded for industrious research, now that so ample an opportunity for making exact observation has been placed in the hands of the profession, and sufficient means afforded of establishing principles of ophthalmic pathology with the precision of some other branches of surgery.

To forward this great object I considered a legitimate ambition, and to this feeling was due the first detailed notice of the new instrument that had appeared in England, contained in a paper read before the Medical Society of London, accompanied with cases and illustrations of its use derived from my own practice. To review the progressive steps that have been taken to elucidate, with the assistance of the ophthalmoscope, the real nature and seats of the most serious diseases of the eye, would require a special volume. It is more than probable, also, were I to attempt an account of successes during the unsettled phases of a transition state of knowledge, my observations would only lead to innumerable reclamations from several ardent and equally praiseworthy explorers in the same field: not to mention the questionable position any confident expression of opinion to-day might place me in, when to-morrow, perhaps, a more satisfactory advance would be made towards truth, on the basis of facts so clearly demonstrable in the ophthalmoscope, as to afford no opportunity for doubting or denial.

But I must be allowed, in this introductory address, to enlarge upon the increased responsibility of the profession, generally, to attain to a proper knowledge of the use and advantages of this instrument. It has most certainly done something to rescue a special branch of surgery from the hands of mere empirics and ignorant pretenders to a knowledge that, previous to its introduction, was unattainable; and which was, perhaps, under the circumstances, sufficient excuse for the conscientious practitioner who might be reluctant to interfere in cases where an error in practice was attended by such serious consequences as in diseases affecting the organ of vision. We all know what the stethoscope has done for affections of the chest, and the relying confidence in its assistance with which the general practitioner now explores, with interest and anxious concern, the condition of the lungs in the earliest stage of threatened disease; and with much advantage, individually, as well as to the great national question of annual mortality among the population, who can doubt? And not less valuable, I firmly believe, will be the result of the introduction of the ophthalmoscope into general practice. It promises a vast diminution in the number of those cases where extinction of the sight, the most valuable and cheering of the senses, so often results from ignorance of the nature of the attack, or of the real seat of the disease. I may truly say that the most painful experience of a surgeon to a public institution for eye disease, arises from the circumstances of his position informing him that many of the totally blind that come under his observation, might have escaped so great a misfortune, had circumstances been earlier favourable for exploring the otherwise dark chamber of the eye, and reading off, as it were, a correct diagnosis, whilst opportunity was afforded for proper measures of relief to have been adopted. It must, therefore, I think, be deemed morally imperative that every member of our profession should, for the future, make ophthalmic surgery a particular object of study during his term of hospital attendance. And it is also worthy of consideration, how many different ways an accustomed and ready use of this little instrument will avail in the solution, when correspondingly assisted, of many otherwise obscurely situated complaints; for there is no stronger corroborative evidence of the value of the ophthalmoscope, as a reliable aid in diagnosis, than the adaptation of the same principles to instruments for the examination of the larynx and throat.

As regards the arrangement of my subject matter, the text having been entirely re-written, the plan upon which I have proceeded requires a little explanation. In the first place, the instruments more particularly described are those which my own experience enables me with confidence to recommend. The simpler forms, I feel assured, are the best for the general practitioner, though for purposes of study and hospital practice the more elaborate and fixed kind is to be preferred, as admitting of steady and exact adjustment. To have attempted more in this direction would have required a special volume upon the numerous ingenious ophthalmoscopes that have been submitted to the profession since Helmholtz's invaluable discovery. I may further add, as regards the principles and theory of vision involved in the examination, they are too exactly fixed, upon data almost mathematical, to admit of any variation or even novelty of remark in describing them. Nor did my purpose require any very laboured disquisition. Where necessary, I have quoted Helmholtz and Donders, who have done so much for improving our knowledge upon the accommodation of sight; they have given us the most recent as well as the most rational views on the subject. For more scientific and enlarged details upon general optics in connection with the use of the ophthalmoscope, Dr. Rainy's treatise may be consulted with advantage. With respect to other authorities, I have not failed to make use of any information which I could confirm by my own observation; for my aim on all occasions has been to establish principles of correct diagnosis in the hitherto obscure diseases of the internal eye.

It will be observed, as regards cataract, I have somewhat enlarged on the anatomical and physiological details of the several parts implicated in its progressive development. I felt this was required, by the numerous distinctive forms introduced in the pathology of this important class of eye disease; and it cannot be doubted that it is essentially necessary to be as well acquainted with the normal conditions as with the diseased appearances of all the structures, as seen with the ophthalmoscope. In a great number of cases, changes may be discovered in progress sufficiently early—it is stated and believed by some physiologists—to prevent further advance.

In the classification of eye diseases I have arranged them in the order of situation, and grouped them accordingly, instead of strictly following the great natural divisions of pathology, which are more suited to the generalization of disease, than to the particular application of the principles to a specially selected organ. It also admits of a less arbitrary restriction to technical terms in describing new appearances, upon the nature of which, circumstances as yet have not afforded us full opportunity of deciding; for by the aid of the ophthalmoscope we are enabled to diagnose slight internal changes which were before unrecognized. To illustrate the situation I am alluding to, I may refer to the symptoms describing *retinitis*, as laid down a few years ago in books and clinical lectures, and upon which no reliance can now be placed, as distinguishing it from several other diseases of internal structures of the eye revealed to us in the ophthalmoscope. In this transition state of knowledge, therefore, some latitude must be allowed in expression, and a little excuse made for what may appear indefinite and undecided. My readers may rest satisfied that it is always designed and prospective of future advance to be made. In the mean time, I trust there will be many explorers in the same field who will record their observations, as I have ventured to do; and in this way a valuable collection of facts will result, that must hasten the elucidation of the scientific principles upon which a proper classification of eye disease can alone be based. At the same time, I may add, that I have chiefly recorded the results of my own experience, rather than relied upon the published cases of other observers, or as occurring in other institutions than the Royal Westminster Ophthalmic Hospital, where I could watch the various details of treatment, the changing phases of progress, and ultimate conclusion, so as to possess definite data to test the soundness or otherwise of a previously formed diagnosis. Hospitals for special cases afford unusual opportunities and facilities for the study of the particular diseases for which they are set apart, and a two-fold responsibility rests upon their medical officers. In the first place, they owe to the patients much of their time, and all their care and skill; and, in the next, their professional brethren very naturally look to have communicated to them whatever superior knowledge such exceptionable advantages have enabled them to acquire.

A new era has, at all events, commenced in ophthalmic surgery; and if we reflect what has already been done since the introduction of the ophthalmoscope, we may well anticipate still more splendid results. Let me enumerate the important points already attained: and, in view of which, it may well be asked, who would have ventured, a very few years ago, to have foretold the present state of knowledge? 1stly, we have, now, not the least difficulty in determining the existence or non-existence of cataract, formerly surrounded by so much doubt that sometimes no amount of professional skill or experience could satisfactorily solve. 2ndly, the approach of cataract may be observed in its earliest stage, and long before it is discoverable by the unassisted eye. 3rdly, it demonstrates the physical cause of muscæ, and, conversely, when it is a symptom of disorder. 4thly, it has removed almost from ophthalmic nomenclature the indefinite term of amaurosis, where, as Walther observed, "the patient and the physician were both blind," by revealing the dependance of many such cases on causes widely different, but easily enough perceived with the ophthalmoscope. 5thly, by disclosing retinal apoplexy, it prevents, in some cases, an injurious resort to mercurials; and, on the other hand, by showing the presence of effusion of lymph on the deeper structures of the eye, it enables us to judge when such a treatment will prove advantageous and proper; and 6thly, its value is considerable, even in those cases of what may be called negative advantage, where, by showing the retina, already detached and disorganized, the surgeon might otherwise, without such knowledge, have been tempted to perform an utterly useless operation.

In conclusion, I have only to observe, that although I have endeavoured to make the coloured illustrations of eye diseases more perfect and correct than in any former edition, yet, from the difficulty of finding a skilled artist, competent to read off appearances which are plain enough to the practised eye of the surgeon (added to the great expense incurred by printing in colours, which precludes continued corrections), I have not by any means succeeded to the extent I could have desired.

To render my little work more complete, I have added specimen pages of Jäger's test-types, generally in use, and referred to in my cases.

London,

1, Bedford Square,

June, 1863.

ERRATA.

Page 3, line 6, *for* inter, *read* intra.
—— 4, — 31, *for* has, *read* have.
—— 9, — 24, *for* biconvex, *read* biconcave.
—— 14, — 13, *for* on, *read* in.
—— 15, — 30, *for* surgeon, *read* patient.
—— 15, — 34, *for* the, *read* a.
—— 15, — 35, *after* the full point, *read* A speculum oculi, with or without a second lens, is employed in the usual manner by the surgeon.
—— 29, foot note, *for* Stelling *read* Stellwag.
—— 33, line 3, strike out the word spectral.
—— 33, — 9, *for* spectrum, *read* light.
—— 41, — 14, strike out the words, besides my own.
—— 45, — 18, strike out the words, which arises.
—— 57, — 3, *for* ten, *read* two.
—— 57, — 14, *for* wholes, read whole.
—— 60, — 18, strike out the words, other recti.
—— 81, — 3, *for* fall, *read* falls.
—— 81, — 5, strike out belongs, and insert, may be added.
—— 81, — 27, *for* instrumental, *read* spectacle.
—— 81, — 28, *for* accustom the eye, *read* bring the eyes.
—— 84, — 26, *for* glass, *read* glasses.
——100, — 7, strike out the words, of the muscular fibres.
——102, — 29, *for* slightly, *read* pearly.
——103, — 25, *for* phenomena, *read* pulsation.
——105, — 7, *for* inter, *read* intra.
——106, — 29, *for* inter, *read* intra.
——118, — 9, *for* inter, *read* intra.
——118, — 20, *for* spread, *read* develope.
——123, — 29, *for* artheromatos, *read* atheromatous.
——139, — 20, *for* optici, *read* opticus.
——142, — 25, *for* which is, *read* these are.
——143, — 24, *for* has, *read* have.
——155, — 25, *for* Albuminuria, *read* Albuminurica.
——157, — 7, *for* was, *read* were.
——161, last line but one, *for* these, *read* such.
——164, line 32, *for* Anagnostakis, *read* Anagnostaki.
——165, — 21, *for* taken, *read* employed.
——165, — 32, *for* have given, *read* induced.
——170, — 27, *for* albuminuria retinitis, *read* retinitis albuminurica.
——173, — 16, *for* treaks, *read* striæ.
——179, — 31, *for* Leucæmia, *read* Leucæmica.
——203, last line, *for* leucæmia, *read* leucæmica.
——205, line 15, after observed, strike out, lying between them.
——205, — 15, *for* nerve, *read* nerves.
——214, — 15, *for* tubercular, *read* tubercula.
——215, — 5, *for* tubercular quadragemini, *read* tubercula quadrigemina.
——220, — 3, *for* where, *read* when.
——220, — 7, *for* Marcotte's, *read* Mariotte's.
——227, — 23, 28, and 32, *for* Unilocular, *read* Monocular.
——228, — 12, and 16, *for* retina, *read* retinæ.
——229, — 16, 17, and 32, *for* retina, *read* retinæ.
——230, — 18, *for* retina, *read* retinæ.
——230, — 25, *for* Farro, *read* Fano.
——331, — 9, *for* stages, *read* stage.
——232, — 5, *for* fever, *read* fevers.
——233, — 5, *for* diseased, *read* disordered; *for* and is, *read* a disease.
——239, — 34, and in subsequent pages, *for* Philz, *read* Pilz.*
——248, — 29, strike out the words, being then torn from its ciliary attachment.
——249, — 24, *for* M. Schwigger, *read* M. Schweigger.
——273, foot note, *read* Bildliche Darstellungen der Krankheiten des menschlichen Auges.
——276, — 2, after the semicolon, insert the words, these were.
——277, — 17, *for* at a, *read* to an.

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* Dr. Josef Pilz, "Lehrbuch der Augenheilkunde," Prager, 1859.

A MANUAL

OF

OPHTHALMOSCOPIC SURGERY.

CHAPTER I.

Altered Circumstances of the Modern Practice of Surgery connected with Eye Disease.

Not the least important of the many triumphs of the Ophthalmoscope, is the increased attention to eye disease and ophthalmic surgery its introduction has excited among the profession generally. In fact, every one, who is honestly endeavouring to keep pace with the progress made in the scientific discoveries of the day, and who is at all sensible of the value and utility of a direct means of examination in otherwise most obscure and doubtful cases, must confess that the little instrument of Helmholtz has originated not only a new method of inquiry, but must occasion a great revolution in all previous systems of ophthalmology. It is indeed curious to mark how men of established reputation, who, as a rule, are averse to novelty, and unfriendly to innovation, have, one after the other, successively surrendered their alleged objections, and become the strongest advocates for the use of the ophthalmoscope, when its revelations were found to be too obviously sound to admit of being disputed, wherever opinion was challenged to this simple but decisive test.

With such unmistakable evidence of its great practical importance, and considering the extensive popularity it has achieved in comparatively a very short period, it is a matter of no little satisfaction to me that the profession should in any way associate my name with its first introduction to their notice; and, with the object of continuing a connection so honorable to myself, on the occasion of a third edition being called for of my little work on the Ophthalmoscope, published in 1856, I have determined to enlarge the scope of its original purpose, as chiefly illustrative of the theory of the ophthalmoscope, into the more ambitious purpose of supplying a reliable hand-book of its use, giving descriptions of the characters and appearances of those diseases of the transparent media, and of the more important of the internal structural apparatus of the human eye, which that instrument now affords us so invaluable, and at the same time so convenient, a means of observing.

In giving to the profession such a manual of Ophthalmoscopic Surgery, it is not intended to dwell upon elements presumed to be sufficiently well known; nor, on the other hand, to follow up the extreme refinements of theoretical science connected with the subject, and which have sometimes gone beyond what present experience could really warrant. But it must be obvious that the circumstances which have arisen with the occasion—the many novel and remarkable symptoms now for the first time observed—require to be reduced into a system of properly defined diseases; especially when a particular tecnology has been invented to describe these new appearances properly, and to find suitable language in which to record the wonderful progress made within the last few years in the pathology of the human eye.

The task, moreover, is undertaken with an agreeable feeling that, in the general advance of human knowledge which late years have witnessed, ophthalmic surgery holds a position commensurable with the importance of the organ in its especial charge. It has ceased to be the suspicious domain of the lingering empiricism of the last century; for the oculist now takes rank among the most scientific men in our profession. It is in this branch of practice that the interesting results of microscopic anatomy come to be beneficially utilized; and now that the ophthalmoscope gives the further command of a direct means of examining the several *media* and inter-ocular structures of the eye, diagnosis in its diseases finds firm ground upon which to rest or base an opinion. The consequence is, that the uncertainty of symptomology, which formerly deterred so many conscientious surgeons of the first rank in the profession from interfering with diseased structure or even disordered condition of the eye, has become in a great measure a mere bye-remark of congratulatory comparison with the immeasurably improved circumstances under which, not only the ordinary general practitioner may confidently proceed with the care of the most serious cases, but which even enables an enquiring student of medicine to judge in a short time with the certainty of the more experienced practitioner of at least the character and extent of mischief within the orbit, wherever and whenever admitting of ophthalmoscopic investigation.

And if the profession have reason to rejoice that the responsibilities of ophthalmic surgery, in a great measure, have ceased to be habitually referred to an empirical confidence, where success in treatment was more a matter of accident than the directed result of enlightened knowledge, how much more so must the general public share this feeling, with whom the eye, of all organs, is the most important and valuable. Examinations, not of form, as too often the case hitherto, now follows immediately upon injury; and, nothing doubting, the practitioner in the humblest sphere expects to find easily the situation and nature of the hurt. No valuable time is lost before proper measures of relief are adopted; and the unfortunate sufferers are therefore no longer exposed to the additional danger arising from hesitation and delay—the too frequent causes of deplorable consequences in injuries to the delicate structure of the eye.

Equally worthy of notice with this increased facility of investigation, and the self-dependance it forms in the general practitioner, is the altered relation of some striking symptoms in many important cases. Prior to the invention of the ophthalmoscope, a diagnosis frequently led to very erroneous conclusions, by confounding together various affections of the eye, differing widely in seat and proximate cause. For example : no distinction of appearance, or other resort of physical examination, could distinguish, in the large class of diseases called amaurosis, between functional disturbance in the apparatus of the eye, depending upon derangement in the general system, from other far more serious affections, depending upon actual disorganization in some important part. And if the value of the ophthalmoscope be only estimated by the direct revelations it makes in such cases, there can be but one opinion on the subject. By directing treatment according to the special appearances now easily recognized, proper measures of relief are adopted from the first advent of the complaint, and all chances are avoided, or at least ought to be, of depleting where the opposite course should be taken, or *vice versâ ;* the not unfrequent consequences of the former doubt and obscurity with which the whole subject was surrounded. Some hope to the patient, and at all events more promise of credit to the surgeon, are also to a considerable extent secured, with a convenient help to prognosis at hand, which enables us to determine what measure of relief is to be expected, or whether the case is of such a nature as to authorize encouragement being given that sight will be improved by any treatment whatever.

The same observations upon the great practical use of the ophthalmoscope, and the altered circumstances of modern practice which has accompanied its introduction, apply also to its convenience as a means of discriminating between the healthy and morbid conditions of the true optical apparatus, and satisfactorily ascertaining the state and degrees of transparency in all the important *media*, from the cornea to the fundus of the globe. True cataract is no longer liable to be confounded with an apparent or reflected opacity, associated with glaucoma; and diseases in the posterior tunics of the eye are readily distinguished, which were formerly too apt to be referred to opacity in the crystalline lens, and sometimes led to an entirely useless operation. In short, it may be correctly asserted that with the invention of the ophthalmoscope commenced a new era in ophthalmic pathology. It has substituted exact knowledge concerning several diseases, differing vastly in character, origin, and seat, by converting indefinite and uncertain appearances into symptoms referrable to physical data that do not admit of misinterpretation. Directed thus unerringly, diagnosis is enabled to complete its work, by pointing out the proper remedies or measures of relief required; and it is only repeating a trite axiom, to observe, that nothing is more assuring of a favorable result than the possession of such knowledge of the real nature and facts of the case*. It is obvious, however, that a contrary charge lies against the old system of determining the character of eye disease; and a feeling that it was so, had long been felt by the profession. Several ingenious minds, indeed, appear to have sought in the same direction as Helmholtz for a solution of the difficulties experienced in forming a satisfactory judgment in cases that came under their care.

The Progressive Character of the Invention of the Ophthalmoscope.

The earliest observation, and which doubtless contains in its explanation the whole of the theory, and led to the

* An accomplished and able physician (Dr. Mackenzie) has most truly observed, that "the great secret in treating eye cases—the secret without which every thing else must fail—is to know and discriminate the various states of disease to which the eye is subject. The successful removal of eye diseases depends almost entirely upon accurate diagnosis. Discover what the disease is, make out accurately the pathology of the case before us, make out the *rationale* of the symptoms, local and general, and if the case be cureable, the cure is generally simple. Confound many different diseases, *huddle* them promiscuously together under a few general and perhaps unmeaning terms, and to a certainty we shall *mistreat* some of them."

discovery, of the ophthalmoscope, was the mirror-like reflection of light seen to emanate from the eyes of certain animals*. Prevost demonstrated, in 1810, that this was produced by a ray of light falling upon the eye, and being reflected back, gave the eye that mirror-like appearance; to see which perfectly, the animal must be in a darkened place, and the light made to fall upon it from without. This general observation of Prevost has only lately been revived and studied by Cumming, Helmholtz, Erlach, Brücke, and others, with relation to the human eye, and for the purposes of ophthalmic surgery. In the early discussions upon the subject, it had been determined that the rays of light must be made to fall very obliquely into the eye, and that that of the observer should be placed on the same plane, or nearly parallel with the object eye. It was also remarked that the reflection could be more readily observed in a darkened room, with a candle or other light placed about eight or ten feet before the eye upon which the experiment was being made. Our own countryman, Mr. Cumming, now more than sixteen years ago, in a paper "On the luminous Appearance of the Human Eye," contained in the 29th vol. of the Medico-Chirurgical Transactions (1846), pointed out the existence of a reflection from the fundus of the eye, and distinctly recognizes the significancy of the discovery†. He observes: "The establishment of the fact of a similar reflection from the healthy human eye to that from the eyes of animals, appears to me chiefly important in its adoption as a mode of examining the posterior part of the eye. The retina and

* "There is nothing more easy than to see the vessels of the retina in a cat's eye without the ophthalmoscope. Having previously dilated the pupil by atropia solution, drop some water into the eye while the eye-lids are held apart, and cover the cornea with a thin plate of glass. The vessels of the retina can then be seen slightly magnified."—Wharton Jones.

† It is due to Mr. Babbage to state that he appears to have been the first to suggest the use of a mirror with a small portion of silver removed from the centre. Here, however, he stopped short, without carrying his idea further; or, at least, if he did, no record of the experiment is to be found.

choroid hitherto concealed in the living eye, and little opportunity being afforded of examining their condition after life, in consequence of their diseases not terminating fatally, considerable uncertainty has hitherto attended the diseases ascribed to these structures; but the existence of this luminosity, its non-existence or abnormal appearance, may enable us to detect changes in these structures heretofore unknown, or satisfactorily to see those which we only suspected. If we dilate the pupil by atropia, we have the means afforded of seeing the condition of the retina and choroid in every case. The cases I have examined in this way have confirmed the general impression that the retina is not frequently the seat of change in amaurosis; for out of several cases of amaurosis, in which the mere opacity of the cornea, lens, and humours, allowed this mode of examination, I found but two in which the retina was so changed that the reflection was not seen.

"The only circumstances necessary for observing the interior of the eye, are—first, that the eye must be placed at some distance from the source of light, the distance being greater as to the intensity; second, that the rays of light diffused around the patient, and sometimes around the eye itself, be excluded; third, that the observer occupy a position as near as possible in a direct line between the source of light and the eye to be examined.

"Let the person to be examined sit or stand eight or ten feet from a gas-light, looking a little to the side; then approach him in a direct line, and at once will be seen the reflection of the bottom of the eye. If solar light be admitted through a closed shutter into a dark room, the patient standing five or six feet in front of the aperture, approach him as before indicated, when the luminosity of the interior of the eye will be immediately perceived.

"On approaching within a few inches of the eye, the reflection is not visible; for before the eye of the observer can be brought within range of the reflected rays, the incidental rays of light are excluded.

" In cases in which the lens had been removed, the reflection was indistinct at a distance, but was rendered clearer by the aid of a double convex lens placed before the eye under examination; but at two or three feet distant, the reflection was as obvious as in cases in which the lens was present.

" The brilliancy of the luminosity of the healthy eye appears to be in proportion to the light colour of the pigment; for, upon examining the eye of an Albino, by placing close to the eye a black card with an aperture a little larger than the pupil, the reflection was little brighter than that of a fair person examined side by side, but was of a more decided pink colour."

Mr. Cumming then proceeds to inquire into the source of this reflection:

" The retina in the living eye is a perfectly transparent medium in contact with the choroid or vitreous body. The transparency of the retina is, however, no proof that it does not itself reflect many of the rays of light that impinge upon it, although the greater proportion are transmitted: the transparency of a structure being quite consistent with considerable reflection, but not with absorption of the rays of light; and thus reflection would be rendered more obvious by the position of the choroid."

It may be gathered from these remarks that the first practical suggestions for the present mode of examining the internal eye, and investigating its diseases, were made by Cumming. In the objects stated with which he commenced his experiments, in the means he used for examining eyes, and the precautions necessary to obtain the desired effect, we find all the fundamental principles engaged in the practice, or which enter into the theory, of the ophthalmoscope. All that was required to complete his discovery and produce the present convenient instrument, was the adoption of the mirror, and the use of reflected instead of transmitted light. Helmholtz was the first to perceive the advantages to be thus derived; and it is usual to associate with his name the honor of the invention of the ophthalmoscope. To him is certainly due the credit of having been the first to employ a reflecting apparatus as a means of exploring the eye; but in the form which he proposed there were obstacles to its general use that made it less available even than the more direct method of Cumming, except in the hands of expert and practised operators. It is even a question now, with many distinguished oculists, whether some diseases seated far forward in the eye are not more clearly discernible and distinguished by the condensed, transmitted light of a biconvex lens, rather than by reflected light thrown artificially into the eye. No notice seems to have been taken of Mr. Cumming's experiments in this country; but it appears that, during the following year, his paper fell under the eyes of M. Brücke, Professor of Physiology at the University of Vienna; and here, with great opportunities for studying these phenomena, and at the same time being associated with the inventive genius of Helmholtz, the first form of the ophthalmoscope was eventually given to the profession. This consisted of a small metallic box, the interior of which was blackened, to prevent the diffusion of light. At one extremity, in close juxta-position, were placed three parallel plates of glass, inclined at an angle of about 56°: at the other end was a circular hole, or short tube, in which was fixed a biconvex lens, through which the observer looked into the eye of the patient sitting opposite. Into this the light of a lamp was received and reflected from the surface of the glass, part of which, on its return, passed through the plates and reached the eye of the observer; who was thus enabled to obtain an inverted and magnified image of the fundus oculi. It was soon found, however, that the image was too faint and indistinct to be of any great practical use; for the glass plates interfered with a free transmission of light, and thus the greater part of the few rays returning in the visual axis were lost. To this, in a great measure, is to be attributed the abandonment of Helmholtz's form of the ophthalmoscope; for although his own suggestion, of introducing another biconvex lens between the glass plates and the patient's eye, remedied to some extent the indistinctness of the image, still it was only available in examinations of the crystalline lens and humours, the light it afforded being insufficient to admit of the deeper parts of the eye being clearly seen.

Although Brücke's investigations at the University of Vienna, which led to the invention of the ophthalmoscope by Helmholtz, were instigated in the first place by a perusal of Cumming's paper, the claims of our countryman to be considered an original observer have been signally overlooked on the Continent; and Desmarres gives all credit, without reserve, to Helmholtz, who, according to his statement, invented the ophthalmoscope in 1851. It is not difficult, however, nor need it be made an invidious task, to accord, each one his due, to all the distinguished labourers in that course of progressive improvements which ultimately produced the present efficient, though I must not presume to say perfect, form of the instrument.

Coccius, it appears, first substituted a reflecting mirror for the plates of glass; and it is upon this principle that all the ophthalmoscopes now in use are based. The proposition of another German oculist, Meyerstein, to replace both plates and mirrors by the use of a perforated prism, never attained to any degree of favour. In using it as a hand instrument, the length of the sight hole, or prolonged canal rather, through the substance of the glass, rendered its management, in obtaining the axis of mutual vision, an almost insurmountable difficulty.

Zehender's ophthalmoscope differs from that of Coccius only in substituting a perforated plane metallic mirror, instead of the concave silvered glass one; but in practice it is found that, if it possesses one advantage of more perfect illumination at short distances from the eye, in the direct method of examination, still Coccius's is to be preferred, as involving fewer considerations of careful adjustment, and less danger of an imperfectly reflecting surface, from the deteriorating action of the atmosphere, accidental scratches, &c.

The improvement which, about the same time, Jager proposed, by fixing two lens of different focal lengths upon the projecting arm of a frame supporting the mirror, was an advance towards the larger and more perfect ophthalmoscope of Liebreich, which soon followed, with all its convenient appliances, to correct the unsteadiness of the surgeon's hands, while holding the lens and mirror, and to secure the permanency of the patient's head in one plane and position, so necessary to obtain a perfect view of the fundus of an illuminated eye. Before proceeding, however, in a separate section, to describe this latter instrument in detail, as exhibiting the best combination of all the several aids in ophthalmoscopic examinations, I must be allowed to make the general acknowledgment, that it is to Germany the credit is chiefly due of most of those inventions which have raised the study of diseases of the eye to its present very advanced and most satisfactory position.

The Construction of the Ophthalmoscope.

As may be collected from my previous remarks, a great number of ophthalmoscopes, of different forms, have been invented; but all are based upon the same principle, the essential requirements being a mirror or reflecting surface, and a lens. The object is, that the eye of the observer shall be placed in such circumstances as to receive the greatest number of rays returning from the illuminated retina of the patient under examination. "Every one knows the difficulty of seeing the interior of a chamber lighted by a small aperture when it is looked at from the outside, even though the chamber may appear well lighted to those within. Thus, if we attempt to look through the window of a room from the other side of the street, we find it difficult to see the opposite wall of the room; because each point on its surface, instead of having light falling upon it from every direction, as it would have if it were in the open air, is illuminated by a cone or pyramid of light, the apex of which coincides with the point in question, while its angle is determined by the size of the window and the depth of the room." * * * * "If the observer's head is much larger than the aperture through which the light falls, he will find it difficult to place himself at any convenient distance nearer the aperture than the source of light itself is, so that light from the point in the chamber he wishes to see may enter his eye, without shutting off, by the intervention of his head, all the light from the interior of the chamber; while, if he places the source of light between himself and the aperture, his own eye will be dazzled." *

This familiar illustration graphically describes the chief obstacle which renders it impossible, under ordinary circumstances, to see objects within the chamber of the living eye. Helmholtz, in his first researches upon the subject, demonstrated that the blackness observed in the eye of another is the absolute result of no available light in interchangeably reflected rays being received by either individual, and that, unless some special means were taken, it is not possible for one person to place his eye so as to receive within its range of vision the rays returning from the retina of another's; for in attempting to do so he intercepts all the rays of light, which must in the first place fall upon the fundus of the eye observed, before they are reflected back to his own. When, however, the eye of the observer can be so placed in the axis of the cone or bundle of rays of light emerging from the pupil of the eye observed, without interposing any obstacle to the free passage of the light passing into the latter, a good view of the fundus of the eye is capable of being obtained. The effect of the operation is greatly increased, if the observer's eye is protected by a shade from the direct light of the lamp, or other artificial means of illumination circumstances require; and if, at the same time, he can change the direction of the reflected rays, so that they be made to meet at the proper focus on the observer's retina.

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* Rainy's 'Theory of the Ophthalmoscope,' page 4.

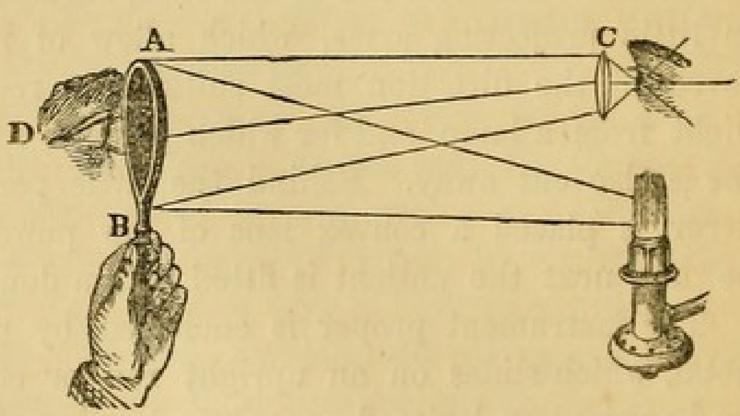
These required conditions for the successful exploration of the chamber, media, and fundus of the eye, are supplied by most forms of the ophthalmoscope. A description of one will therefore be quite sufficient for the object I have in view, of giving a popular (in a sense restricted to the profession) and, I trust, a useful hand-book of the employment of this most important and valuable instrument. I have selected Liebreich's large ophthalmoscope, inasmuch as it is generally allowed to be the most available for careful research, and most convenient for the study of ophthalmic pathology, as revealed to us by this new method of investigation. When once properly adjusted, even the non-professional artist finds little difficulty in detecting the minutest traces of altered structure or condition in the parts affected, to which his attention has been directed.

Liebreich's large ophthalmoscope may be described as consisting of a telescopic tube, or rather two tubes, one sliding within the other, and admitting of extension for local adjustment by a rack and pinion. A perforated mirror is placed in position at the observer's end of the tube, suspended vertically on little projecting arms, which allow of its being easily moved in the direction most suitable to receive the rays of light from a lamp, and for which purpose a portion of the tube is also cut away. Behind the little perforation in the mirror, is placed a convex lens of low power. The end of the tube next the patient is fitted with a double convex lens. The instrument proper is encircled by a strong ring of metal, which slides on an upright rod or stand, so that it can be raised or lowered according to circumstances. Above and below the tube itself, are two other sliding arms, fitted with pads, one to receive the chin of the patient, the other to support the forehead, so that the completest rest is assured during examination. To fix accurately the position of the eye itself, a small brass ball at the extremity of a pointed rod is attached to the tube, and can be placed in any direction. The whole instrument is screwed to the table or desk, by a strong clamp and screw.

For demonstrating to students, and for drawing, Liebreich's instrument is the most useful I know of: any number of persons, indeed, can observe the appearances.

Although I have described this larger instrument of Liebreich's as being almost perfect for purposes of study and clinical examination, I shall not introduce special illustrations or diagrams of the optical problem involved in its operation; these I reserve for the smaller and much simpler form of ophthalmoscope, and which is sufficient for all ordinary purposes. The one I make use of myself is a small circular mirror; indeed, nothing more than the silvered speculum used with the compound microscope, having a hole bored in the centre, and mounted on a little frame of tortoise-shell. This simple form of instrument has proved by far the most convenient; as it is held easily in the hand, and can be brought to any position, or turned in any direction, as necessity may dictate. The mode of using this little instrument is shown in the annexed diagram:

Fig. 1.



In using this ophthalmoscope, and which is generally known as that of M. Anagnostaki's, from a Greek physician, who first introduced it into general practice*, a lamp is placed in such a position, behind and to the side of the pa-

* It is stated that Anagnostaki was a pupil of Reute's, in Vienna, at the time of Von Erlach's and Helmholtz's researches, and thus obtained a knowledge of this particular form of ophthalmoscope.

tient's head, as to throw its light upon the mirror A B. The converging rays proceeding from the concave surface of the mirror are intercepted at a short distance from the eye of the patient, and made to pass through a biconvex lens (C), which so considerably increases the convergence as to bring them sooner to a focus in front of the retina, where dispersing after intersection, the whole of that membrane is illuminated, and what may be termed the *camera* or chamber of the eye is filled with light. It is necessary, not only for the uniformity of the illumination, that the focus be made to fall relatively before or behind the retina, but also to obviate some irregularities of appearance to which I shall refer hereafter, and which arise from adverse circumstances, that cannot be avoided in the construction and use of the instrument. It only requires to be observed here, that the mirror (A) is perforated in the centre with a small aperture or sight hole, about one sixth of an inch in diameter, through which, in the illustration, the observer's eye D is supposed to be looking; while the other eye is employed in directing the convex lens, and keeping the patient's eye in the visual axis. The mirror, it should be noted, is here represented much too large.

Another ophthalmoscope, which is so far properly described as holding a middle place between the fixed and the hand forms of the instrument, is a recent invention of M. de Grandmont of Paris, and has been pronounced by some eminent French oculists to be a great success, possessing every desirable requirement. By means of an elastic band, a kind of skeleton spectacle frame is securely fastened upon the head of the surgeon. Between the orbital rings is a metallic plate, adapted to the form of, and resting upon, the bridge of the nose. From this projects a grooved bar, also of metal, and several inches long, on which slides a double-jointed arm, supporting the lens, that may thus be readily adjusted to any required distance. The advantages of this form of the ophthalmoscope are stated by the inventor to be—firstly: that it supplies practitioners with a readier means of accurately observing the fundus oculi; all other kinds requiring much practice, and trying the powers of endurance both of the observed and the observer. Secondly: as a consequence of the quickness with which observations are made, the patient escapes the evils to be feared from injury to an already over-sensitive retina, likely to arise from long-continued examinations. At the same time, many persons in succession may observe the appearances without disturbing the optical arrangement of the instrument. Thirdly: the right hand of the surgeon is left free to fix or direct the head of the patient in any required position—an advantage illustrated in seeing the vessels on the surface of the retina, when it is necessary frequently to alter the position of the head, so as to bring the vessels and papilla optica within the field of vision. Fourthly: by holding the instrument in the hand, the image obtained is subject to some considerable change of appearance, owing to the unavoidable shaking of the hand that holds the lens—a defect remedied by the lens being fixed in this instrument. Lastly: the rod to which the instrument is attached admits of the employment of a lens with a long focal range, which magnifies the image and affords every opportunity of examining the minutest details.

I have been induced thus to particularize the alleged advantages possessed by this invention of M. de Grandmont, from the circumstance of its use being strongly recommended: but after many earnest endeavours to realize the desirable objects enumerated, I must say that I have been somewhat disappointed, and cannot bear testimony in favour of its superiority over that of others. The idea that it represents a useful mean, as correcting the deficiencies between the two forms of the fixed and hand instruments, cannot be sustained for a moment; at least, those who entertain such an opinion must differ considerably from me in their estimate of the great practical purposes served by retaining the two forms and using them as circumstances may require. With the convenient hand mirror and pocket lens, a very moderate amount of practice enables us to obtain an accurate diagnosis in most cases. The lesser ophthalmoscope possesses a readiness of application that will always recommend it, in preference to any other which involves a large amount of careful, if not considerable, adjustment, before it can be effectively used. At the same time, the hand mirror does not, nor ought it, exclude the fixed or larger kind of instrument, for the close and attentive observation of the various forms and phases of eye disease. To depend upon any thing less efficient, whereever doubt or obscurity exists, is sacrificing too much to convenience; and it is on such grounds that I object to any proposed mean, however happy, between the ready aid afforded by the lesser ophthalmoscope (which is quite sufficient in the great majority of cases, but far from accomplishing all that is sometimes required), and that which is only to be obtained by the employment of the more perfect, although more complicated, fixed instrument.

My chief objection, however, to M. de Grandmont's ophthalmoscope, is the constant mental effort necessary to sustain that first principle in all examinations of the kind—the keeping the eyes of the observer and the observed in one axis or line of sight. Owing to the greatly enlarged arc that the further extremity of the projecting arm necessarily describes, on the least movement of the end resting on the bridge of the nose, it demands very considerable practice and dexterity to determine the degree of fineness, and no more, in the movements of the head, which is constantly required to enable us to look steadily through the limited area of the patient's pupil. This, I think, will prove an insurmountable obstacle to the general use of the otherwise ingenious contrivance of M. de Grandmont—even if there were not many cases in which the patient's eyes are so unsteady that a lens fixed in any way cannot be used at all.

It remains for me to notice a slightly modified form of Meyerstein's ophthalmoscope, which I am in the habit of using. Interposed between the flame of a common paraffin lamp (*e*, *fig*. 2), and the instrument *a*, *a*, sliding on the upright rod *b*, and clampt to the edge of a table *c*, is a screen of blackened cardboard, *g*, made sufficiently long to extend either way beyond the heads of the surgeon and of the patient under observation. A circular hole in this shade conducts the light to a plain mirror, which reflects it at right angles along the main sight tube to the fundus of the eye. A little projecting wooden support, *d*, for the chin of the patient is also clampt to the table, and completes the apparatus. When necessary, in long examinations, a bar of wood to rest

Fig. 2.

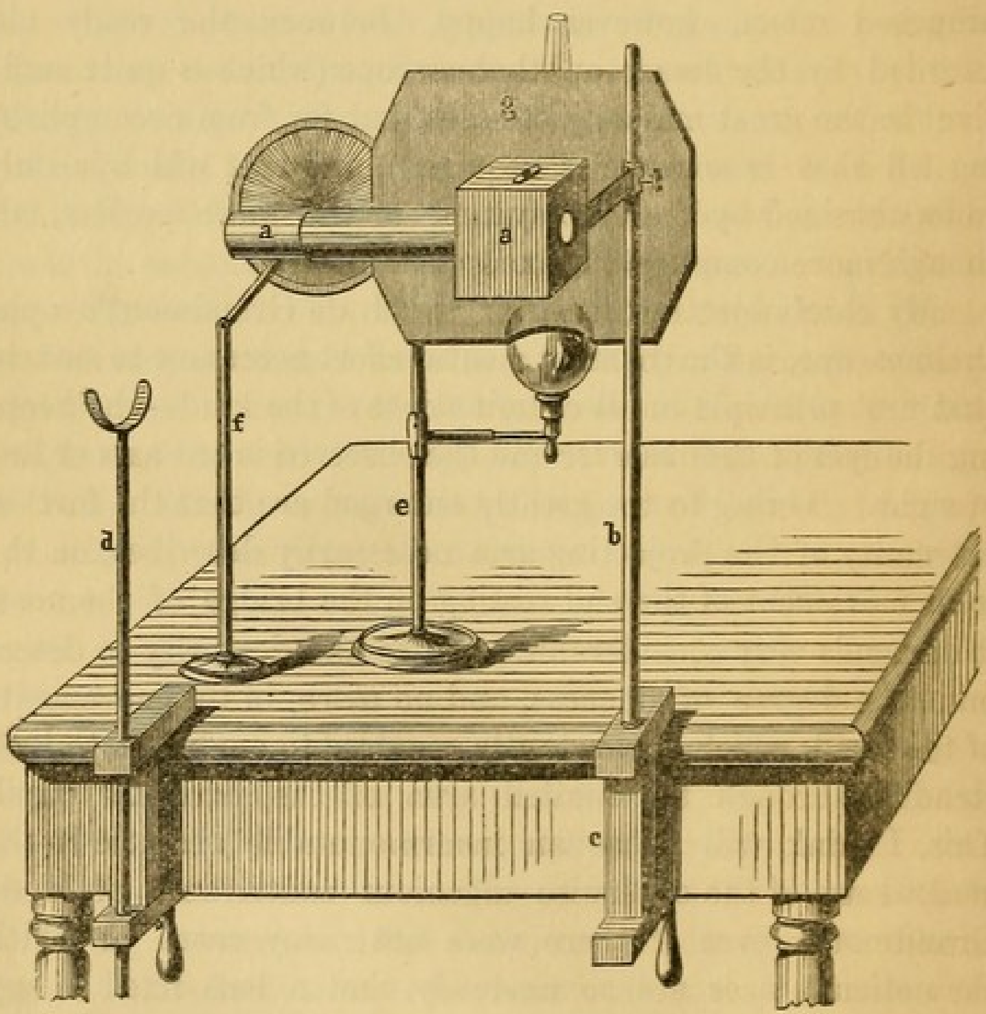


Fig 2.—Fixed ophthalmoscope. *a a*, the telescopic tube, and square box containing lenses and mirror, firmly secured to the upright rod, *b*, and clampt to the table, *c*. A wooden support, *d*, is also clampt to the table, for the purpose of supporting and steadying the patient's head. The mirror being illuminated by the lamp, *e*, while the screens, *f* and *g*, shut out the light from the face of both patient and surgeon.

the forehead against can be attached to the crutch under the chin. The hand screen, *f*, effectively shuts off all light from the patient's face. With this instrument, I find little or no difficulty in arranging and adjusting all things at pleasure, and so far can command the best opportunity, circumstances admit of, for becoming well acquainted with the disease under investigation. If not altogether perfect, and leaving something yet for future ingenuity to improve upon, still I have abundant cause to be satisfied with the valuable assistance I am continually deriving from this simple apparatus. It also affords a ready means of clinical demonstration, as well as facility of obtaining the aid of an artist to produce illustrative drawings.

I have merely a few remarks further to add upon the binocular ophthalmoscope lately introduced, the invention of M. Nachet. Its chief peculiarity is, that the mirror is placed in the median line between the visual axes of the two eyes, and moves with a hinge-like motion upon a horizontal axis. The lamp is also placed in the median line, behind and immediately above the head of the patient, into whose eye the reflected light is thrown by adjusting the mirror to the necessary angle of reflection. Projecting frames, placed on both sides of the instrument, contain two small prisms in each, and are intended for the accommodation of myopic and presbyopic observers. To facilitate the necessary change in position, these prisms are set in sliding grooves. With normal sight, the observation is made by looking through the prisms, much as we do in the well-known stereoscope. In this mode of illuminating the eye, any inconvenience arising from the unreflected spot which marks the sight aperture in the ordinary ophthalmoscope is entirely obviated; and some advantage is also gained by the position of the lamp. Experienced observers, however, will, I think, continue to prefer the much more portable form so generally employed, all the deficiencies of which may be corrected by a little patience and tact.

CHAPTER II.

OPTICAL PRINCIPLES INVOLVED IN THE USE OF THE OPHTHALMOSCOPE.

The Nature of Light.

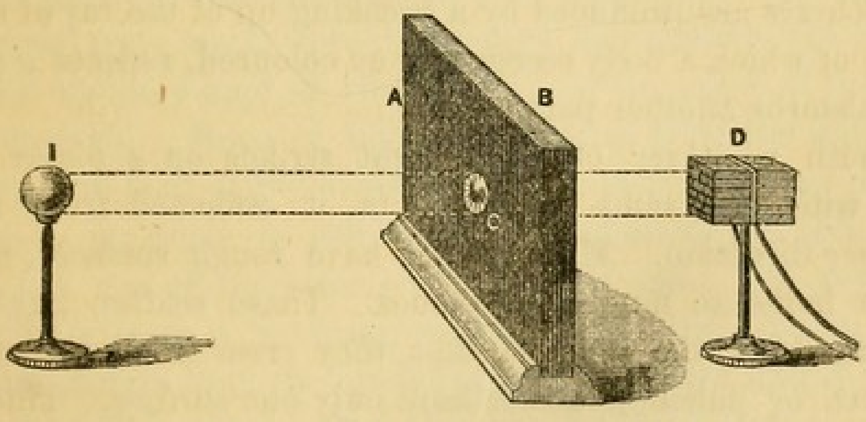
LIGHT is an emanation from the sun, becoming less intense as it is diffused, and which, by falling on other bodies, and being reflected thence to the eye, renders them visible. Recent scientific investigations go far to prove that the sun is an enormous mass, or rather nucleus of matter, heated to an inconceivable degree, and luminous in proportion, with an atmosphere of flame surrounding it. To this globe of ours it is the chief source of heat and light, propagated by means of an ether which fills all space, and of the existence of which we become cognizant by its retarding the speed of comets. Both heat and light consist in certain movements or vibrations in the atoms of this luminous mass; and when these vibrations are communicated to the surrounding ether, they are said to *radiate;* when they are interrupted and arrested by any other body, they are said to be *absorbed.*

Immense masses of solid matter are readily penetrated by light. Thick plates of solid rock-crystal, mountains of ice, &c. are instantly pervaded by a beam of light. Nevertheless, some solid and gaseous bodies possess the curious property of separating the heat from the light ray. The transparent solid body, rock-salt, does this; likewise some gases, as oxygen and hydrogen. These, as well as a few others, also absorb radiant heat of different qualities and in different degrees—a fact of some interest, inasmuch as

Professor Tyndall proved that the eye possesses a wonderful provision for the exclusion of heat rays. He found, beyond the visible spectrum in both directions, rays which excite no impression of light. Those at the red end excite heat, but no light; and the reason why they fail to excite light in the eye, is, probably, that they are never permitted to reach the retina. To show this experimentally, a thermo-electric pile was placed near to the red end of the spectrum, but still outside of it; the needle of a large galvanometer connected with the pile was deflected and came to rest in a position about 45° from zero. The transparent vitreous humour of the eye of an ox was now placed in the path of the rays, the light of the spectrum was not perceptibly diminished, but the needle of the galvanometer fell to zero; thus proving that the obscure rays of the spectrum, to which the galvanometric deflection was due, were wholly absorbed by the humours of the eye.

The quantity of heat is measured by the amount of the galvanometric deflection which it produces; its power of passing through media may be taken as a test of *quality*.

Fig. 3.



This experiment may be varied in the following manner: A B, *fig.* 3, represents a blackened screen, with a central aperture in it of about half an inch in diameter; I, a heated ball of iron; and D, a thermo-pile, having connecting wires in communication with the galvanometer, and which shows a considerable deflection. If an ox-eye be now accurately adjusted to fill up the aperture C, all the heat rays are immediately stopped, and the galvanometer returns to zero.

Particular kinds of light are absorbed or transmitted much more readily by some substances than they are by others. The apparent colour, as well as intensity of the light reflected from or transmitted through different bodies, depends very much upon contrast; and certain substances have a property termed diplochromatism, in virtue of which they reflect light of one colour, and transmit light of another colour. The crystalline lens of a glaucomatous eye, which appears to be greenish by reflected light, and yellowish brown by ordinary transmitted light, day-light*, is an example of this.

However, all bodies that are visible reflect light; in other words, cause a ray to turn back or rebound from their surface when it impinges upon them. It is by the entrance into the eye of these reflected rays that an object is seen. A perfectly transparent object would be invisible. Many transparent bodies, as glass, water, and the media of the eye, reflect a part of the light that falls on them. Water also absorbs a part. Any thing that entirely absorbs light is opaque or black. Any thing that completely reflects all the light, is white or destitute of colour.

Colours are produced by a breaking up of the ray of white light, of which a body recognized as coloured, reflects a part, and absorbs another part.

With whatever obliquity light strikes on a plane surface, with the same obliquity is it reflected from it in another direction. Most bodies have rough surfaces, made of an immense number of planes. These scatter light by sending back the rays, so that they cross in all directions. Smooth or polished bodies have only one surface. This reflects light in one direction, so as to afford to the eye an image of any object before them. Of such surfaces, of metal or glass, are formed mirrors or specula.

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* Dr. Mackenzie—On the Diseases of the Eye, 4th edition, page 895.

Dioptric Principles involved in Ophthalmoscopic Examinations.

It is unnecessary to enter here more fully into the nature and properties of light. I therefore proceed at once to direct attention to some general laws which regulate the passage of light from one point to another, through bodies of diverse forms and through media of different densities; as these are all involved in the theory of the ophthalmoscope, and without a knowledge of which, the use of that instrument becomes merely empirical, if indeed it may not be said to be unreasonable.

Rays of light, when once they have passed into a medium of uniform density, proceed in straight lines. If, however, they are interrupted in their course, and made to pass through another substance differing in density—as, for example, from air to water—the lines of original direction are altered at the surface of the new medium. To cite a well-known example:—Place a shilling in a basin, and retire to such a distance that the shilling is lost sight of. If an assistant now pour water into the basin, the shilling will again appear within range of vision. This is the effect of the law of refraction. Rays of light, on passing from the water to the air, are bent at the surface, so as to clear the edge of the basin by an angle of refraction, and made to fall obliquely into the eye of the observer. In this case, the rays of light pass from a medium, water, which has greater refractive powers than the air into which they pass, and accordingly it will be found that they are deflected from the perpendicular; or, as it is otherwise expressed, the angle of refraction is greater than the angle of incidence. On the contrary, the reciprocating rays of light returning from the eye to the object point are subject to an opposite effect, in passing from the air, which has less refracting powers than that of the aqueous fluid; they are deflected towards the perpendicular; or, in other words, the angle of incidence is greater than the angle of refraction*.

The form of a refracting surface materially affects the direction of rays of light. In passing through a plate of glass, the refracting power of which is greater than that of air, if its two surfaces are perfectly plane and parallel to each other, a ray of light passes on unrefracted; or, if it be so, the angle of deviation as it enters being equal to the angle of deviation as it passes out, and as these angles are on opposite sides of the ray, the direction line, after being twice refracted, will be parallel to its original direction. If the two surfaces of the medium incline towards each other at an angle, as in the ordinary prism, the course of the ray of light, after its second refraction, is not in its original path, but is deflected away after passing through the medium, according to the angle formed by the intersection of the two surfaces. Prisms, the surfaces of which are inclined towards each other at a sufficiently great angle, do not transmit any ray of light which is incident on the second surface, in such a manner as that its corresponding angle of refraction would exceed 90 degrees. Under these circumstances, rays of light pass out through one or other of these surfaces, after being reflected once or oftener. Ophthalmoscopic reflectors are sometimes made of this kind, perforated with a small hole, so that some of the rays of light returning from the patient's eye may reach the eye of the observer. Meyerstein was the first to employ such a reflector.

A refracting surface which is the segment of a sphere

* The angle of refraction—that is, the angle which the direction line of a ray so deflected makes with a straight line (or perpendicular) drawn through the surface of the medium, and at right angles to it—bears such a relation to the angle of incidence, that for the same media the sines of the angles of incidence and refraction are always similarly proportioned to one another. Thus, if we represent the sine of the angle of incidence of a ray passing from air into glass by the number 3, and the sine of the angle of refraction of the same ray by 2, then the sine of the angle of incidence of another ray passing from air into glass be 6, the sine of the angle of refraction of the second ray will be represented by 4.—Dr. G. Rainy's 'Theory of the Ophthalmoscope.'

will either have a common focus, or, after refraction, rays of light will proceed in a parallel direction with their original course. A refracting surface whose convexity is presented to a medium of less refracting power—as, for example, the cornea in relation to the atmosphere—condenses the light it refracts. On the other hand, a refracting surface, concave towards the less refracting power, disperses the light which passes through it.

The double convex lens is a transparent body having two spherical refracting surfaces, convex towards the atmosphere, a medium of less refracting power, and with a common axis. Incident rays, after having been refracted at the two surfaces of the lens, have the same focal direction. There is a point in the axis of every lens through which, if we draw a straight line in any direction, it will make equal angles with the two surfaces at the points where it cuts them. Rays of light passing through this point will be refracted as if they had passed through two plane refracting surfaces parallel to each other, which amounts to the same thing as if it had passed through without being refracted at all. This point in the axis of the lens is its optical centre, and a line drawn through it and the focus of an incident pencil of rays is the optical axis of this pencil. The optical centre of a double convex lens, having equal radii of curvature, is equidistant from them, and the focal distance is equal to the radius of curvature measured from the centre to the surface.

In a double concave lens we have the two surfaces of the medium of higher refracting power, so opposed to the rarer as to produce a dispersing effect upon light which has passed through it, instead of condensing it, as would be the case with a double convex lens. Indeed, all the remarks with respect to the latter may be applied in a reverse sense to the biconcave lens, always bearing in mind, "If the surface of the medium which has the higher refracting power presents a concavity to that which has the lower, and if the rays composing the incident pencil have their focus between the refracting surface and its centre of curvature, the rays of the refracted pencil will diverge less than those of the incident pencil, when the light is entering the medium of higher refracting power, and they will converge more than those of the incident pencil, when the light is re-entering the medium of lower refracting power;" that is, on its passage out through the second surface of a biconcave lens.

In consequence of the compound nature of light, its severally component rays are not only differently coloured, but have different refrangibility, which give a different index of refraction for each transparent substance. In the case of lenses, form or curvature, here, produces a sensible effect—so much so, that the rays of light which fall upon them at a distance from the axis, intersect those that fall nearer to the axis; and therefore, from being refracted nearer than their principal focus, slight indistinctness is produced—an effect known as *spherical aberration.*

The lens having the least amount of spherical aberration is a double convex one, whose radii are as one to six. Any augmentation of this curvature not only shortens its focal length, but increases spherical aberration. For optical purposes, it is not enough that the image of an object produced by a lens shall be distinct in its lineaments, which it will be in proportion as the spherical aberration is effaced, it must also be sufficiently illuminated to affect the eye in a sensible degree.

Now the intensity of the illumination of such an image will be proportional to the number of rays, proceeding from each point of the object, which are collected upon the corresponding point of the image; and it can be readily shown that this will depend upon the angle formed by lines drawn from any point of the object to the extreme edges of the lens. Indistinctness is also produced by *chromatic aberration* at the periphery of the lens, and must not be entirely disregarded. The extent of chromatic aberration is measured by the interval between the red and violet images, and is termed the *dispersion* of the lens. No single lens can be produced entirely free from chromatic defect; but since this is one of little or no moment in its employment with the ophthalmoscope, I need not further enter upon the subject, and have merely to remark, that the eye is truly achromatic, is proved by the fact that the objects we behold are not edged with coloured fringes, as is the case with all non-achromatic lenses. But if, by any means, an object is seen out of focus—that is, so that its image shall fall either before or behind the retina—achromatism ceases, and coloured fringes in circles of dispersion immediately become apparent.

We may therefore conclude that the natural achromatism of the eye compensates for most of the imperfections inherent in the formation of lenses. And likewise that the refracting surface of the cornea produces a considerable condensing effect upon the rays of the light as they pass through it.

The Human Eye as a Dioptric Apparatus, and its Hypothetical Equivalent.

THE construction of the eye for the purpose of seeing, exhibits an arrangement and character of parts that have been not inaptly compared with those of an ordinary *camera obscura*. The plate of ground glass, on which the image of the object is formed, figuratively represents the retina; the inclosed box, with its stops to intercept the more oblique rays, is the chamber of the eye, with its admirably adapted curtain, the iris; whilst the crystalline lens is the correlative of the glass one in that popular art-instrument. Rays of light reflected from any object will, after passing through a small pin-hole, form an image of that body on a screen, without the intervention of any special optical apparatus. Let the pin-hole represent the aperture of the pupil, and the screen a sensitive retina, and we have what may be termed a radical type of the organ of vision. Situated and circumstanced, however, as is the living eye, it is necessary that provision be made, not only to support and distend the parts, but that the *media* and structures employed should possess the transparency, and have, besides, a peculiar contrivance to harmonise the properties of the different elements engaged in that wonderful economy, the object of which is sight. The laws of light, accordingly, and the varying refracting powers of substances of different densities, are accommodated to each other in the eye by the interposition of an organised body which has a something more than the form:—the character and the actual purpose of a common lens. Further, to complete every requirement, we have spread over, and in fact arising from, the tissues of the eye, a double layer of the finest muscular fibres, which are firmly attached to the edge of the containing capsule of the crystalline lens. These collectively, are called the ciliary muscle, are under the control of the nervous system, and, contracting or elongating according to circumstances, adjust the focal distance of the lens, with the nicest delicacy, to the point of distinct vision on the retina.

The human eye presents to the passage of light three curved surfaces: 1, the cornea; 2, the anterior, and 3, the posterior surfaces of the crystalline lens. The rays have also, before impinging upon the retina, to pass through four transparent media of different densities or refractive powers. These curved surfaces are not exactly spherical, and their centres are not exactly in the same line; so that the principle already adduced cannot strictly be applied to the circumstances of a living eye. The general effects produced, however, by this combination is the same as that of a double or biconvex lens, or of a single spherical refracting surface, having its convexity towards a medium of less refractive power. An explanation has been given of the optical problem involved, by assuming that very small portions of these surfaces are spherical, each having a centre in the same straight line drawn through the vertex of the cornea to the centre of the *macula lutea* of the retina, and which would represent a common optic or visual axis. Listing was the originator of this hypothetical solution of the many difficulties and apparent anomalies that arise in reconciling theory with actual fact, from the compound structure of the human eye, and from the want of exact knowledge of the powers and values of the different refracting surfaces and media. And this suggestion has been acted upon by every scientific ophthalmoscopist who has since sought to give the abstract theoretical information necessary to understand properly the use of the instrument. None appear, however, to have improved upon the original proposition, and which accordingly I proceed to give in Listing's own words*.

" Indeed, by considering these vertex portions of the refracting surfaces of the eye as spherical segments, and their centres as placed on the optical or visual axis, we have transformed the eye into a system of spherical refracting surfaces, of which the centres are all the same straight line; and this may well be called an ideal or *diagramatic* eye. Of course we can apply all the principles (dioptric) just developed to such an ideal eye without further imitation. It must, however, be always remembered—and, owing to its importance, a repetition may be allowed—that all the principles, &c. hitherto developed are valid only for those rays that form very small angles (strictly speaking, infinitely small) with the axis, and which at the same time strike the refracting surfaces very near their vertices, so that the angles of incidence may be extremely small. An example may render this more striking. If this page be placed eight inches from the eye, and the number of the page be the part fixed upon, it must not be expected that the pencils of rays proceeding from the letters immediately beneath will be refracted according to the same laws as the rays proceeding from the number fixed: the former rays would form too great angles with the axis; hence their course cannot be at all determined by the constructions previously given. Owing to the compound nature

* I have the high authority of Helmholtz (who himself employs Listing's formula) also to the same effect with respect to, at least, one continental writer upon the subject. He remarks, in his 'Theorie der Augenspiegel,' that the " improvements which Stelling von Carion has sought to introduce into the said hypothesis, I cannot acknowledge to be such."

of the light, a mathematically exact image is never formed on the retina; accordingly we may readily understand that objects at different distances are seen with equal distinctness, provided their images are not attended by too large circles of dispersion. The eye is practically accommodated for a line, and not for a point—a fact especially pointed out by Czermak, who has called it "*the line of accommodation;*" its length varies inversely as the rate of increase in the circles of dispersion; and the more slowly they advance, the longer it will be."

These circles of dispersion describe the condition of a bundle of rays of refracted light after or before having been brought to a focus on the retina. In the ideal eye, parallel rays come to a focus before or behind that membrane, thus forming upon it what we term circles of dispersion.

It will be more perfectly understood that, in the diagrams I am about to give with my discussions of the two different methods, the direct and indirect, of examining the eye with the ophthalmoscope, the eyes represented are supposed to be homogeneous, or possessing one refracting spherical surface, which is the hypothetical equivalent of the various surfaces and media in a real eye. A higher index of refraction given than is the real equivalent of the actual media, preserves all the proportions between the natural differences, and also of the distances of the cornea and retina from the optical centre, nearly unchanged; and so far as concerns any conclusions important to ophthalmoscopists, the results obtained from the equivalent, or hypothetical eye, may be regarded as if quite accurate.

Neither the rules nor principles laid down with respect to this hypothetical eye refer to any other rays of light than such as fall perpendicularly—horizontally—on the spherical refracting surface in or very near its vertex, and which accordingly suffer no change in their direction after having been refracted. This, therefore, presumes a very small pupil, as the image of objects in a plane perpendicular to the optical axis must be formed on another plane perpendicular to its axis, which can be true only of a very small portion of the retina. This circumstance affords me the opportunity of illustrating the rigid character of Listing's ideal eye, and comparing it with the beautiful adaptibility of the natural eye, abounding with provisions for the proper refraction of rays falling at every angle upon the convex surface of the cornea, thus producing perfect images of lateral objects upon the retina. Whilst, therefore, the approximate results of exact demonstration upon hypothetical data can be fully relied upon in explaining the general dioptric phenomena of the human eye, there are still many evident provisions for special purposes, which, with our present knowledge, can be no further explained than by referring them to natural deviations in the refracting surfaces and media of the eye, from the simple and uniform type found so convenient in mathematical optics.

Artificial Illumination of the Human Eye.

It is by the aid of artificial illumination alone, that an observer at any time may so place his own eye in the axis of the vision of another, that rays of light reflected from the fundus of the eye observed, can enter and produce in his a sensible impression of what is there to be seen and noted. This is done by connecting some reflecting surface with the eye, in such a manner that, when looking at the object, it throws off in the line of vision, or nearly so, rays of light, which, being again reflected, come back in the same direction, and are then made to pass through the pupil and impinge upon the retina of the observer. The first idea, in fact, of the ophthalmoscope is due to the incidental observation of Von Erlach, which fell from him in the presence of Helmholtz, that he could sometimes see, by the reflected light thrown off from his spectacle-glasses when examining a case, the fundus, or internal posterior surface of the eye. He was perfectly aware of the theory of his observation—namely, that the glass of his spectacles acted as a reflector to rays proceeding from the light, and that those which passed in a parallel direction with the axis of mutual vision, between the observer and the observed eye, returning in the same line, produced this remarkable effect, one which has led to such important results in ophthalmic surgery.

Without entering upon the more abstruse and exact considerations which define satisfactorily the respective advantages under given circumstances (the arbitrary conditions of all mathematical speculation) that arise from the use of concave, convex, or plane surfaces, as reflectors of light, it is sufficient for me to state, that, practically, as far as my own experience goes, the slightly concave or plane perforated glass mirror is sufficient for all the purposes of ordinary practice. Of course, I sacrifice here something of a reputation for rigid, scientific exactness; but I compensate myself by feeling assured that, however future progress may authorise more profound studies in connection with the use of the ophthalmoscope, at present these would only interfere with the general reception among practitioners of a most useful and invaluable assistance in diagnosing eye disease, by conjuring up ideas of difficulty, that really belong to other inquiries than those which are sufficiently satisfied by the emphatic evidences of changed structure which the ophthalmoscope discloses to the examining eye of the oculist.

To illuminate the eye of a patient properly, it is better that it should be done in a darkened room; but the admission of a little daylight, at the same time, is found not to interfere materially with the distinctness of the objects seen. The larger the pupil, also the greater is the facility of observation. This, then, is an additional reason for taking the patient into a darkened room. As a rule, where no lens is used, the whiter the source of artificial light, and the nearer the reflector is to the eye examined, the more effective and uniform will the illumination of the fundus be. In the great majority of cases, however, it is necessary to use a biconvex lens, to condense the light and bring the rays quickly to a focus on the retina; and if the transparent media are in no way obscured, there is no difficulty, after one or two trials, in lighting up the whole area of the fundus oculi. The principal object is to throw the spectral light of the reflector, as near as possible, full on the centre of the eye. To effect this readily is first to observe the manner in which this reflected image is produced on the face of the patient before directing it full on to the eye. Whatever little trouble beginners may meet with in lighting up the chamber of the eye, from the unmanageableness of the reflected spectrum, will be, however, best overcome by practising a little, as if in an examination with the ophthalmoscope, and throwing the reflection from the mirror upon a card suitably placed, upon which is described a small circle to represent the pupil.

Although the use of the lens obviates the inconvenience altogether, it will be useful to mention, that in some eyes, perfectly free from any obscurity, yet not in a normal state with respect to the refractive powers of the media (such, for instance, as in the hypermetropic, or where the crystalline lens has been removed), it is sometimes difficult to illuminate the fundus, from the very contracted size of the luminous space in the centre of the circles of dispersion, which in such cases falls too far behind the retina.

To obviate this, it is only necessary to remove the reflector and the lamp a little further from the patient, or by increasing the intensity of the light, the field of the reflector produces a corresponding effect upon the circles of dispersion, and the size of their luminous centres.

It is evident that, if the artificial light employed was of uniform intensity (which it is not, as the flame has a dark centre), and if the surface of the mirror reflected equally from every point, a maximum uniformity of illumination would be obtained; but as the mirror generally used has also an aperture in the centre, it will be found in practice that a corresponding dark place in the centre of the illuminated area of the fundus of the eye interferes with a uniform brightness, and must be allowed for in conclusions arrived at. There is also another interference with complete illumination, owing to an appearance in the field of an image of the flame, which, when the pupil is small, occupies nearly the whole of the area otherwise visible. The inexperienced eye naturally adjusts itself to this bright reflection, rather than to the patient's retina, which by comparison is much more faintly illuminated.

These adverse circumstances, to which I have drawn attention, are soon overcome by a short practical acquaintance with the ophthalmoscope, as the discovery is then made that they depend chiefly upon the focal relations of the mirror to the eye examined, and that the inconveniences spoken of are obviated by producing on the retina circles of dispersion, which at once cover with light the dark space referred to. In all cases, the centre of the visible area should appear brightest to the observer's eye, the parts towards the circumference being more faintly seen; and this can generally be attained by approaching as near to the eye observed, as circumstances and the required adjustment for illuminating purposes will admit of.

It is now well known that a sufficiently large area may be illuminated with excellent effect by employing a common paraffine lamp, with a circular wick, the light of which is thrown into the eye by a concave glass mirror, two inches in diameter, and having a focal length of six or eight inches. The perforation in its centre should not exceed one-sixth of an inch. The biconvex lens now generally used to condense the reflected light of the mirror, has a focal length of from two, to two and a half inches. Thus prepared, " it is not necessary that we should attain the maximum in this respect with theoretical accuracy, and it is impossible in ordinary practice; but the observer will find that he can make an approximation to it by altering the distance between the flame and the reflector, and that between the lens and the patient's eye, taking care that his own eye is at the proper distance from the lens."*

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* Rainy, page 60.

Mode of examining the Internal Eye.

In the theory of the ophthalmoscope, the mirror is supposed to be employed only for the purpose of throwing light into the chamber of the eye. Practically, however, it is made to subserve another and more important object. The small aperture in its centre allows an observer so to place himself in the axis of the vision of another, that rays of light reflected from the fundus oculi of the latter shall pass into his own eye; and a view of the interior, nerve and vessels, is thus easily obtained. But although this is attainable by the observer placing his own eye at the somewhat inconvenient distance from the eye observed of not more than two or three inches, as may be supposed, the very limited view of the image obtained and the small number of rays which enter the eye under these circumstances, render such an examination tedious and trying, both to the observer and the observed; to the latter, even painful at times, owing to the concentration of the rays of light upon an over-sensitive retina.

We usually talk of the *direct* and *indirect* methods of examining the internal eye.

Fig. 4.

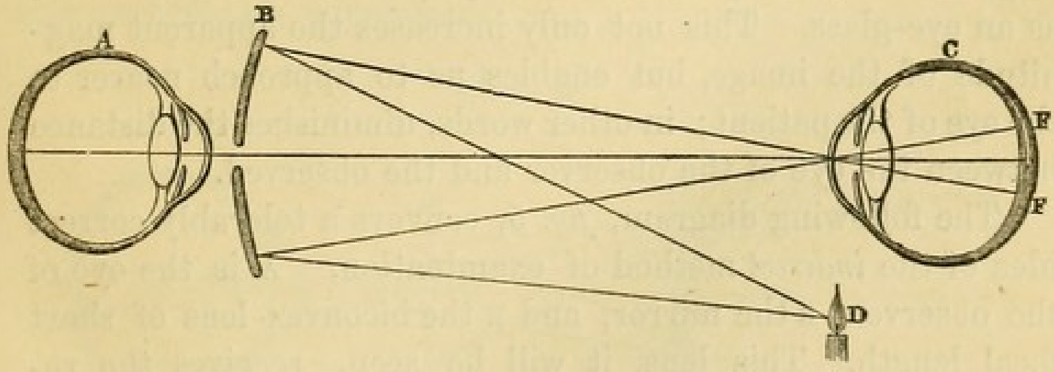


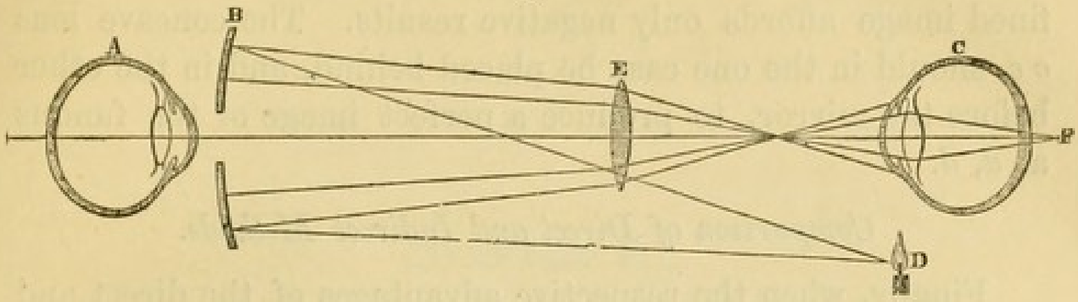
Fig. 4 is intended to illustrate the *direct* method. The ophthalmoscope is supposed to be arranged for normal vision; but the relative distance between the eye of the observed and the observer is not accurately shown in the diagram. A is the eye of an observer, placed behind the central aperture in the mirror, B, which collects the rays of light from a candle or lamp at D, and reflects them into the eye of the patient at C, where they are received on the fundus in circles of dispersion, described between F, F.

The observer sees a virtual erect image of the fundus, magnified by the refracting media of the eye. In the myopic, we obtain a general view of the fundus in this way; but, in such a case, it becomes the *indirect* method as from the greater elongation of the globe the whole is more or less indistinctly seen, we require to use a concave lens before a perfectly clear outline is obtained.

In the *indirect* method of examination, the observer removes the mirror to the ordinary distance of distinct vision, from the eye of the observed, and places before the latter a biconvex lens of about two inches focus. If the returning rays are parallel, or very nearly so, and the biconvex lens is held two inches from the eye of the patient, then an inverted aërial image of the fundus will be formed two inches from the lens, or four inches from the patient's pupil, and consequently it will appear so much nearer to the eye of the surgeon. If we wish to increase the size of the image, or give better definition to it, another lens, called an amplifying lens, of greater focal length must be employed behind the mirror, as an eye-glass. This not only increases the apparent magnitude of the image, but enables us to approach nearer to the eye of the patient; in other words, diminishes the distance between the eye of the observer and the observed.

The following diagram, *fig.* 5, conveys a tolerably correct idea of the *indirect* method of examination. A is the eye of the observer, B the mirror, and E the biconvex lens of short focal length. This lens, it will be seen, receives the reflected rays of a candle D, and concentrates them upon the fundus, from which they are returned, and an enlarged inverted image is formed at some point between it and the eye of the surgeon at A. The lens, in this case, concentrat-

Fig. 5.

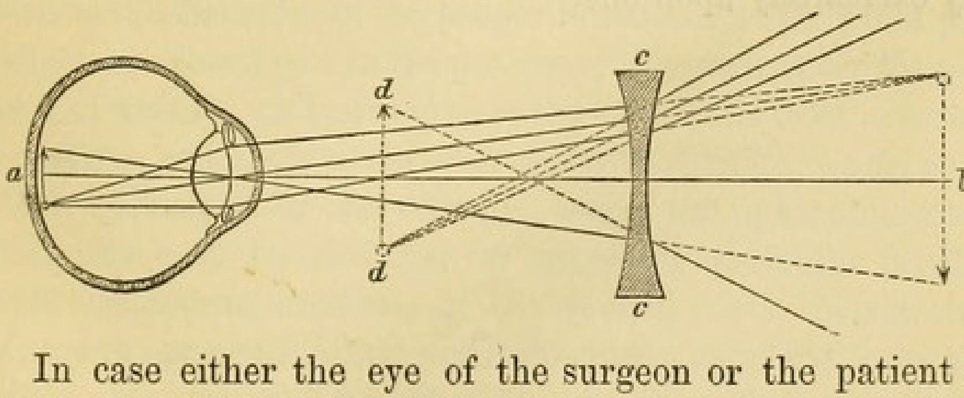


ing the rays of light from the mirror, adds to its illuminating power and lessens the circles of dispersion; thus also a larger and clearer view of the back of the eye is obtained. There is a first reflection of the flame from the surface of the cornea, which must be obviated by inclining the mirror more or less obliquely to its surface. This reflection is often an annoyance to beginners.

In all cases, the visible area increases in size as we withdraw the biconvex lens from the patient's eye; in very many cases, it will be found that an eye exposed to the strong light of the mirror has a tendency to fall into a state of adjustment for distant objects, especially if atropine has been employed to dilate the pupil.

If a biconcave lens be employed, an enlarged erect virtual image of the retina is seen—an effect due to the dioptric media of the eye in conjunction with the lens, converting it into an ordinary telescope.

Fig. 6.



In case either the eye of the surgeon or the patient be myopic, then it becomes absolutely necessary to use a concave lens, to give the requisite degree of parallelism, or divergence to the reflected rays, as in fig 6, otherwise a confused ill-defined image affords only negative results. The concave lens *c c*, should in the one case be placed behind, and in the other before the mirror, to produce a perfect image of the fundus at *d*, *d*.

Comparison of Direct and Indirect Methods.

Finally, when the respective advantages of the direct and indirect methods of examination come to be fairly considered, the superiority of the latter, in most cases, must be admitted; and when once the illusive displacement of the fundus oculi has become inoperative, by mental adjustment, then the indirect method really enables us to get a much better idea of the relative position and the proper magnitude of objects; larger portions also of the fundus oculi can be brought under observation at the same moment. Details come out with a distinctness and exactness of definition which is not always the case in the direct method of examination. A beginner will perhaps be less embarrassed by using the direct method; he is not perplexed by any inversion of the image which is projected clearly from the fundus, and admits of a tolerably close examination; he may, however, find this, if too prolonged, very fatiguing. To become familiar with both methods is the rule, as the observer will then be less liable to misinterpret alterations in structure, and much less likely to overlook points of diagnostic value, than if he were to rely exclusively upon one.

CHAPTER III.

STRUCTURAL AND FUNCTIONAL ACCESSORIES OF VISION. MUTUAL RELATIONS OF THE STRUCTURAL ACCESSORIES OF VISION. ADJUSTMENT AND ACCOMMODATION OF THE EYES.

The Structural Accessories of Vision; their mutual Relation and probable Functions.

THE structural accessories of vision contained within the eye require particular consideration. A close anatomical description of the parts, however, is not necessary, as every member of the profession must be sufficiently well acquainted with their general character. My present purpose is chiefly to direct attention to recent microscopic examinations of the cornea, the iris, the crystalline lens, the ciliary muscle, the retina, the choroid coat, and the humours of the eye, as well as to those investigations which have been made with special reference to the discovery of the proper function, and the exact participation of each part in the process of adjustment for the purpose of vision. A knowledge of the deviations from a normal condition, which are sometimes very considerable, is also absolutely necessary for the effective use of the ophthalmoscope. This can only be obtained by becoming perfectly familiar with the natural relations of the several parts, their mutual influence upon each other, and collectively upon the formation of the eye. It may not, therefore, be altogether out of place to insert here an enlarged diagram of a segment of the eye, as it will be convenient for reference in the further discussion of my subject.

Fig. 7.

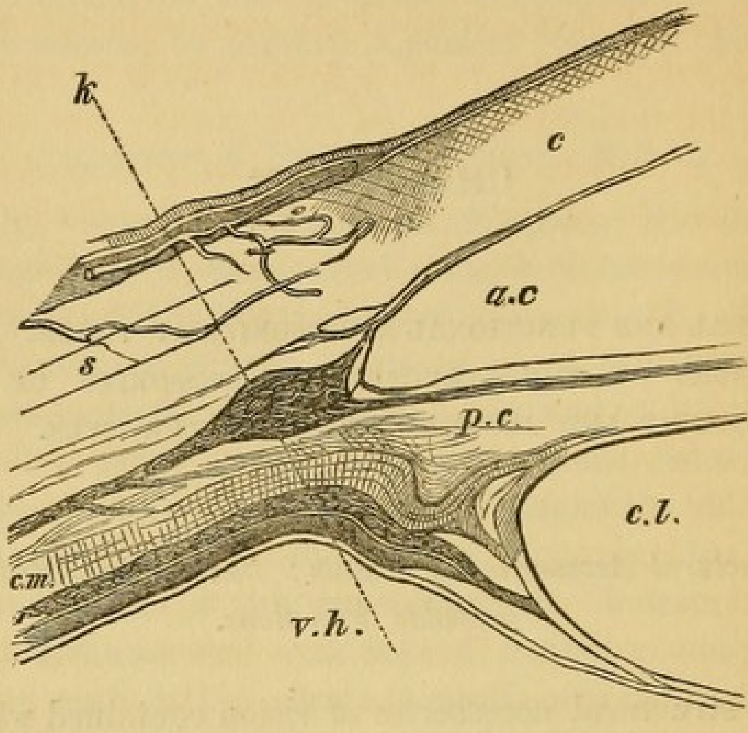


Fig. 7.—An enlarged vertical section of the Eye: *c*, the cornea; *s*, the sclerotic coat; *a*, *c*, the anterior chamber; between which and *p*, *c*, the posterior chamber, lies the iris and its pigmental coat; and to the left, *c*, *m*, the ciliary muscle and ligament; *c*, *l*, the crystalline lens; *v*, *h*, the vitreous humour. The dotted line, *k*, indicates the direction the knife takes in the operation for division of the ciliary muscle.

The external envelope of the eyeball is formed by a dense fibrous coat, which is divided into a smaller anterior transparent structure, the cornea, and a larger posterior and opaque part, the sclerotic.

The healthy cornea is one of the most transparent substances we know of, and it is so constructed us to allow rays of light to penetrate the eye which would otherwise be lost by reflection. The vascularity of the extension of the true skin over the cornea is not now disputed, nor is it difficult, with a good microscope, to make out the probable situation of the vessels in that organisation so distinctly traceable in a double layer of epithelial scales, the lowest series of which offer, in an erect position and denser texture, an appearance of greater contrasting vitality than do the loose and apparently flaccid condition of the more superficial scales. The extreme sensitiveness also of the conjunctival covering of the eye to the minutest extraneous body coming in contact with it, is clearly demonstrative of an ample supply of nerves.

The internal structure of the cornea has attracted particular attention, as being the chief seat of the more obvious diseases of the eye, and fortunately offering greater facilities for accurate diagnosis than the more deeply situated structures. It has been satisfactorily determined to be a continuation of the sclerotic coat, the fibres of which have here assumed a close laminated texture, the number of laminæ in a vertical section exceeding one hundred. After considerable pains to ascertain the real nature of these fibres, and, besides my own, following closely the detailed examinations of others with the microscope, I have adopted the following conclusion: "that the arrangement and connection of these laminæ result from the mass of the fibres passing in the curve of the cornea, but none of them reaching throughout the whole extent of it, and not being continued in their whole course in precisely the same line, so that some fibres are constantly terminating and passing into the layer above or below, whilst others are constantly arising; that whilst the general mass pursues a longitudinal course (the cornea under examination, it must be observed, being laid flat, and not in the usual position in the living eye), from one margin of the cornea to another, and the fibres, for the most part of their length, lie side to side in parallel layers, or nearly so, their terminations pass into other layers, and thus connect them together. This mode of connection satisfactorily explains why the cornea should be stronger and more resistant in the direction of the lamellæ than between them." *

Virchow has also described lamellæ of fusiform and stellate, nucleated cells, which he regards as "corpuscles of connective tissue, or corneal corpuscles." He considers that the nutrient fluid of the cornea is chiefly conducted and distributed throughout its substance by these stellate cells. This view,

* Nunneley—'Organs of Vision.'

he observes, receives confirmation; "as we find, in diseases of the cornea, these cells frequently contain fat corpuscles, and, in exceptional cases, according to Donders, even pigment in their interior."

"If," says Virchow, "we view a section, made from the cornea of a patient suffering from keratitis, with a high power, we shall see that the change is essentially seated in these corpuscles, or cells of the cornea; and that, in proportion as we approach the clouded spot, either from without or within, the little narrow cells become larger and more cloudy. At last, we find them presenting almost the appearance of sacculated canals or tubes. Whilst this enlargement of the elementary structures, this acute hypertrophy, is going on, the contents of the cells are, at the same time, becoming more cloudy, and proceeding on to opacity of all the structure; except the basement membrane, and this appears to be unaffected. This cloudiness of the contents is in part occasioned by particles of a fatty nature; so that the process seems to have begun to put on the character of a degeneration of structure." *

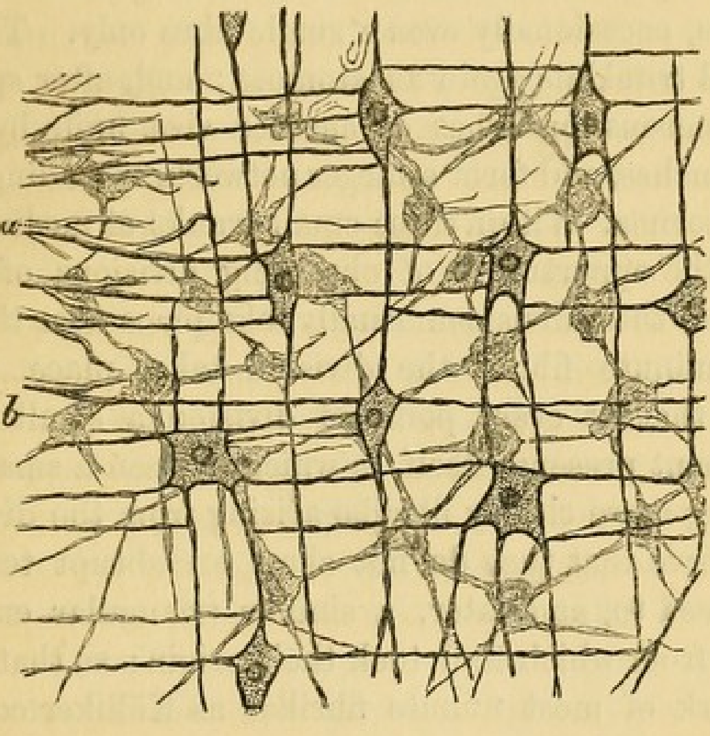
During my own examination of the cornea, I confess to have been much interested in the question of the distribution of its nerve-supply.

Schlemm was the first to demonstrate the presence of nerves derived from the *nervuli ciliares* and passing into the fibrous layer of the cornea. From twenty to thirty, or more, trunklets are distinguishable round its border, forming a numerous and wide-spreading network, extending throughout the whole cornea. "Bifurcations of the original tubes present themselves but rarely in the trunks of these nerves; and never in the plexus formed by them—the actual condition of which, however, can scarcely be fully investigated, on account of its translucency. This plexus lies in the proper cornea, but nearer to the anterior surface; and since no trace

* Virchow's 'Cellular Pathology.' Fatty degeneration of the cornea, and its pathological indications, have been fully described by Mr. Canton. See 'Lectures,' in the Lancet, 1861-2.

of free terminations of nerve-fibres can be seen, it would appear to consist solely of anastomosing twigs of the finest kind; therefore, if not in the form of loops, still some connection of the nerve-tubes with one another may be assumed."

Fig. 8.



Nerve and stellate cells of cornea, magnified 300 diameters.
a, Nerve cells. *b*, Stellate cells.

Dr. His describes and figures a somewhat similar arrangement of the nerves of the cornea; but he denies their distribution throughout the stellate structure, as shown in my illustration. I therefore think it desirable to give this anatomist's views.

"The greater part of them," he writes, "are derived from the posterior ciliary nerves, the lesser from the small trunks of the conjunctiva bulbi. On entering the cornea, their branches are partly filled with tubular matter; some have a dark double contour; others, a pale colour, evidently containing nuclei. In this respect there is no prevailing rule; as one may occasionally observe pale gelatinous fibres entering side by side, or in the same trunk with fibres containing dark tubular matter.

"In every instance, however, the fibres which, on entering, presented a dark contour, very soon lose their medullary contents, become pale, and, in their further progress, show pale, granulated, oblong or staff-shaped nuclei. At varying distances from their entrance, the small trunks either separate into equal branches, or send off a single fasciculus of a few fibres, occasionally even a single fibre only. The secondary small trunklets again anastomose; and, after splitting up into numerous branches of smaller size, unite by means of their branches, and form a larger network, spreading throughout the cornea. Within these small trunks of medium calibre, one has the opportunity of observing divisions of primitive fibres, and these divisions usually take place near the nucleus. In the minute fibres, the division takes place in such a manner, that at every point of division a small triangular enlargement presents itself, in which is seen a small nucleus. In tracing more closely fibrillæ arising from the division, one may observe that they do not show an abrupt termination, but proceed to, and enter, a similar triangular enlargement as those from which they took their origin; so that they form a network of most minute fibrillæ, as Kölliker conjectured. The triangular enlargement may probably be looked upon as a kind of ganglionic nerve-cell.

"With the cells of the cornea, and their offsets, the nerves do not stand in any anatomical relation. The accurate observer cannot well mistake the smaller fibrillæ for the tail-like processes (offsets) of the corneal cells; the nerve-fibres being distinguished by their peculiar brilliancy, their straight course, and (excepting the nucleolated enlargement) their unchanging calibre. In doubtful cases, the criterion would be that of tracing the connection of the fibres with the chief nerve-trunk. In regard to the extension of the nerves throughout the thickness of the cornea, it is a very limited one; and it was an erroneous conclusion of Strube to admit the presence of nerve-fibres in all the strata of the cornea. Accurate investigation shows that branches, dipping even into the deeper strata of the cornea, very soon come towards the surface, and spread into terminal divisions there.

"The chief seat of the nerves of the cornea is in the anterior third of the membrane, and it is only exceptionally that single trunks are to be found in the deeper portions; in the posterior third, probably none. The most minute ramifications take place immediately below the surface, and to this it is owing that we see those small branches which remain in the deeper portions forming sharp angles.

"The nerves of the cornea in their primary arrangement consist of fusiform cells, with long oval nuclei, as shown in a human fœtus at the end of the fifth month." *

His, it will be seen, denies the existence of nerve-cells in the strata of the corneal substance. I believe that these nerve-cells are connected with the nerves of Schlemm; and although my sections do not always show the regular-looking reticulated arrangement represented by the artist in *fig.* 8, which arises from the great difficulty experienced in cutting fine sections of so delicate a structure, nevertheless there is no difficulty in making out the nerve-cells, with well-defined nuclei, embedded in granular matter—seen at *a*—as separate from the layer of stellate cells, *b*. It is most interesting to compare the characteristic identity of the nerve-cells of the cornea, although so much smaller, with the very similar appearance of those displayed in sections of the nerve-cells of the cerebral substance, and of the spinal column. The repetition of the same formed bodies in an evidently organised system of distribution, is too apparent and significant to admit of dispute, and doubtless have an important bearing upon the perfection of accommodation, as well as that of either separating, admitting, or arresting only just those rays of light that are necessary to good vision.

Loops of capillary vessels, derived partly from the conjunctiva, and partly from the sclerotic, run across the margin of the cornea, and either at once form single loops, or unite

* Dr. W. His—'Histologie der Cornea.'

with each other in a network of vessels around its circumference. With regard to the relation of the cells to the lymphatics, nothing certain is known; but, although it is not possible to determine this for want of sufficient data, nor how nutrition is maintained, yet, that the cornea is a more complicated and highly organised structure than it had hitherto been believed to be, is now very generally admitted.

The elastic lamina is the third layer of the cornea, possessing specific characters, which readily distinguish it. It is easily separated, and, although very hard and dense to the knife, may be torn with little effort. It is remarkable for its elasticity, and curls up always in a direction contrary to that in which it is laid down—a property no doubt very available in assisting to adapt the curvature of the cornea to the requirements of adjusted vision, as it seems to be of the nature of a compressible spring, adapted to its posterior surface.

Immediately behind the cornea, which it supports, is the aqueous humour, contained in a space divided by the iris into an anterior and posterior chamber, communicating through the pupil. By equally distending the parts between the cornea and the crystalline lens with a fluid, the freest movement is ensured to the pupillary margin of the iris. And here we have a liquid meniscus, forming together a concavo-convex lens of somewhat less density than the cornea itself: such an arrangement materially assists in rendering the eye the perfect achromatic instrument it practically is. In quantity the aqueous humour seldom exceeds six grains, of which the posterior chamber, which is much the smaller of the two, contains less than an eighth part.

The iris is the perforated curtain, or diaphragm, which, besides regulating the amount of light admitted, materially assists in preventing spherical aberration, by excluding all rays that strike the eye too obliquely to be brought to a proper focus upon the retina. It hangs in an exact plane in the aqueous humour, its posterior surface being in close proximity to the lens. The outer margin of the iris is attached to the corneal juncture with the sclerotic, along points corresponding to the border of the elastic lamina. The anterior surface reflects the light, and its colour depends upon the pigmentum nigrum or uvea, being blue or grey where the posterior surface only is covered, and brown where a considerable quantity is mixed among its fibres. Except in albinoes, the posterior surface always presents a thick layer of this dark colouring matter, which, in this situation, besides assisting the choroid in absorbing the rays of light, after striking the retina, also renders the iris perfectly opaque, and thus prevents the transmission of light through its delicate and intimately woven fibres.

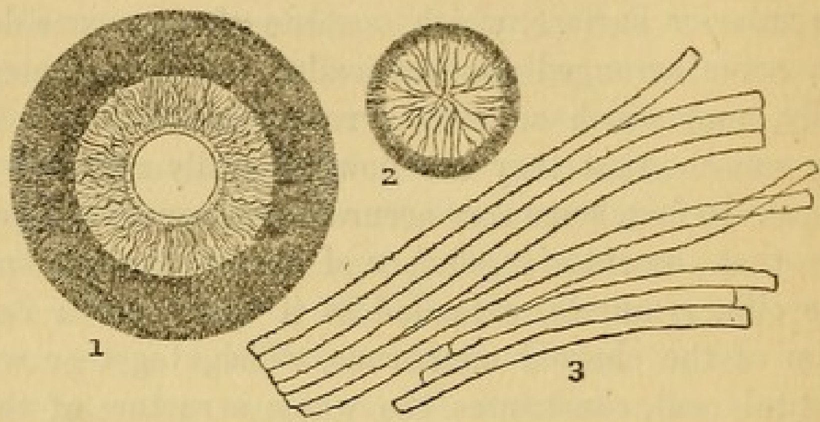
The nature of this pigment, the purpose of which is self-evident, represents the dark colouring matter of the choroidal veins, determined with an economic object to a greater development over the whole of the internal surface of the choroid and iris, where it performs the office of the black coating on the inside of the tube of a telescope or microscope. Recent observations have, in fact, confirmed what had long been presumed, that the pigment membrane of the eye was analogous with the deepest layer (rete Malpighii) of the skin. As this exists in a colourless state in the albino, it was inferred that the pigment membrane would also be found to be so, and a strongly corroborated fact, I consider, accompanied this discovery of Mr. Wharton Jones; for, instead of the usual hexagonal, flat, transparent, central bodies, connected by their edges and loaded with dark colouring matter, plates of a circular form were found without pigment; the difference in form being, no doubt, due to the absence of lateral pressure, which, when abundantly produced, would cause the choroidal pigment cells to assume an hexagonal shape.

The presence of the pigmentum nigrum on the whole of the internal surface of the choroid, the iris, and the ciliary processes, serves, in a measure, to connect all these several accessories of vision in one general view of functional purpose—a supposition which is not weakened when their actual structure comes to be examined, being made up of blood-vessels and a fibrous tissue common to all, the proportionate development of which seems chiefly to distinguish their specific characters. To suppose that this extensive vascularity is alone intended for a due supply of the pigment, is not borne out by facts; as, although we find this membrane present in albinoes, and fully developed, that function is not performed. Considered as a whole therefore, I am inclined to believe, from its situation, its structural character, and the probable nature of its office, suggested by all the surrounding circumstances, that the vascular system, which includes the choroid, the iris, and the ciliary processes, belongs to that class of erectile tissue which nature has specially provided to meet very opposite contingencies of blood-supply, occurring under conditions of great uncertainty. The structure and presumed use of the spleen, as the supplemental blood-reservoir, preserving the equilibrium of circulation in the stomach, whether at rest or during active digestion after a full meal, offers an analogy for the purpose of illustrating this point. Now, as the waking eye is sustained by ordinary means always in a state of watchful attention, resources of an extraordinary character are required to meet circumstances of particular and earnest gaze, most frequently called up by mental emotion, sometimes by instinctive impulse, like a blush in the capillaries of the skin, and also by particular efforts, voluntary and involuntary, made to perfect sight by the necessary adjustment of the dioptric apparatus of the eye. This appears to me the great purpose of the choroidal vascular system, which, by a sudden and peculiar effort becoming distended with blood, materially alters the relative position of the parts concerned, and which again assume their quiescent position by a corresponding collapse when the necessity has passed away.

The structure and functions of the iris favour this view of the character of the choroidal vascular system, as it exhibits a combination of blood-vessels, and peculiar fibrous tissue, arranged with reference to the special and distinct offices of its anterior and posterior surfaces. Reflected from the base of the ciliary processes, a continuation of the pigment membrane forms an internal coat lying upon the highly vascular texture of the iris, here consisting of a plexus of vessels, derived exclusively from the ciliary arteries: and taking a further argument from the great quantity of pigment deposited, the intimate relationship of this surface with the choroidal system alluded to must, I think, be allowed. In front of this vascular layer, and more or less mingled with it, is the anterior surface, which consists of numerous delicate fibres, some arranged concentrically, but the greater part radially, and which so closely resemble the tissue of the ciliary muscle, that they are now generally admitted to be identical. In fact, some very accurate observers do not hesitate to say, that the anterior surface of the iris is a prolongation of the ciliary muscle, extended as it were over a reflected portion of the choroid membrane, which, together with its pigmental coat, constitutes the whole structure of the iris. Moreover, this important adjusting accessory of sight, the iris, by its delicate sensitiveness and mobility, exhibits the chief characteristics of the two-fold structure of the choroid coat of the eye; we may, therefore, infer from the nature of its duties, which are to regulate the amount of light admitted into the eye, and to preclude all rays but such as pass through the more central portion of the crystalline lens, that the choroid coat and its ciliary accessories, including the muscle, to which in its structure it is so intimately allied, are also included in the means provided to ensure the accurate adjustment of the eye, by assuming a condition of action or repose, accordingly as a sensitive retina measures its need for the due focusing of the rays of light, as coming from a near or distant object. This excitement of the choroidal and ciliary vessels is quite analogous to corresponding experience elsewhere, and in a very similar structure. The presence of food acts, unconsciously to us, upon the salivary glands, to prepare the stomach for its due reception; and there can be little doubt that in some such manner light affects the condition of the choroid and retina, so as to admit, by anticipation, of a proper adjustment for the perfection of vision.

The ciliary processes, as derived from the choroid, will be found to afford corroborative evidence of the unity of design and purpose which connects the whole of the severally situated membranes into one erectile system. These bodies constitute a fringe of numerously anastomosing loops of the

Fig. 9.



1, A slightly enlarged View of the Iris and Ciliary Processes, after washing away the pigment.

2, Schlemm's Nerves of the Cornea, stained with iodine.

3, Fibres or Tubules of the Lens, magnified 250 diameters.

choroidal vessels; and as they also contain elastic fibrous tissue, it is difficult to consider it otherwise than a continuation of that membrane. They rest in a series of radiating folds on the anterior surface of the vitreous humour forming the floor of the posterior aqueous chamber, upon the contents of which any alteration of condition from a relaxed to a turgid state must produce a corresponding effect upon the eye, by a kind of intra-ocular pressure, telling, as usual, particularly and primarily upon the curvature of the cornea. It has been shown how, in the structure of this latter, it is supplied with a highly elastic tissue, beautifully contrived for the contingency here pointed out; so that, when the urgency ceases, without other effort, all the parts concerned resume again their ordinary quiescent position. Together with the aqueous humour, the cornea forms a compound lens, the surface of which is evidently adapted for this ready alteration in its curvature; and it would be strange, if, in any natural contrivance for focal adjustment, a structure and means so sufficient for all purposes were found to be least concerned in the effect produced. A little instrument, formed for looking into the eye, with light thrown as usual from a concave mirror, is based upon this principle of affecting the form of the cornea. A peculiarly formed glass cup is filled with tepid water, and placed upon the eye: the effect produced is to flatten the cornea; examined through which, a beautifully distinct and magnified image of the fundus is seen. This contrivance has been called, by its inventor, Czermak, the Orthoscope.

The character and position of the ciliary muscle is also favorable to this explanation of the problem of visual adjustment—the two directions of its fibres, separated as it were at the point called the pillars of the iris, one part proceeding to form the anterior surface, and the other being attached to the edge of the elastic lamina, which, by some anatomists, is actually described as passing continuously into this muscle. Motor power must be ascribed to, or as the object of, this arrangement; and, according to my view, it is found just where it is required, to regulate the due disposition of two really antagonistic influences—the elasticity of the cornea, and the erectile nature of the ciliary processes; and the control of which, a natural impulse, whether in birds, mammalia, or man, is thus enabled to hold as it were in hand.*

* The first mention of the *ciliary muscle* appears in the writings of Sir Philip Crampton, in a paper describing dissections made on the eye of the domestic fowl, in 1818. Other anatomists, some time before—among whom we may mention Porterfield—noticed the peculiar structure, and deemed it to be muscular, but advanced no sufficiently conclusive arguments in support of this view; and it remained for Mr. Bowman to give a better and fuller description of it, in his 'Lectures,' in 1847. Mr. G. Rainy, in 1851, made a series of examinations into the functions performed by it, the particulars of which he published in the Lancet, July, 1851. He suggests that the adjustment of the eye to objects at different distances may be effected by means of the ciliary muscle compressing the ciliary processes through the medium of the aqueous humour; and thus, by alternate partial emptying and refilling of these processes, room is made in the globe to allow of the lens changing its position, and so altering its focus.

I must here observe that my diagram of the sectional view of the internal eye (although a little exaggerated by the artist), Fig. 7, differs considerably from that given by Mr. Bowman; inasmuch as I have not been able to make out the expanded form of the ciliary muscle as he represents it, but, on the contrary, I find the ciliary muscle and processes, as well as the suspensory ligament as it approaches the lens, so intimately associated with the vascular choroid, that it appears to me better to describe them as a whole under the name of the choroidal system, as having reference to their action and functions in combination. The ligament of the lens, it may be observed, embraces it as delicate fingers would do a spherical body; so that we might truly say, it is 'held in hand' by it, for the purposes of adjustment and accommodation. This is better seen in the eyes of some inferior animals; the rat for instance, an outline sectional view of which I give, Fig. 10. My drawing is made from a beautifully prepared transparent injection in the possession

Fig. 10.

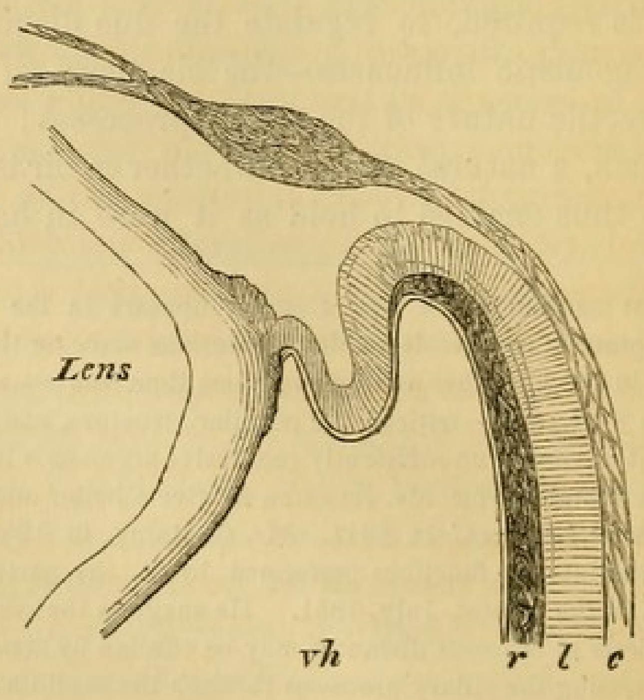


Fig. 10. Sectional view of the Eye of a Rat magnified 150 diameters. Lens; *v h*, vitreous humour; *r*, retina; *l*, suspensory ligament, passing up to embrace the lens and join the ciliary muscle and processes; *c*, choroid.

of Messrs. Smith and Beck. The parts, carefully preserved in *situ*, have been so little disturbed, that the true relation of the several membranes to each other are shown with a degree of accuracy unattainable by any other process; indeed, without any of that derangement incidental to the knife of the most careful dissector.

The choroid is not only the true structural origin of the ciliary processes, but also of the iris, and the ciliary muscle, constituting together the convenient generalisation I have called the choroidal system. Viewed separately, the choroid is a highly vascular membrane, contributing largely to the parieties of the eyeball; for this purpose it is strengthened by the addition of a peculiar fibrous tissue, and the true nature of which is more decidedly developed in the iris and ciliary muscle. Some anatomists, with whom I am inclined to agree, consider this tissue as interposed between the arteries on its inner surface, and the veins on the outer. A layer of capillaries accompany the former also, which Ruysch has successfully injected and separated from the larger vessels upon which they seem to repose. The veins of the choroid are equally numerous, and, from their peculiar course and, apparently, involved inosculation with each other, are called the *vasa vorticosa;* and exhibit, under the microscope, the most curious arrangement of any vessels in the body.* The character of the structure, however, strongly suggests a relation of functional purpose, corresponding to that of erectile tissue, which is intended to meet circumstances of different degrees of excitement by a proportionate blood supply, and which as readily subsides when the stimulus is

* "These veins are often found injected after death, and may be seen by simply removing the whole of the sclerotic coat. A better way of seeing them, is to cut out a third of the choroid coat of the sheep, ox, or horse, with the ciliary muscle, ciliary processes, and iris; gently wash away as much of the colouring matter as possible, and very carefully spread the whole out upon a thin watch glass, the curved surface of which allows the membrane to lie smooth. When dry and viewed with an inch lens, not only will the vasa vorticosa be beautifully seen, but also the continuity of the ciliary muscle, ciliary body and processes, and iris, with the choroid."—Nunneley.

withdrawn. If this be true, therefore, of the choroid coat, the natural conclusion is, that this membrane and its connections are principally concerned in effecting the mechanical changes of relative situation between the refracting media of the eye and the retina necessary for perfect vision under extraordinary circumstances. And it is difficult to conceive anything better adapted for this purpose than the character of the choroidal system generally—composed of muscular fibres—fully determined to be so by all histological observers—and a highly vascular tissue, remarkable for its convoluted and lobulated inosculations: my inference therefore is, that, as elsewhere where a similar structure exists, the distension of the latter with blood by an arrested circulation form fixed points of effective operation for the former; and at the same time, in this particular situation, produce, by an actual increase of bulk, considerable modifications in the form of the eye. Any distension of the ciliary processes especially, must affect the focal relation of the refracting media, either by pressing backwards upon the *zonula* of Zinn, and retracting the crystalline lens to a corresponding extent, or by affecting the curvature of the cornea by pressure exerted forward upon the contents of the aqueous chambers of the eye. And even should all this be deemed as not actually demonstrated, still the necessity of some sufficient agency to fix, by a kind of muscular effort, the optical centre of the lens exactly and steadily in the axis of vision, under all circumstances of adjustment or accommodation, argues strongly for the purpose which the character and situation of the fibrous tissue of the choroid system seems well calculated to perform. It may be remarked, also, that the presence of an erectile tissue is not required for the secretion of the *pigmentum nigrum;* for which purpose alone, as I before stated, some physiologists contend that the choroid coat of the eye is intended to maintain the supply of. We find, in coloured people, a substance quite as freely produced by the *corium*, which, however vascular in its texture, has not certainly been described as an erectile tissue. Indeed, to infer any thing more from the presence of this pigment than that the capillaries of the choroid, so much exposed to light, perform in the eye exactly the same office as those in the external skin, when acted upon by the direct rays of a tropical sun, would be exceeding fair analogy, and almost ignoring the specific function of the choroidal membrane, and one which I believe to be its chief characteristic.

Of the pigmentum nigrum itself, I shall only give such a description as is required for ophthalmic purposes, presuming its more intimate anatomical and physiological characters to be sufficiently well known. That it is identical with the colouring matter of the skin, and is one of the most perfect absorbents of light in nature, is now generally admitted.* And its use is equally obvious, placed upon the posterior surface of the iris; it prevents the rays of light entering, ex cept through the crystalline lens, whilst that on the inner surface of the choroid lining the posterior chamber of the eye, most effectually absorbs the light after it has impinged upon the retina. The pigment is easily washed off from the membrane, which so plentifully secretes it, and it is as easily separated from it by abnormal lesion: in this latter particular it presents a feature of some importance to be considered in connection with appearances in the eye when affected by disease. Mr. Nunneley directs attention to this circumstance; and I have no hesitation in expressing my concurrence with the following remarks:

" The arrangement of the pigment affords, I think, a satisfactory anatomical explanation of an abnormal condition which has hitherto not been understood—*muscæ volitantes.* If any one, who has himself been subject to these motes, or has got patients who are so to draw figures of what they

* Pigment particles are the granulous contents of the pigment cells, and are like ordinary elementary granules with the addition of colouring matter; the latter may be removed by the action of chlorine. In the *Tapetum lucidum*, of the eyes of animals, the colour is not owing so much to the pigment particles, as to the way in which light is reflected, namely, in the same way as it is from mother-of-pearl. Coloured feathers and the scales of fishes owe much of their beautiful colour to a mechanical arrangement of similar particles.

complain of, will examine, as I have described, a portion of choroid coat teased out, he cannot fail to be struck with the perfect resemblance of the two—the nodulated masses with connecting and stellate fibres, and the muscæ volitantes. It also explains why these *muscæ* may be temporary or permanent, trifling and fanciful, or very serious and organic. If the stellate arrangement results, as I believe it does, from the aggravation and attachment of the minute true pigment cells to the vessels, the least variation in this connection on the condition of the vessels may at once cause an irregular arrangement of the pigment cells, and impress the retina—for we must bear in mind that all images upon it are microscopic. This impression may appear and disappear with the varying condition of the vessels, arising from disordered stomach or cerebral circulation, and be cured, as we know it constantly to be, by whatever corrects their condition; or the *muscæ* may result from different organic changes in the choroid coat, which are incapable of being removed, and may indicate patches of effusion, or other structural lesions. In point of fact, we now know the important bearing which these dark specks have in our diagnosis of that important class of choroidal and retinal diseases which have been so generally confounded under the names of amaurosis and glaucoma. It also explains why these *muscæ* may be constant in form in one case, and constantly changing in another; in the latter, a different loop of capillaries may be congested or contracted, or a morsel of fibrine may be deposited or absorbed; in the former, the deposit may be organised, or the capillaries permanently altered.*

Having already explained the anatomical relations of the cornea, and referred to its special characteristics as an accessory of no mean value in rendering vision more perfect and distinct by the form of its curved surface, I pass on to the consideration of the aqueous humour, assisting to complete that most perfect of optical instruments, the eye. The

* Organs of Vision, p. 174.

simple nature of this structureless means of distending the greater portion of the globe is worthy of notice: in the first place, it consists of little more than ten parts of some saline and normal matter in one hundred parts of water. Its density has been determined to be somewhat less than that of the cornea, for the purpose, it is presumed, of rendering achromatic the compound lens the two form in combination. It is admirably adapted to facilitate the freest movement of the iris, and as readily admits of those focal oscillations of the crystalline lens, rendered more necessary by every alteration of form in the cornea; for I have no doubt that, by the instrumentality of the ciliary processes, and the erectile function of the choroid system generally, the due adjustment of the wholes is effected (like corresponding parts by the adjusting screws in a microscope), so as to preserve a constant integrity of purpose in focusing upon the retina.*

Of the crystalline lens, I have chiefly to remark upon the evidence its structure affords of the extent and character of its participation in the process of accommodation; and here I differ considerably from recent continental observers, whose arguments, experiments, and cases in point, it seems the practice in England now to accept, with much too little question of their worth or importance. A display of learned and industrious research is apt to invest with fictitious importance statements as to facts which, tested by an equally close inquiry, will not bear out the inferences that have been derived from them. No better instance of this can be given than the discussion which has arisen upon the situation of the changes in the form of the refracting surfaces of the eye, to adjust it for near or distant objects. Upon this subject, volumes, I may say, have been written, to prove how small

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* It would be impossible to deny that the cornea undergoes considerable change both in form and curvature; in *conical cornea*, for instance, we have the greatest degree of myopia produced, and the reverse in glaucoma from flattening. Between these two conditions, various modifications are produced by intra-ocular pressure.

is the influence exerted by the curvature of the cornea, in which we know alterations, and abnormal phenomena in consequence, are constantly occurring, as if intended to demonstrate the importance of this part in the function of accommodation; whilst, on the contrary, the greatest stress is laid upon changes which, at the best, can only be assumed, not only on the anterior surface of the crystalline lens, but on the posterior surface, although this is so far embedded in the vitreous humour as, at all events, to preclude any experimental observation upon which much reliance could be placed. For my own part, I believe that, in the accommodation of the eye, the curvature of the crystalline body itself is unchanged, and that its movements depend upon the special organisms provided for this important purpose; namely, the erectile tissue of the ciliary bodies, the ciliary muscle, and the reaction of its elastic suspensory ligament. I also conclude, from the peculiar character of the structure of the lens, admirably adapted as it is to obviate any inconvenience that would otherwise arise from spherical aberration, or the differing foci of rays coming from a distant or from a near object, so that no interference of a secondary nature can be philosophically assumed to arise which might tend to destroy, or at least suspend, this useful provision. We know that the crystalline lens possesses a gradually increasing density from its circumference to its centre, the former being represented by a refractive power of about 1·3767, the latter being increased to 1·3920. It is also evident that it contains some proportion of water; and it is a fair inference that this difference in the density of the lens may be produced by some corresponding difference in the distribution of fluid throughout the varying thicknesses of its structural layers; and these, arranged in segments, are again split up into the most delicate serrated fibres, as shown in Fig. 9, from its optical axis to its marginal edge. At all events, there is that in this delicate adjusting provision for exact sight which, above all, claims protection for any interruption of effect. If, however, we yield assent to the advocates of those extensive changes occurring in the surfaces of the lens during the process of adjustment or accommodation, and that such changes are effected by pressure exerted by the suspensory ligament of the lens, we at once concede that this compensatory property in the structure of the lens has no fixed value or law, but is subject to all the fluctuations incidental to the ever-changing requirements of vision.

The vitreous body fills up and distends the posterior three-fourths, or even more, of the globe of the eye. The retina, as far as the ora serrata is superimposed upon its investing membrane, the hyaloid, the delicate tissue intervening, or, according to some authorities, amounting to an organic connection. This I have not been able to confirm; though it is undeniable that the question is one that does not admit of easy determination, owing to the firm adhesion of the two membranes, and their extreme translucency. Of the gelatinous substance itself, opinion is equally conflicting as to its structure, and the character of the organisation which supports and nourishes it. The safest conclusion seems to be, that it is simply a collection of very delicately organised cells, containing a viscid fluid, the refractive power of which, accorded to Brewster, is about 1.3,394.

Except in containing a larger proportion of albumen, it differs little in constitution from the aqueous humour. In my remarks on the nature of light, see page 21, I have described experiments which sufficiently prove that, besides its mechanical use in the construction of the eye, as the mere instrument or organ of seeing, the vitreous humour subserves what must be presumed to be an equally important purpose —that of excluding the heat rays, so as to preserve, under all circumstances of exposure, a uniform condition and effect upon the retina.

How far the vitreous body is affected by those changes of form that must take place in the eye in the various processes of accommodation and adjustment, is to me a question of considerable interest. If the communication of the need is a matter connected with the direction or amount of light received from the actual object examined—and there is no reason why this should not be the case—then, consistency to my opinion of the influence exerted in accommodation by the choroidal system generally, requires me to adhere to the view that, between the degrees of the greatest and the least extremes of the operation referred to, corresponding extents of the special apparatus provided would only require to be excited to the necessary amount of action. The absorption of light by the choroid coat, and its correlative parts, would thus constitute the measure, and it would evidently be the motor agent of the change in the form of the eye, and which, commencing in its fullest and most sensitive development the iris and ciliary body, would extend backwards until even the fundus, and consequently the whole vitreous body, must become subject to a pressure of increased turgidity in the vessels of the choroid coat itself. This certainly would not tell upon the unyielding expansions of the sclerotic and the tendinous insertions of the intra-orbital muscles, but rather upon the less resisting vitreous body, producing an elongation of the globe forwards, or that protrusion which characterises the staring eye of the anxious or excited mind.

In the analogy observable between the forms and relative densities of the transparent humours which enter into the formation of the eye, the achromatic combination of lenses is too striking to be passed over in silence; and we are irresistibly impressed with the conviction that the combination is made to be quite achromatic. The two menisci formed by the aqueous and vitreous humours having the double-convex crystalline placed between them of greater density than either, and the two former differing from each other in density, appear to fulfil the conditions of achromatism in a striking manner; and it is doubtless to this combination that is due the freedom from colour in the image depicted on the retina. I think it necessary to observe that it is the opinion of Sir David Brewster that spherical aberration is also corrected by the varying density of the crystalline lens, which, having a greater refractive power near its centre, refracts the central rays in each pencil to the same point as its circumferential rays.

Functional Accessories in the Economy of Vision.

The nerves of the cornea, and their peculiar reticular distribution, I have already described; and it is only necessary to observe further of them here, that they are generally said to proceed from the long ciliary nerves derived from the third pair. My own observations, however, lead me to the conclusion that they are filaments belonging to the first division of the fifth pair, a nerve of ordinary sensation, uniting with others received from the sympathetic plexus.

The character of the distribution of the third pair of nerves in the orbit, with branches of the fourth and sixth in addition, all being motor nerves, has attracted considerable attention, and which I cannot pass by without remarking upon the confirmation it affords of my view as to the general relaxing effort in all the other recti muscles of the eyeball, to give intensity of contracted power to the corresponding ones on either side, by which a consentaneous action and accordance in direction are secured in both eyes. It must be noticed that five out of the seven muscles within the orbit are supplied by the third pair, whilst the fourth and sixth pairs are each directed almost exclusively to individual muscles; namely, the superior oblique and the external rectus. This special arrangement is evidently intended to subserve some economical purpose; for, all being motor nerves, no other reason but such as I have pointed out can well be imagined to account for the fact of the third pair of nerves not supplying the whole of the muscles of the eye, in strict analogy with other parts of the body, where one motor trunk is specially made the medium between the muscles and the brain.

Considerable discussion has also arisen as to the real source of nervous irritability to the fibres of the ciliary muscle and iris, and much discordance exists between the various authorities who have written upon the subject. There is no doubt, the ciliary nerves derived from the third pair can be readily traced into the structure of the iris; and as, in birds, where the ciliary muscle is largely developed, these nerves are found increased in size, analogy is strongly in favour of ascribing the peculiar movements of the iris also to their presence. Several investigators, however, have sought to prove that, whilst contraction might be due to the ciliary nerves, dilatation, on the contrary, was due to the influence of certain minute branches issuing from the superior cervical ganglion of the sympathetic, passing up into the cerebral plexus, and from thence to the lenticular ganglion, situated at the back part of the orbit. The experiments and illustrations employed to establish this opinion appear to me insufficient, by conflicting with the simplicity of a much more natural explanation, based upon the positive presence of true motor filaments from the third pair, sufficient of itself to account for all the movements of the iris, if considered as a sphincter muscle of an exceptional, but not altogether of an involuntary character, since several cases are recorded of the evident influence of the will over the movements of the pupil. At all events, we know that the filaments which are derived from the sympathetic are insufficient to produce contraction under circumstances where paralysis of the third pair has led to the completest dilatation of the pupil. In face of all these circumstances, the opinion alluded to is, I think, scarcely tenable.

The most important of the accessories of the eye, and which has been admirably designed for the purposes of vision, is the *retina*. This was formerly regarded as only a simple expansion of the optic nerve. Histological anatomy has carried our knowledge considerably beyond this limited view of one of the most elaborate organisms of the body. Besides the special nervous elements of its structure, it exhibits, under the microscope, tissues peculiarly its own. Enumerated as they can be discerned in a succession of examined objects—for it is impossible, in this most delicate texture, to follow up the observation of more than two of the several layers at once—the first, in close connection with the choroid coat, is the minute cylindrical bodies which constitute the membrane described by Dr. Jacob, and named after him. They are closely packed together, like the pile of a rich velvet, standing at right angles to the true fibrous expansion of the optic nerve, and accordingly perpendicularly in relation to the centre of the eye. Some observers describe a bulbous enlargement at both ends, which, however, I can only corroborate with regard to their lower insertion or origin with their parent source. And I can scarcely understand these so-called rods or cylinders to be any thing else but the sensorial organs of vision, and allied in character to the much coarser development which mark the terminations of the gustatory nerve on the surface of the tongue—an analogy to which I shall direct more especial attention when I come to speak of certain functional disorders of the eye. Surrounding the inner ends of these rods are observed numerous cylindrical bodies, which, with a much thicker and better-defined layer of granular elements that succeed them, I am inclined to think are intimately connected with the fully developed rods, both in structure and use. As far as regards the cones, Kölliker certainly entertains a similar opinion; as he describes them as being rods with a conical inner extremity, instead of a filamentous one, such as he thinks marks the corresponding end of the true rod of Jacob's membrane.

A vesicular layer is next distinguished, consisting of a grey cineritious cerebral substance, interesting chiefly as evidently determining the commencement of a distinct structure, in which the first filaments of the fibrous layer of the optic nerve are definitely observed. The latter expansion is separated from the rods by the granular layer being partly imbedded in the vesicular one, from the cellular structure of which its specific character sufficiently distinguishes it. Its inner surface is well marked by the distribution of the vascular layer, as it is called, which is supplied by the central artery of the retina, and disappears in a capillary form whenever its vessels penetrate the vesicular and granular structure. Last of all, interposed between the fibrous layer and the vitreous humour are the hyaloidal cells, which some anatomists contend belong to the fibrous layer, whilst others allege that they are to be considered as part of the hyaloid membrane—a matter of little importance beyond attaining that exactness of determination which so honorably marks modern research in every thing connected with histology, and the structure of the eye in particular.

Having thus briefly enumerated the various described layers into which the structure of the retina has been resolved, I desire to direct particular attention to the following ingenious summary of the probable *modus operandi* by which rays of light proceeding from an object produce a sensation upon the retina, and convey a knowledge of its presence and character to the brain:

" Instead of regarding the retina as composed of layers, however, we are now generally agreed in considering that the fibres of the optic nerve pass *radially* through the retina. Thus, from the fibres a thread passes downwards till it meets a cell of the vesicular layer ; this, in turn, is in connection with a granule of the granular layer, which terminates in a cone and rod—these latter forming the real termination of the optic fibres on the pigment layer of the choroid coat. It is now held that the rods and cones are the percipients of light, which they communicate to the cells of the vesicular layer, thence to the optic fibres, and thence to the optic ganglion. The point to be borne in mind, in this description, is that the sensitive part of the retina is not the surface on which the light immediately falls, but the surface which is in contact with the black pigment.

" So that if we suppose an image to be formed on the retina, it will not be transmitted to the brain ; but it will excite the specific sensations of which the optic centre is alone capable, and *these* will be transmitted. But it will be easy to prove that no images can be formed on the surface of the retina. In the first place, the retina, during life and health, is as transparent as glass. The rays of light must therefore pass through it and enter the pigmental layer, which, being perfectly black, absorbs all the rays. Further, it has been proved that the optic fibres are *totally insensible* to light. There is the 'blind spot' where the optic nerve enters, and where nothing but nerve fibres exist. There is also a spot in each eye where the sensitiveness to light is at its maximum; and this is a mass of cells, without a continuous surface layer of fibres. The especial part for the reception of light rays, out of which the necessary images are formed, Professor Draper maintains to be the *pigment layer*. To prove that this is the real optical screen on which the images are formed, he reminds us of Franklin's experiments, of placing variously-coloured pieces of cloth in the sunlight on the snow, and so arranged that the rays should fall on them equally. After a certain period, he examined them, and found that the black cloth had melted its way deeply into the snow, the yellow to a less depth, and the white scarcely at all. The conclusion which he drew has since been abundantly confirmed: namely—that surfaces become warm in exact proportion to the depth of their tint; because the darker the surface, the greater the amount of rays absorbed. A dark surface, absorbing all the rays, becomes the hottest. This principle Professor Draper invokes in his examination of the eye; and he insists 'that the argument against the retina being the screen on which images are formed, is, both optical and anatomical, perfectly unanswerable. During life, it is a transparent medium, as incapable of receiving an image as a sheet of clear glass, or the atmospheric air itself; and its sensory surface is its exterior one: this is the one nearest the choroid coat. But the black pigment, from its perfect opacity, not only completely absorbs the rays of light, turning them, if such a phrase may be used, into heat, no matter how faintly that may be, but also discharges the well-known duty of darkening the interior of the eye. Perfection of vision requires that the images should form on a mathematical superfices, and not in the midst of a transparent medium. The black pigment satisfies that condition; the retina does not.

"If the retina is insensible to the light which passes through it, it will be equally insensible to the light which is reflected from the pigment layer. On the other hand, although the pigment layer is capable of absorbing light, we cannot suppose it also sensitive to light. How then is the luminous sensation produced? Professor Draper furnishes an answer to this:—'The primary effect of the rays of light upon the black pigment is to slightly augment its temperature, and this to a degree which is in relation to their intensity and intrinsic colour—light which is of a yellow tint exerting the most energetic action; and rays which correspond to the extreme red and extreme violet, the feeblest. The varied images of external objects, which are thus painted upon the black pigment, raise its temperature on becoming extinguished, and that in the order of their brilliancy and colour. *In this local disturbance of temperature the act of vision commences;* this doctrine being in perfect harmony with the anatomical structure of the retina, the posterior surface of which is its sensory surface, and *not the anterior*, as it ought to be, if the explanation usually given of the nature of vision is correct; and therefore, when we pass the tip of the finger over the surface of bodies, and recognize cold and warm spaces thereupon, the same process occurs, with infinitely more delicacy, in the eye. The club-shaped particles of Jacob's membrane are truly tactile organs, which communicate to the sensory surface of the retina the condition of temperature of the black pigment. Professor Draper's experiments satisfactorily prove that all photographic effects result from an increase of temperature. 'The impinging of a ray of light on a point, raises the temperature of that point to the same degree as that possessed by the source from which the ray comes; but an immediate descent takes place through conduction to the neighbouring particles. This conducted heat, by reason of its indefinitely lower intensity, ceases to have any chemical effect; and hence photographic images are perfectly sharp on their edges. It may be demonstrated that the same thing takes place in vision; and in this respect it may almost be said that vision is a photographic effect, the receiving surface being a mathematical superfices, acting under the preceding condition. All objects will therefore be definite and sharply defined upon it; nor can there be any thing like lateral spreading. If vision took place in the retina as a receiving medium, all objects would be nebulous on the edges.*

"To explain the process by which the change of temperature in the pigment becomes a luminous sensation will not be difficult, if—remembering that the luminous sensation is not one depending on the specific stimulus of light, but on the specific nature of the optic centre—we follow this change in its passage from the pigment to the rods and cones of Jacob's membrane, which it affects. These are in direct connection with the ganglionic nerve-cells, in which we suppose the nervous impression to be excited; this impression is thence transmitted, by means of the optic fibres, to the optic ganglion, and hence it becomes a sensation. Funke has a good illustration of this. 'The wave of light,' he says, 'can no more excite the optic nerve *directly*, than the pressure of a finger upon the air, or the walls of the organ-pipe can excite musical notes. The finger produces a tone by pressing on the keys: each particular key that is pressed brings forth a corresponding tone as the air enters the pipe.

* The photographic process, it has been said, is a true analogue of the physical part of vision. The prepared plate is called *sensitive;* so too the expansion of the optic nerve within the eye is like it. Mr. Grove has shown that light falling on a plate prepared for photography, will set up a galvanic current. Does not this also suggest itself as an illustration of the process of vision? Light impinging on the retina determines therein a chemical change, which develops in the optic nerve the nervous force. This force sets up in the brain an action of the same order as that in the retina. Hence, again, originates a nervous force, which, conveyed back to the eye, sets up yet, a third time, a change (in the iris) which causes contraction of the pupil.

In this illustration, the optic fibres are as the organ-pipes; the rods and cones of Jacob's membrane, as the keys; and the waves of light, as the air. But the most convincing argument against the retina as the receiving screen of images, and in favour of the pigmental layer, is, in my opinion, to be found in the eyes of the invertebrata. In the eye of the cephalopoda, this portion of the pigment has long been a puzzle; and Professor Owen says that it must doubtless be 'performed by the retinal papillæ; or otherwise a perception of light must take place in a manner incompatible with our knowledge of the ordinary mode in which the retina is affected by luminous rays.'

"In the crab's eye, the pigment layer covers the retina; in the blind crustacea, no pigment is present; and in albinos, in whom the pigment is deficient in colouring matter, the vision is very imperfect. In the nudibranchs, vision is simply the perception of light and darkness. The changes of temperature produced by the absorption of the rays in their pigment cannot be elevated into the perception of an image, because the optical conditions for the formation of an image are absent. An indefinite sensation, resulting from a change of temperature, is all that they can perceive. Nay, even were their eyes so constructed as to form optical images, there is little doubt that vision, in our human sense, would still fail them, owing to the absence of the necessary combination of tactile sensations with sensations of light. We see very much by the aid of our fingers. If we remember that, according to the hypothesis, light only affects the retina after changing the temperature of the pigment, which change is communicated to the rods and cones, and thence to the vesicular layer, there will be nothing irreconcileable in the inverse arrangement of the retina in the invertebrata; in both, the process is essentially the same; and mere difference of position is not more than the difference of the chain of ganglia, which in the vertebrata is dorsal, and in the invertebrata is ventral."*

* Quarterly Review.

Considerations connected with the Mutual Accommodation and Adjustment of the Eyes.

The theory of the accommodation of the eye in adapting itself to meet all contingencies of situation and size in visible objects, so necessary to perfect vision, has been, and may continue to be, a very unsatisfactory arena of learned discussion. As usual, however, I shall endeavour to avoid all useless and laborious disquisition where our knowledge of facts is, at present, too limited to admit of plain and sensible explanation. One thing is evident enough—that the eye does possess this power of accommodation; and whether it be effected by influences acting upon the movements of the iris, or by alterations produced in the curved surfaces of the cornea and crystalline lens, or whether, by altering the relative position of the lens and retina by muscular action exerted upon the former, or by shortening and elongating the axis of the eye by pressure affecting the contained humours, or, lastly, whether it be by the concurrent operation of all these assignable causes, every one must feel assured that the old doctrine entertained by such men as Haller, Magendie, and others equally eminent, that the eye does not possess any power of accommodating itself to different distances, is utterly untenable.

How this is done, and so far as this important function of the eye is to be considered in relation to the proper use of the ophthalmoscope, I shall endeavour to explain according to my own views, being, in a measure, compelled to take this course; for, as a recent writer justly remarks, "no investigation has given rise to so much speculation, to more experiments, or to a greater number of learned calculations, with less satisfactory result for the labour bestowed, than this enquiry."

In the first place, it is necessary to observe that the position of the eye in the orbit is sustained by an equilibrium of common action in the direct muscles of the eye-ball, and which, for all purposes of attentive observation—that is, for fixing and steadying the eye in direct vision—act as one. This function of combined effort is apt to be overlooked, though it really constitutes the great difference of condition between the eye-ball out of action, asleep, reposing on its soft cushion of adipose tissue, and its waking, watchful duty, to let no knowledge escape that comes within its province and power to communicate to the brain. This does not preclude an independent specific action in each separate muscle, which indeed is predicated by their several directions and distinct points of origin from around the optic foramen, and surrounding the entrance of the optic nerve. The twofold object to be obtained is, the freest mobility, with the steadiest and surest aim at will; and, in my opinion, this is more easily reconciled with an arrangement of motor power, such as I have described, than by referring it to an inactive state of these muscles at all times, except when impulses of will communicate the motion desired; illustrating the circumstances thus sought to be explained, by the case of a ball suspended in a fluid, and susceptible of motion in any and every direction—a most unfortunate analogy, inasmuch as it suggests nothing of that admirable steadiness of object attention, to secure which, is the chief purpose, I believe, of the *recti*-muscles of the eye-ball. It is more to the purpose to refer for illustration rather to the nicely sustained equilibrium which keeps the body in an erect position by a counterpoising effort of the mutually antagonising intra- and supra-pelvic muscles of the lower extremity, and which, suddenly suspended—as, for example, where a momentary death occurs on the battle-field—so sufficiently demonstrates by a prostrate form the effect of inactivity.

Another most important consideration also leads to the conclusion of continuous action, being the normal state of these muscles. To prevent two impressions being conveyed to the brain, by separate images upon the two retinæ, looking at the same object, a perfectly consentaneous action is necessary in the muscles of both. An effort of the will, however, operating in different directions—for instance, in moving the *abductors* and *adductors* of the opposite eyes—under ordinary circumstances, implies a contradiction; but the anomaly is obviated, and reason satisfied, by supposing that the required result is obtained by a simultaneous relaxing of all the other muscles, excepting those required to direct the eyes on the object desired.

But this adjustment of the two eyes, so that the retinæ should convey true impressions of a single object to the brain, does not concern the ophthalmoscopist so much as a further provision for altering the focal length between the field of the retina and the dioptric media of the eye; and to explain which, and the organic economy employed to effect it, has led to the particular study of the accommodation of the sight for distant objects, and, in some degree, to the size also of objects looked at.

Parallel rays falling upon a lens from a distant object, and divergent rays from a near one, vary considerably in their distances of focal length upon optical principles sufficiently well known. Some means are, therefore, proved, *à priori*, to be necessary, to adapt the refractive media of the eye, according to circumstances, so that the focal images of objects, far or near, shall fall exactly upon the retina. And it follows, also necessarily, that a different conformation of the eye must take place in every adjustment for distinct vision at different distances.

In the normal eye, it is evident that this accommodation is, in great part, an involuntary act, capable, however, of an impulsive increase of energy, as observed in the difference between ordinary attention to all and everything around, and the effort of more complete vision when required to examine a point, or scrutinize an object under the microscope. The aid even of other parts is sometimes called upon to assist: as, for example, when, for a distant object, the hand is used as a shade. Nor is it at all unusual for short-sighted people habitually to bring their eye-lids close together, so that by flattening the surface of the cornea, and by excluding useless rays of light, they may thus obviate some of the inconveniences of an abnormal condition of sight.

If we examine the structure of the eye for the purpose of discovering the organic agency by which ordinary accommodation is effected, it is most essential to bear in mind the great difference that exists between certain special deviations from the normal standard of a healthy eye, and such as are occasioned by organic lesions and disorganisation, or are caused by mere functional disturbance. The former may be perfectly natural in an individual sense, as in the presbyopic and congenital myopic—the one being the necessary consequence of a gradual decline in the powers of life, the other an obvious structural defect, with which pathology has nothing to do, save in a negative way to infer the condition in some true diseases of the eye, the symptoms of which correspond with defective appearances in myopia. At the same time, where so much doubt and obscurity exist as to the actual uses of each of the several adjusting accessories of the eye, it cannot be a sound philosophy that would seek to establish a theory upon the subject, by evidence derived from abnormal phenomena, which depend upon some change of structure, especially when so many illustrations exist in the history of medicine of the extraordinary adaptations of neighbouring parts to other than their own proper functions, which nature has resorted to, to compensate for deficiences, the result of accident or disease. The too frequent neglect of this great distinction in the circumstances of the two conditions of the eye has led to unsatisfactory discussions and contradictory conclusions, and at which I cannot but express some surprise, as there are sufficient evidences of the means employed, to adjust the eye in perfect vision, to be found in the vital mechanism developed in the anatomical structure of this marvellous organ.

Before we pass on to other considerations, it will perhaps be expected that I introduce a short summary of the conclusions entertained upon the subject of accommodation by eminent continental ophthalmologists.

Since Kepler first ventured an opinion of the difficult question of how change is effected in the eye, it has constantly occupied the attention of physicists and physiologists. At different times, an altered position of the lens, elongation of the anterio-posterior diameter of the eye, contraction of the pupil, change in the form of the lens, have been supposed to furnish a sufficient explanation, either separately or combined. The experiments of Cramer and Helmholtz on this subject seem to have resulted in the determination of the following changes as taking place in the eye during the process of accommodation for near objects.

" 1. The pupil contracts.

" 2. The pupillary margin of the iris moves forwards.

" 3. The periphery of the iris is thrown backwards.

" 4. The anterior surface of the lens becomes more convex, and its vertex passes more forwards.

" 5. The posterior surface of the lens becomes also a little more convex, but does not perceptibly change its position. The middle of the lens therefore becomes thicker."

Accommodation for near objects is effected by increasing the curves of the two surfaces of the crystalline lens—*i. e.* by diminishing their radii, the vertex of the posterior surface of the lens remains *in situ*, that of the anterior passes forwards, and thus the space between the two becomes greater.

Henke maintains that accommodation for distant objects is effected by contraction of the radial fibres of the ciliary muscle. The ligament of the lens, he observes, is relaxed when the radial fibres of the ciliary muscle are contracted, the circular fibres at the same time pressing on its equator.

" Cramer concludes, from his experiments, that the increased convexity of the anterior surface of the lens is caused by the action of the iris, both circular and radial fibres being contracted at the same time, compressing the periphery of the lens, and thus pushing forwards the central portions. He also considers the use of the ciliary muscle only to be to prevent the lens passing backwards when compressed by the iris, and also to protect the retina. This was opposed by the observation of Gräfe—that, in mydriasis, the power of accommodation may be either lost or not. In the former case, the pupil may again become mobile, and yet the paralysis of accommodation continue; or inversely, the pupil may remain immoveable, and yet the power of accommodating the eye return. Szontagh, who has the power of voluntarily dilating the pupil, accommodated for his nearest point of distinct vision equally well with his pupil, varying from 3.9 to 7.1 m. m. in diameter. In him the accommodation is evidently independent of the size of the pupil. Ruete found good accommodation in a case of congenital absence of the iris; and, finally, a case has been recorded in which Gräfe removed the whole of the iris, yet the accommodation remained almost normal.

"The fact that it may continue normal in cases of congenital or artificial coloboma of the iris, in anterior and posterior synechiæ, although worthy of consideration, was, *per se*, insufficient to prove the absence of any participation of the iris in the process. A. von Gräfe hence concludes that not only the processes of accommodation, but also the action of atropine, are independent of the presence of the iris.

"In both respects, the tensor choroideæ must be the single active agent. As to the manner of action, no further deduction can be drawn from the position of the ciliary processes, than that exact contiguity to the equator of the lens is not necessary. Donders endeavoured to explain the accommodation by the conjoined action of the iris and ciliary muscle. He was the first to assign an important part to the ciliary muscle—that of forming a fixed point for the action of the radial fibres of the iris: he also referred a certain amount to the action of the iris. Helmholtz believed that the zonula Zinnii, when tense, flattened the lens, and that it became relaxed by contraction of the ciliary muscle. Heinrich Müller distinguished two sets of muscular fibres in the ciliary muscle, external or radial, springing from the inner wall of Schlemm's canal, and passing outwards and backwards, to be inserted into both sclerotic and choroid, and internal or circular, running parallel with the corneal margin, and principally situated in the anterio-internal part of the muscle, near the insertion of the iris. Müller considers that the circular fibres, when contracted, must exercise pressure on the ciliary processes, ciliary margin of the iris, and thus on the margin of the lens, and that the longitudinal (radial) fibres caused increased pressure on the vitreous body. The posterior surface of the lens is thus impeded from passing backwards, and the effect of the pressure exercised on its margin is essentially limited to the anterior surface. These changes he considered to be favored by the iris and zonula Zinnii. Mannhardt holds that the posterior insertion of the muscle forms the fixed point, towards which it draws the anterior portion. He does not deny, however, that the posterior part is also carried a little forwards. According to him, the ciliary muscle is probably the single *causa movens* of the mechanism of accommodation, causing a difference in the hydrostatic pressure in the anterior and posterior parts of the eye. The change in the form of the lens is effected by a tension and altered direction of the zonula Zinnii—the very opposite of the view generally adopted by other German authorities, who consider the tensor choroideæ, or ciliary muscle, the principal active agent." *

Dr. Pilz, in connection with this subject, makes the following remarks:

" Every eye has, in accordance with the structure of its optic media, a certain refractive power. Consequently, the spot on which the image of any object is produced on the retina can only remain the same when the object is a certain distance from the eye. With a change of the latter, the image assumes a different position, falling in front of the retina when the object is removed further from the eye, or behind it when the object is placed nearer to the eye. In such cases, instead of a distinct image of the object viewed, diffused rays would strike the retina, and vision would be

* Medico-Chirurgical Review, 1862.

extremely imperfect, did the eye not possess the power of bringing rays from objects at different distances to a focus at one particular point, which power chiefly depends on the refracting apparatus."

Doubtless the examination of a body, whether far or near, requires a conscious effort to direct and determine the line of vision of the eyes in two converging lines, severally terminating at the object point examined. This essential preliminary to perfect vision is provided for by the consentaneous action of the intra-orbital muscles, as I have before mentioned; but it is accompanied also with a more occult and a perfectly involuntary excitation in the transparent media of the eye itself, the object of which is to adjust the dioptric apparatus, so as to secure, under all circumstances, the proper focusing of rays of light, coming from sources either far or near, upon the retina. From first principles, we might naturally suppose some such power to exist; for if a lens concentrate parallel rays into a focus, at a certain distance behind it, let the object approach so near that the rays are diverging, the focus will then recede further from the lens—a phenomenon which increases as the object is brought nearer still. As a first step in the investigation of the movement necessary to obviate the effect of this law of optics, and adapt the eye to all situations, Olbers very wisely calculated the amount of difference in the focal lengths for distant and near objects, as deduced from the refractive powers of the media of the human eye; and he found the change in distance of the retina from the lens required for vision at all distances, supposing the cornea and lens to maintain the same form, would not exceed more than one line, which he considered might be effected by an elongation of the eye, or by a change in the position of the lens. I have already advanced an opinion myself as to the probable means employed in altering the focal adjustment of the crystalline lens, so as to allow perfect images of near or distant objects to come to a proper focus upon the retina; and I may add, that several trustworthy authorities—such as Porterfield, Camper, and others—maintained corresponding views of the direct functional influence, for this important purpose, possessed by the ciliary processes and muscle.

Strengthened in my conviction by such names as these, I think it unnecessary to extend the discussion further on the *modus operandi* of adjustment—than which, few other subjects connected with human physiology have excited more controversy with so little practical results. It is different with regard to the extent of the changes in the internal eye necessary for distinct vision at different distances; for this is a matter so capable of satisfactory demonstration by individual experiment, that it is only requisite for me to direct attention to certain rules of observation, by which uniformity of expression and a standard method are secured, for the general information and advantage of surgeons, patients, and manufacturing opticians who supply the necessary glasses.

It is observed that the eye, when most at rest, is adapted for a certain distance, usually called the most distant point of distinct vision; and rays of light proceeding from an object at this distance come to a focus exactly upon the retina. By exerting a certain power, we are likewise able to see with distinctness objects placed much nearer, which is a positive act of accommodation, in which the media of the eye have so changed their relative position that the diverging rays in this latter case are also brought to focus accurately on the retina, instead of in some point of a line (more or less, according to the position of the object being examined) behind that membrane. In short, there is in every eye a limit, nearer than which an object cannot be brought without its becoming indistinct; and this is called the nearest point of distinct vision. Another limit is also given by the range of the eye when at rest, and this is called the furthest point of distinct vision. Throughout a space between these two, the normal eye is enabled to see distinctly, and with unconscious effort.

As the age of man increases, however, it is found that the refractive powers of the eye diminish, and a series of changes take place, the result of which is, that the power of accommodating vision to near objects is gradually lost. Even before such changes can be discovered, the ophthalmoscope shows that the media become less transparent as years advance—a fact especially noticeable in comparison with the beautifully clear fundus oculi of the child, although the power of accommodation is much earlier diminished than that of refraction, the position of the more distant point of distinct vision long remaining the same, whilst that of the nearest point becomes gradually further and further removed from the eye. In fact, the change in the refracting powers of the eye are usually observed only in very advanced age, when a *convex* glass becomes necessary for seeing distant objects distinctly.

It is generally considered that, in healthy, youthful subjects, eyes of natural conformation will read with distinctness at the distance of fifteen or sixteen inches. Ten inches, however, is the distance of easy ordinary vision, as in reading or examining objects attentively. Beyond this it is usual also to describe a presumed limit to distant sight, further than which effective vision cannot be usefully directed; though it appears to me no arbitrary maximum can properly be alleged. Providing objects are visible at all—or, as Gräfe expresses it in these words, " of infinite distance"—and with sufficient light to be reflected, parallel rays from any distance can be brought to a focus on the retina, with particular effect, as distinguished from the general picture of external nature, the spontaneous presence of which on the retina defines its sensorial function, and describes vision in the abstract. The nearest point of distinct vision varies in different subjects, from four to seven or eight inches; but on this part of the subject of accommodation I need say no more here, as the question relates entirely to healthy eyes.

It is very different with regard to the consideration of abnormal deviations from the standard of natural vision, where, from some defect or malformation in the structural apparatus of the eyes, imperfect or indistinct images of external objects are produced upon the sensitive field of vision. It is generally some unusual or anomalous circumstance, connected, more or less, with a defective accommodation, that first awakens suspicion in the patient's mind of the presence of some evil threatening his sight; and to learn the extent of which, as determined by a practical test, is a primary object with the surgeon, to measure the progress which the disease has already made, and mark the unit from which to judge of future changes. For this purpose, several little instruments, usually called optometers, have been invented; the credit of the first suggested being due to our own countryman, Porterfield. The characteristic self-dependance and ingenuity of continental ophthalmologists have led to several modifications; but, as a general conclusion, it may be said that all have proved failures, owing chiefly to the conditions of the examination not being favorable, even in the case of healthy eyes, to the exercise of the natural powers of accommodation, and must therefore produce fallacious results where abnormal sight is concerned. At the utmost, they can only show some of the distances for which the eye can accommodate itself; but not the limits of nearest and furthest points of uninfluenced distinct vision. The consequence has been that reliance is now placed almost altogether upon what are termed *type-tests*. A conveniently graduated one, on the same principle as that suggested by Jäger, is constantly used at the Royal Westminster Ophthalmic Hospital, and a copy of which is readily obtainable through any medical publisher. There are few cases of disease, and these are confined to the crystalline lens, in which resort is useful to the ordinary optometer of opticians employed in selecting spectacles, where the use of a convex or other lens is ingeniously conjoined with a graduated scale, so as to indicate accurately and conveniently, by corresponding values, the powers of the glasses required to suit individual sight. The chief objection against the general use of lenses in measuring the extent of accommodation, is that they almost always magnify the object, when the nearest point of distinct vision is being ascertained;

and the consequence is, that a reliable conclusion, under such circumstances, cannot be attained, as the measured space will, after all, not represent the true natural one.

The best way to proceed, in examining a case, is first to determine how near and how far off the smallest type in the test page can be distinctly read with the unaided eye, and in ordinary daylight. The next point of importance is to determine, not so much the greatest distance of perfect vision, as the actual lineal extent of visual range, and which may be found by submitting, at a distance of about eighteen feet, the largest type used in the test page. If this is perfectly legible, it is evident that the eye receives and can accommodate itself to parallel rays—the question of chief importance involved in the determination of the most distant point, regarded merely as an aid in diagnosing presumed disease in the accessories of vision, or the condition of the refracting media of the eye. Degrees of power will also be evident, characterising different cases, and accompanying the several stages, whether of progress or of relief.

Although I have, so far, carefully restricted myself to the absolute need of eyes in some stage of disease, and beyond which examinations to determine the powers of accommodation would avail very little, it is necessary that congenital deviations from the normal standard of healthy eyes should be always carefully attended to, as they generally indicate a morbid disposition in the parts, and must have a proportionately corresponding effect in modifying the appearances observed in the ophthalmoscope; and in illustration of which, I have already alluded to the characteristic non-requirement of a lens when examining myopic eyes; and the necessity, on the other hand, of using one where the crystalline, by operation or accident, has been removed.

Donders, to whom is due the credit of classifying eyes into a natural system, at once simple and convenient, distinguishes—firstly, *normal* or *emmetropic* eyes, in which parallel rays are focused by a natural effort upon the retina, and possess the power of accommodation, without difficulty, for divergent rays coming from objects six or eight inches from the eye; secondly, *myopic* eyes, where the principal focus (that is, for parallel rays) fall before or in front of the retina: thirdly, *hypermetropic* eyes, the principal focus of which lies behind the retina. To this last belongs ordinary *presbyopia*, which, although merely a limitation of the range of accommodation due to the declining powers of life, is still a condition which requires artificial means to obviate the inconvenience that accompanies it, and therefore may justly be considered as within the province of ophthalmic surgery.

Myopia is referred either to a too high refractive power in the transparent media, or to the optic axis of the eye being too long, the refractive power remaining normal. The principal focus, or that produced by parallel rays, falls therefore in front of the retina, upon which circles of dispersion produce an indistinctness, as if a halo surrounded the images. Divergent rays coming from near objects, however, focus on the retina, and are distinctly seen.

Hypermetropia is a nearly opposite condition to that which is the case in *myopia*, or short-sight, as it arises rather from the refractive power of the media being too low, or the optic axis too short, the effect being to throw the focal point behind the retina, so that convergent rays only are united upon the retina. Both conditions of myopia and hypermetropia are attributable to a want of the power of accommodation altogether; or, what is more probable, to original weakness of this muscular act, leading to the use of instrumental aid for relief, which ultimately accustom the eye to the new optical conditions they involve, and hence perpetuate the evil, until, as age advances, the natural change in the eye which marks presbyopia, or long sight, in some cases affords opportunity for spontaneous relief. A strong proof that the power of adjustment is easily subverted, is given by the fact that myopia may be acquired by employing the eye constantly for the perception of near objects; as in close reading, and neglecting distant vision—a difference which marks the discipline of a college or a barracks with corresponding results, in the need for spectacles between the two different classes of young men concerned.

But, after all the protracted discussion that has arisen upon the *modus operandi* of accommodation, I may perhaps be allowed to observe, that, at all events, as regards the use of spectacles, they do not really correct any defect in the functions of the ciliary muscle, or other quasi-mechanical accessory of adjustment, but simply compensate for some defect in the refractive media of the eye. Thus the want of the crystalline is supplemented by strong convex glasses; and between this extreme case and the slightest deviation from the natural curvature of a healthy lens, desiderates spectacles of every corresponding degree of power, to compensate for the failing powers of vision; and this without admitting any question to arise as to the condition of the accommodating powers of the ciliary muscle to meet the circumstances of near or distant sight; for as yet I have not heard of any artificial optical means which are in the least sufficient to remedy the temporary disturbance of vision, at all distances, which arises in the every-day experiment of paralysing that muscle by the use of atropine or belladonna.

We are seldom consulted for congenital myopia; nevertheless, in all cases care should be early taken, in young persons, to correct it, by proper advice and suitable spectacles. Some slight decrease may certainly be expected as age advances. Donders is inclined to dispute this, although he himself admits that by the increased diminution of the pupil such eyes frequently do see better at a distance as they grow older. Other remarks of this eminent oculist upon that always very serious circumstance, progressive myopia, are much more important, and deserve to be quoted in his own words.

"During youth, every myopia is, perhaps, more or less progressive; the progress of the affection is then accompanied by symptoms of irritation, which, according to Von Gräfe, may even assume the character of sclerotico-choroiditis posterior. This is the critical period for the myopic eye: if the myopia does not at the same time increase too much, it may remain stationary; or, at a more advanced age, even decrease. If, however, it becomes greatly developed, we shall find it almost impossible hereafter to arrest its progress. At this stage, we must therefore avoid every thing that may cause determination of blood to the eye, and thereby tend to increase, not only the sclerotico-choroiditis, but also the tension within the eye. I cannot lay too much stress upon this. Every progressing myopia is threatening to the eye. If it remains progressive, the eye will soon become less and less usable (troublesome symptoms at the same time showing themselves), and not unfrequently vision is irrevocably lost at the age of fifty or sixty (if not sooner), through detachment of the retina, extravasation, or atrophy and degeneration of the yellow spot." *

The practical commentary upon the above extract that naturally suggests itself, is the care and caution necessary to prevent young people, threatened with myopia, from engaging in pursuits calculated to develop the affection, or greatly to exaggerate the evil if already present. It is about the age of puberty that the first symptoms are most apt to appear; and accordingly the close application of the eyes, at that period, to studies, or to write a continued or too fine a character, is clearly contraindicated. Any occupation that exercises the accommodation of the eye to very short distances, as watchmaking, fine engraving, &c. after a time imposes a permanent condition undoubtedly myopic, as the power, in one eye at least, to unite parallel rays, under ordinary circumstances, upon the retina is lost. Varying degrees, in either eye, of this defect, are also frequently observed producing corresponding degrees of indistinctness with which either eye, at the same distance, can distinguish the lines of printed characters on a plane surface from each other; and in selecting spectacles it is important to keep this fact in view, as many cases of impaired vision complained of are,

* Von Gräfe, Archiv, vol. vi, 2. 220.

when investigated, characterized by this irregularity of focal coincidence on the retinæ. Patients are too apt, indeed, to neglect the eye that is most near-sighted until it becomes quite useless in looking at any near object; that is to say, the image formed in that eye is not perceived, unless attention is particularly directed to it. A more disagreeable effect is when spontaneous efforts to overcome the irregularity induce strabismus—a symptom which, on its first appearance, should suggest an immediate examination of the condition of the eyes in this respect, which, admitting of an effectual remedy by providing proper glasses, becomes, by delay or neglect, not only a permanent disfigurement, but a source of much discomfort, in the impaired vision that always accompanies it. Such cases frequently come under observation. Lately I was called upon to divide the internal recti muscles in a young lady, myopic from childhood, where amblyopia to the extent of complete loss of sight in one eye, had arisen from the strabismus; and the operation, by restoring the natural correspondency between the axes of the two eyes, was followed by the further satisfactory result of perfect vision being again shared in by both.

"Now all practitioners are agreed as to the advisability of allowing myopic persons spectacles for the purpose of seeing distant objects. For we thus change their eyes into normal ones, and enable them to unite parallel rays upon the retina. We should, however, prescribe the weakest glass with which the patient can see clearly and distinctly at a distance, so that he may only make use of a minimum of his power of accommodation, and not have to strain it unduly when observing near objects. For we must remember that he will but seldom have to look for any length of time at a distance, but will alternately observe near and distant objects. Now, if the glasses are too strong, he is already obliged to use more than a minimum of his power of accommodation when observing distant objects, and will consequently have to make use of a still greater amount (perhaps almost the whole) when looking at things but a short distance from him. His myopia will therefore soon increase.

"There can also be no harm in allowing short-sighted persons glasses for the purpose of seeing things at the distance of a few feet (*e. g.* playing the piano, &c.). But the patient may also desire spectacles for reading, writing, &c. Donders thinks that, although it is advisable to give myopic persons at first weaker glasses for reading than for distant objects, we should at a later period, if their range of accommodation be good, give them (even for reading) spectacles which completely neutralise their myopia.

"It is still, however, a much-debated question whether short-sighted persons should be allowed glasses for reading, &c. Donders strongly recommends it (except in exceptional cases), for the following reasons:—1. Because strong convergence of the optic axes is necessarily accompanied with tension of accommodation. The latter is an associated action, not arising from the mechanism of the convergence, but existing within the eye itself, and may consequently easily lead to an increase of the myopia. Besides this, the pressure of the muscles upon the eyeball appears to be greater when the optic axes are convergent than when they are parallel; and this increase of pressure cannot but tend to give rise to the development of posterior staphyloma. 2. On account of the habit which short-sighted persons have of bending their heads forwards during reading or writing. This must cause an increased flow of blood to the eye, and an increased tension within the eye itself. Owing to this, the development of sclerotico-choroiditis posterior, effusions of blood, and detachment of the retina, which are so apt to occur in short-sighted persons, are undoubtedly greatly promoted. For this reason, we should always tell these patients to read with their head well thrown back, and to write at a sloping desk.

"But it may, on the other hand, be urged that it is just in looking at near objects that myopic persons have an advantage; for they can see them remarkably distinctly. And the great danger is, that after reading for a short time with spectacles, the patient, on getting somewhat fatigued, will, instead of laying the book aside, approach it nearer to the eye, in order to gain greater retinal images, and thus strain and tax his power of accommodation too much. If we, for instance, give a patient, whose far point lies at eight inches, a pair of spectacles which enable him to read at twelve inches, he will, if not very careful, after a short time almost insensibly bring the book nearer to his eyes, and thus have to make use of a greater amount of accommodation. If he does this frequently, he will soon increase his myopia. The greater the range of accommodation, the less harm will spectacles do, and *vice versâ.*"

"The presbyopic patient (who is generally above forty years of age) complains that his sight, particularly in the evening, is beginning to fail him for near objects, small print, &c. At a distance, however, he can see perfectly. In order to see minute objects more distinctly, he removes them farther from the eye, or even, perhaps, seeks a bright light, so as to diminish the circles of dispersion upon the retina by narrowing the area of the pupil. But as, on account of the distance at which these fine objects are held, their retinal images are very small, he will soon experience a commensurate difficulty in clearly distinguishing them, and feel the want of spectacles.

"In true presbyopia, the far point is at a normal distance from the eye, parallel rays are united upon the retina, and neither concave nor convex glasses (even after the application of atropine) at all improve distant vision. The eye is neither myopic nor hypermetropic. There is, in fact, no anomaly of refraction, but only a narrowing of the range of accommodation; the near point is removed too far from the eye, and hence the difficulty of accurately distinguishing small objects.

"Presbyopia is, however, often accompanied by amblyopia (weakness of sight), and the latter is sometimes mistaken for it; this may the more easily occur, as the amblyopic patient also cannot see small objects distinctly, and as convex glasses improve his vision by affording him larger retinal images. In a purely presbyopic eye (which is free from amblyopia) we should, by means of the proper convex glass, be able to restore a normal sharpness of vision and a normal range of accommodation. With this glass, the patient should be able to read No. 1 of the type-tests at a distance of about 12 inches. If he cannot do this, but only perhaps decipher Nos. 4 or 6, or if he is obliged to hold the object very near his eye (nearer than is warranted by its size), he is not only far-sighted, but also amblyopic. It may therefore be laid down as a practical rule that the nearer we can approximate, by means of convex glasses, the vision and range of accommodation of a presbyopic eye to that of a normal one, the less is the impairment of sight due to amblyopia, and *vice versâ*.

"Donders has found that in the normal (emmetropic) eye the near point gradually recedes, even from an early age, further and further from the eye; and that, in consequence of this, vision for very minute objects becomes proportionately more and more difficult. This recession of the near point commences already about the tenth year, and progresses regularly with increasing age. At forty, it lies at about eight inches from the eye; at fifty, at eleven or twelve inches; and so on. In the normal eye, no inconvenience or annoyance is experienced from this recession till about the age of forty or forty-five. This change in the position of the near point is met with in all eyes—the emmetropic, the hypermetropic, and the myopic (if the latter remains healthy).

"There can be no question as to the advisability and necessity of affording far-sighted persons the use of spectacles. They should be furnished with them as soon as they are in the slightest degree annoyed or inconvenienced by the presbyopia. Some medical men think that presbyopic patients should do without spectacles as long as possible, for fear the eye should, even at an early period, get so used to them as soon to find them indispensable. This is, however, an error; for if such persons are permitted to work without glasses, we observe that the presbyopia soon increases.

"The proper glasses for the presbyopic may be readily calculated. A convex glass of sixteen inches focus will bring the near point back again to eight inches from the eye. We must generally, however, give somewhat weaker glasses; because, on account of the greater convergence of the optic axes, the near point will, through these glasses (convex 16), be in reality brought nearer than eight inches. Late in life, when there is some diminution in vision, Donders thinks that the near point should sometimes be brought even to six or seven inches, and that it should be brought the nearer, the greater the range of accommodation.

"He further thinks that when no hypermetropia exists, the weakest glasses with which No. 1 of the type-tests can be distinctly and easily read at about twelve inches distance, may generally be given.

"In choosing spectacles for far-sighted persons, we must also be particularly guided by the range of their power of accommodation. If this is good, we may give them glasses which bring their near point to eight inches; but if it is much diminished, weaker glasses should be chosen, so that it may lie at ten or twelve inches from the eye.

"It must be borne in mind that a very rapid increase of presbyopia is one of the premonitory symptoms of glaucoma. If, therefore, a patient tells us that his far-sightedness has rapidly increased within a few months, so that he has had repeatedly to change his spectacles during that time for stronger and stronger ones, our suspicions should be aroused, and we should without fail examine him as to the presence of other premonitory symptoms of glaucoma,—*e. g.* rainbows around the candle, periodical obscurations, &c. Von Gräfe thinks that this rapid increase of presbyopia is most likely due to an increase of intra-ocular presssure."*

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* S. Wells, 'Medical Times and Gazette,' 1861.

CHAPTER IV.

OBJECTIVE AND SUBJECTIVE EXAMINATION OF THE EYE. OPHTHALMOSCOPIC APPEARANCES IN HEALTH. OPHTHALMOSCOPIC APPEARANCES IN DISEASE.

In all investigations connected with diseased conditions of the eye, as in other parts of the body, it is obvious that the evidence obtained is marked by two very different principles directing opinion: one depending upon the surgeon's sense of what he observes himself; the other on what the patient may choose to tell him. The terms objective and subjective, to describe symptoms so relatively distinguished, are here a convenient and suitable employment of these not unfrequently misapplied words. It may therefore be as well to state that I class all evidence as subjective which depends upon the patient's statements and the general history of the case; and on the other hand, all as objective which has resulted from direct examination, and for the value of which I depend upon my own judgment and experience.

The practical importance of some such distinction is evident; for whilst the objective is, or ought to be, positive knowledge, subjective evidence is apt to be very uncertain. Personal feeling, or local sensibility, is sometimes greatly exaggerated, or, on the other hand, depressed or altogether suspended, from circumstances of constitutional or diseased conditions in the individual; and it therefore requires to be especially remembered that investigations made with the view of ascertaining the sensibility of the eyes to external influences, have only a relative value, depending upon the state of the nervous system of the patient generally.

In its normal state, the conjunctiva is not very sensitive to an ordinary touch with the finger, whilst, on the contrary, to sudden or extreme changes of warmth or cold it proves extremely sensitive. If either be long continued, it invariably produces pain. Tears and nervous twitchings of the eyes are also readily excited by the extraordinary sensitiveness of the reflex functions of the nerve supply, which carries intelligence to the sensorium of the presence of some foreign or hostile body on the surface of this membrane. The direct sense of positive feeling is equally strong over its palpabral extension, as the two points of a pair of compasses scarcely the eighth of an inch apart are easily distinguishable; although, when applied to the tarsal margins, the points require to be carried considerably wider apart, even to the extent of eight or ten lines. The conjunctiva nearest to the inner and outer angle of the eye is very sensitive, and the points of the compass may be still more closely approximated, yet still produce a distinctly recognized impression. A corresponding sensibility to degrees of heat and cold also marks the several parts of this structure.

Very great importance attaches to the amount of tension of the coats, and in the globe of the eye, recognizable by the practised touch of an experienced surgeon. Considerable deviations from the normal state are observed to take place under different circumstances of disease. Inflammation is always accompanied with more or less hardness and tension, produced by an increased secretion of the humours, both aqueous and vitreous. On the other hand, these symptoms diminish with the progress of the inflammatory process; as when it passes into suppuration, or, more happily, disappears with corresponding reabsorption of the secretion in excess. But, besides increased fulness in the vessels, or of effused fluids within the eye, owing to idiopathic disease, or resulting from accident, a multitude of symptomatic, otherwise sympathetic, causes arise to interfere with normal functions and produce a similar turgid condition, or the reverse, in the globe—an observation which is intended to include all the different forms and degrees of distension due to what is described, in general, but very vague terms, as glaucomatous tension.

It is most essential, therefore, whenever the eye in disease appears to be of an abnormal fulness, that the degree of tension and hardness should be immediately ascertained, and a careful examination made, firstly of the state of the sclerotic coat, its colour, together with the degree of perception of light; the activity and appearance of the iris should then be observed, and, as far as possible, of the ciliary vessels, which, in every internal disease of the eye, materially affect the circulation, by interfering with the collateral supply of blood, and are the most probable seat of the disturbance, or otherwise its active cause. The advocates for iridectomy, indeed, seem to rely chiefly on the direct reduction of this influence for the success of the operation; as they allege that the excision of a vascular portion of the iris diminishes the secreting surface of the distending fluid.

The mode of examination by pressure of the fingers requires that the patient should close his eyes as if asleep. Both forefingers should then be applied upon the upper lids, pressing a little upon them at the same time. Being satisfied in this way that augmented tension does exist—to estimate the degree, it is necessary to place the forefinger of one hand upon the inner or nasal side of the globe, and the other forefinger upon the outer side; then gently compressing with one finger whilst the eye is steadied by the other, two or three times repeated, and alternately from side to side, a sufficient estimate of any undue hardness or tension is thus easily obtained. A comparison of the condition of the two eyes, made in the same manner, is always a useful proceeding.

A further objective examination of the conjunctiva, and the general appearance of the external coats of the eye, will also aid us considerably in forming an opinion of the extent of the mischief. In this investigation, I request the patient to open the eye as wide as possible, and to look at me full in the face. The upper lid is then raised by placing the hand on the forehead and drawing it upwards with the thumb, whilst the lower can be retracted downwards and pressed by the other hand upon the malar bone. This is also the simplest and best way of exposing the palpebral surface of the conjunctiva for the extraction of a foreign body. Children are generally very troublesome; and when photophobia is present, it is difficult to induce them even to open the eye. In such cases, there is no course, other than that of physical force, but to wait and try the effect of half-grain doses of antimony to subdue the intolerance of light. And in examinations of this kind, where inflammation is present, it is as well to know that, besides the usual distinction between the parallel lines that mark increased vascularity of the sclerotic from the irregular tortuous arrangement observed in a similarly affected conjunctiva, the colour of the former communicates a tinge of purplish crimson to the otherwise brick-red hue of the latter.

When photophobia exists, the objective examination of the eye is sometimes very difficult. In such a case, the patient must be placed with his back to the light, or a fitting shade be employed. In this way rays of light may be thrown into the eye from above, and opportunity thus afforded to determine the character of the disease. In patients afflicted with cataract, where a suspicion exists that it is associated with disease of the retina, a strong light should be thrown into the eye with a lens or plane mirror; and if no effect of its presence is produced, we may justly conclude the retina is insensible, and that an operation would be of no avail.

It is useful also to note the amount of subjective light which results to the patient from pressure of the finger upon the eyeball. In general, the circle of light, when produced, is of a perfect form; and it has been observed that spasmodic contractions of the muscles of the eye give a similar phenomenon. Also the blood which circulates in the retina and choroid may, when rapidly increased in quantity, be made more apparent by mere pressure of the finger; and it often occurs spontaneously after some violent mental and bodily excitement, or on partaking of an immoderate quantity of spirit or narcotic, or by coughing, sneezing, vomiting, &c.; indeed, by every cause that produces a rapid flow of blood to the head. Such phenomena of light and colour are brighter and more intense when the eyes are closed, and in a darkened room; because, in this instance, light and colour produced by pressure are increased by obscuring, or shutting out, the other parts of the field of vision. For the same reason, fever patients frequently see ocular spectra in the dim light, or when the eyes are closed. This phenomenon may be made of some diagnostic value, in cases of closed pupil, or certain kinds of cataract, to determine whether the retina is still active. If equal pressure be made upon the globe, and no light or circles of fire appear to the mental vision of the patient, then the sensibility of the retina is certainly lost, and no operation could be expected to restore sight. With the same object in view, it has been proposed to employ electricity; but as the effect produced by this, will at the same time affect the brain, and excite a sensation of light there when the retina is already completely paralysed, this experiment must often mislead. Nevertheless, it may be often used as a remedial agent; and it is worthy of remark, as I have assured myself by direct experiment, that the form and colour produced differ, as we apply either the positive, or negative pole of the battery, to the closed eyelid.

If it be necessary to examine the condition of the lachrymal gland, an apparently more formidable manipulation of the eye is demanded. The upper lid is drawn as gently as possible from the globe; the extremity of the little finger is then inserted, with the nail laid next or upon the surface of the eye, and pressed obliquely upwards and outwards, when the substance of the gland will be immediately felt. In the healthy state, it appears to the touch like a smooth hard mass, about the size of a small bean. If it varies much in size, in figure, or in hardness, taken in connection with the history of the case, any such condition may be regarded as indicative of disease.

The iris, so prominently and actively engaged in vision, is always to be carefully examined objectively, whenever disease has invaded the globe. Its sensibility, mobility, size and shape, are all to be particularly noted, as affording not only evidence of its own normal or abnormal condition, but many indications of great value in determining that of other parts of the eye with which it is connected by a very characteristic nervous sympathy. Its natural movements, in fact, depend upon the health and integrity of the retina, and the translucency of the optic media.

Under ordinary circumstances, the healthy iris is perfectly circular, the pupillary diameter varying a great deal, even in health; in youth, it is observed to be larger than in adult age. During contraction, it always comes a little forward; but where there is exudation within the vitreous chamber, or any increase in the vitreous body, or in the capsule of the lens, it is pressed outwards very considerably. On the contrary, any corresponding diminution, as where the crystalline lens has been removed, the usually plane surface of the iris becomes concave.

The movements of the iris are all involuntary, and due to a reflex action, rather than to direct nervous sensibility. From this cause, contraction can be induced by irritation of sensitive nerves more or less distant, as is instanced in the application of cold to the pituitary membrane of the nose, or to the surface of the conjunctiva. And it would seem that this reflex action is regulated by the degree of excitement to which the retina is exposed; for the greater the power of the light, the more decided is the contraction of the pupil. The reverse condition corroborates this conclusion; for, in paralysis of the retina, though the action of the third pair of nerves is quite unimpaired, the pupil continues immoveably dilated under the most powerful irritation of light. In sleep, however, it must be observed, it is considerably diminished in size, even when amaurotic disease is present.

This reflex action is well illustrated by the sympathetic correspondence of the pupil of the protected eye with the movements experimentally excited in the other. It is also seen in cases of monocular amblyopia, where the pupil of the diseased eye may be made to contract and dilate with that of the healthy eye. By carefully watching this consentaneous and synchronous effect, we may often obtain some useful objective evidence. It is necessary, however, to take proper precautions; such as causing the patient to look at an object placed before him at the ordinary distance of distinct vision, so that nothing may impede the action of the light upon the retina, and thus unfairly interfere with the reflex movement of the iris. First one eye should be opened and examined, then the other, afterwards both together—each time noting the condition of the pupils. If found to move uniformly, it is a proof at least that there is no paralysis of the motor nerves of the iris; though, as before mentioned, there may be present complete insensibility of the retina in one eye. Again—if, when opening alternately one eye and then the other, we find that, whilst one is shut, the exposed pupil is immoveable or fixed, it is evident that the retina of this eye is paralysed or insensible.

Somewhat the same means may be taken to ascertain the condition of the ciliary nerves, and whether their paralysis is co-existent with that of the retina. The change of accommodation of vision for near or for distant sight is indicated by a corresponding movement in the iris: the pupil contracts when a near object is examined, and dilates when looking at another far off. Holding up a finger, therefore, before one eye whilst the other is closed, and bringing it gradually nearer, the changes produced in the size of the pupil examined, give a tolerably accurate account of the powers of its presiding motor nerves. If neither dilatation nor contraction take place, the inference of paralysis may still, however, be wrong, and the examination should therefore extend to the form and condition of the pupil, to ascertain whether it retains its circular appearance, or is somewhat irregular in outline. In the latter case, its immoveability may arise from adhesions around its margin, amounting to mechanical obstruction; for when the iris is attacked by inflammation, the exuded blood plasma rapidly changes colour, and cobweb-like fibrillæ are thrown out, securing, as it were, the muscular fibres together, and filling up the interstices ordinarily observed. As atrophy of the iris also sometimes supervenes, in consequence of the absorption of the proper tissue and the substitution of an adventitious material, of course immobility may be accounted for in this manner. In making examinations in cases of *synechia*, it is always necessary to use atropine or belladonna: should any dilatation take place, it shows there is only partial obstruction from the adhesions.

The iris, however, may be perfectly regular in form, yet spasmodically contracted, the result of cerebral irritation; as when it follows the early stages of poisoning by opium, or in severe cases of *tabes dorsalis.* It has also been observed attendant upon the presence of tumors in the cervical region, pressing upon the cervical branch of the sympathetic. On the other hand, an equally fixed and dilated pupil is a common indication of some organic disease in the brain. It is present also when extreme intra-ocular pressure seems to paralyse the retina; and under some circumstances of spinal disease, due, it is supposed, to irritation of the great sympathetic, extending to the cervical ganglion, filaments from which preside over the dilatation of the pupil. A sluggish or inactive state of the pupil is always to be considered as measuring corresponding degrees of irritation in these so derived nerves, and should always excite suspicion of some generally disturbing influence in the system.

The objective examination of the iris is not complete without noting its colour, the appearance of its vessels, their normal or abnormal condition, and whether any difference is observed in the two eyes. In inflammation, the colour of the iris immediately changes: a blue iris becomes green; a grey one, sometimes a light green; a dark brown assumes a reddish-brown tint; and a light brown, a yellowish-brown.

These shades are also modified according to the seat of the inflammatory action; for, if deeply situated, the pupillary margin presents a darker hue; if more superficial, the effusion upon which the change of colour depends is of a paler character, and spreads itself uniformly as a thin coat of colour all over the iris.

In health, the comparatively thick walls and the pigment beneath effectually conceal the blood-vessels of the iris; but when examined with a magnifying glass, they are plainly discernible, appearing like fine white threads. Should *hyperæmia* occur, the fibrous wall dilates, and the blood-vessels may then be readily seen at the pupillary margin, as a zone of delicate fringe, no doubt connected in some way with that peculiar retiform arrangement of the muscular fibres of the iris that form its pupillary margin. Not unfrequently we see a single vessel branching out over the anterior surface of the iris, and expanding into a close network of capillaries around its ciliary margin. In some congenital and abnormal states of the eye, a peculiar oscillating or undulatory movement of the iris may be observed, which is generally due to some disorganization in the vitreous humour, as in *synchysis*. It also accompanies dislocation of the lens, and consequent loss of its suspensory ligament.

As a practical point, and one of some interest, I would call attention to the changes which take place in the iris during the inhalation of chloroform. In the first stage, whilst the pulse rises, and the muscular system is excited to rigidity, the pupil contracts; as insensibility gradually becomes more profound, although the pulse then sinks and the muscles relax, the pupil still continues contracted, as in deep sleep, gradually dilating again as consciousness is restored.

In examinations of the iris, the convex lens may be employed, and the light should come from a window, so as to fall over the patient's nose. The surgeon, standing on the same side as that of the eye affected, then raises the upper lid with the thumb, and holds the lens between the index and second finger of his left hand, whilst the right is employed in depressing the lower lid.

The specific action of belladonna upon the iris, and the use made of it to dilate the pupil previously to an examination of the internal eye with the ophthalmoscope, require a few remarks from me; for, although the advantages to be derived are incontestable, the evils sometimes ensuing from its incautious employment should not be allowed to pass unnoticed. I have frequently seen a drop of a very weak solution of atropine produce, in the healthy eye, a very large amount of congestion in the capillary vessels, more than sufficient to deceive the practised eye of the surgeon, and which might well be mistaken for a diseased condition. For some time, therefore, my practice has been tending towards its discontinuance as a general application; and I have found that, in a vast number of cases, simply allowing patients to remain for a short time in a room somewhat duller than the light of the day, has been sufficient to cause all necessary dilatation of the pupil. Besides, it is well that practitioners should be aware that, to act, the atropine must be absorbed; and it then exerts a paralysing effect upon the nerves distributed to the iris, as well as on the ciliary muscle; and the consequence is, the power of accommodation remains seriously affected for several days, and patients are very apt to complain of the annoyance. If, also, the sight from this time should become worse, the great probability is, that the surgeon will be blamed, as having caused some aggravation of the disease.

To account for the dilatation of the pupil by the action of the salts of belladonna, very many experimental investigations have been made to discover the particular nervous track of the specific effect produced. Accordingly, Dr. E. Waller, with Professor Budge, have made experiments which seem to prove that the nerve fibres of the cervical sympathetic which go to the iris originate from the spinal cord, between the sixth cervical and the fourth dorsal vertebræ. And Dr. Brown Séquard has also ascertained that the origin of the fibres of the sympathetic going to the iris are still more extended. He has shown that section of the spinal cord, as high as the level of the fifth cervical, or as low as the ninth or tenth dorsal vertebra, allows the uncontrolled third cerebral nerve to contract the iris. In agreement with Biffi, Cramer, and Ruiter, Budge found that, after section of the sympathetic in the neck, and even after extirpation of the superior cervical ganglion, belladonna still exerts its dilating influence on the pupil, though in a less degree. Dr. Harley noticed that, after section of the sympathetic in the neck, by continuing the application of the atropia, the pupil becomes at last fully dilated.

"If belladonna acted merely by paralysing the sphincter, we could not have such a result as this; seeing that the dilator, already so completely paralysed by section of its nerve, would not be in a condition to act spontaneously on the cessation of the antagonism of the sphincter. The result, however, is consistent with the opinion that belladonna excites the dilator pupillæ, if we admit that the drug comes by absorption to act on that muscle. The result is also not inconsistent with the supposition that belladonna acts both by paralysing the sphincter and exciting the dilator. Budge has cut both the oculo-motor nerve and the sympathetic; nay, more—he has cut all the ciliary nerves, together with the optic; and still found the pupil to dilate distinctly under the influence of atropia. This result is entirely consistent with the opinion that belladonna acts both by paralysing the sphincter and exciting the dilator pupillæ." *

To reconcile conclusions so opposite appears impossible. The natural inference is, that, in whatever way belladonna acts in dilating the pupil, it is not through a medium so indifferently affected by the most serious lesions as are, evidently, the motor communicants of the iris with the brain and spinal column. It seems to me far more analogical to surmise that it is the nerve of sensation itself which becomes partially paralysed by the absorption of the active principle of the belladonna, and, in consequence, is less sensible to

* Professor Wharton Jones.—'Medico-Chirurgical Review.'

the stimulus of light; an effect of surrounding darkness is produced, and the then comparatively uninfluenced ciliary nerves of the iris dilate the pupil in accordance with their natural function. In the face of Budge's crucial experiment, where every motor and sensitive nerve connected with the economy of vision was divided, we must rather conclude that such is the case, or that the contraction of the muscular fibres of the iris is a power *per se*, to the proper exercise of which, belladonna is specifically antagonistic.

Experiments in another direction have also proceeded on observations made of the presumed conflicting action of opium and belladonna; but little more has been proved, in my opinion, than what was previously well known to the profession. The fact that opium and morphia produce contraction of the pupil has always been remarked as the ordinary symptom of their therapeutic operation upon the brain, producing spasmodic constriction of a muscular sphincter, and as if in immediate subjection to an over-sensitive retina, impatient of light; the reverse, in fact, of the condition of the optic nerve when affected by belladonna. To some extent, the specific effect of this latter, mydriatic, might counteract the local symptom produced by opium, without, however, having the slightest influence upon the primary remote cause of irritation on the brain, and would be a very empirical proceeding. Strong coffee would have a much more legitimate effect. But truly the investigation promises no practical benefit in ophthalmic disease; and it is a question with me, whether the decided improvement in some forms of ophthalmia, due to the specific action of opium, reducing local spasm by diminishing the sensibility of the vessels affected, be not really analogous to that which influences the motions of the iris after the application of belladonna?

Ophthalmoscopic Appearances of Healthy Structures.

In examinations with the ophthalmoscope, the direction of the rays of light passing from the concave surface of the mirror into the eye of the patient, though most important for the purposes of illumination, do not concern us so much as the reflected rays coming back from the fundus oculi, and which describe the images of their object source on the retina of the observer. The theory is, that the fundus sends back from each illuminated point a divergent cone of rays, which pass out at the same angles of refraction, and in the same plane of reflection to that in which they entered the eye, presenting an exact picture of its condition and appearance when examined with the ophthalmoscope.

The fundus of a healthy eye is generally described as of a warm orange or pinkish red colour, owing to the rays of light being chiefly reflected from vascular tissues, more particularly from the capillary vessels of the choroid. The colour, however, varies sometimes from perfectly natural causes, such as the quantity of choroidal pigment, or the greater transparency of the retina. If, also, the latter is well illuminated, or when the focus falls exactly upon it, it may be perceived as extending of a light grey or blueish grey over the bright choroid beneath. If, therefore, with normal vision the retina appears somewhat opaque or cloudy, it must not be considered due to a pathological change in structure, but to some constitutional peculiarity, producing a physiological phenomenon.

The bright red of the choroid coat is also modified by the amount of pigment; where it is less than usual, the lighter is the colour, and the brighter and warmer is the red; where it is more, it imparts a yellowish red or brownish tint to the whole of the internal eye. It is to be observed also, that the pigmental colour of the iris is some guide; for we find that with a brown iris the fundus is of a darker red and more florid than when it is blue. In young persons also, and in the delicately pale, the fundus will be found of a brighter and more vivid red than in older and more robust persons. "If we trace the course of the light sent from the ophthalmoscope after it has passed through the refracting media, it must be observed that it first meets with the retina, which, being smooth and transparent, reflects but little light, either regularly or irregularly, when the light falls nearly horizontally on its surface, as it must of necessity do. It next reaches the layer of hexagonal pigment-cells, covering the choroid internally, when a considerable proportion is absorbed, some is transmitted, and a good deal seems to be reflected. The transmitted light arrives at the choroidal vessels in the next place, and some is reflected, some transmitted, and some absorbed. The pigment in the interstices between them will, if strongly developed, absorb most of the light which falls upon it; but some may be transmitted through both it and the vessels and the sclerotic, which has a great reflecting power. The light returning from these more deeply-seated parts suffers loss from absorption in passing again through the more superficial ones; and it is also dispersed by them in such a way that it rather tends to affect the colour of the latter and the apparent brilliancy of the image which we see, than to give us a definite perception of the form and colour of the objects from which it is reflected. The less strongly developed the superficial pigment is, the less absorption and dispersion will take place."*

Considerable discussion has taken place as to the different influences exerted upon light by the several membranes which enter into the structure of the fundus oculi. Rather, however, than engage in any such unsatisfactory inquiry, I have preferred to give the above quotation from the writings of one who has studied the subject. To return to the appearance of the fundus in the ophthalmoscope—in the centre of the observer's field of vision, looking somewhat downwards and inwards, is seen the optic nerve entrance, its colour being slightly or greyish white, and nearly circular in shape. Sometimes, however, it approaches an oval form, and may have even an irregular outline. The arteria centralis retina, with its accompanying vein, pierces the optic nerve and enters the globe through the porus opticus. It immediately divides into four or five branches, which at first run between the hyaloid

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* Rainy, op. cit.

membrane and the nervous layer of the retina, then entering the latter membrane, forms a close capillary network in its substance; at the ora serrata, terminating in a single vessel which bounds the margin of the retina. The veins which begin at the ora serrata by an incomplete circle, run with their trunks parallel to the arteries, and collect in the vena centralis which leaves the eye by the side of the artery. Of the two principal arterial branches, with their corresponding veins, one pair runs upwards and outwards, the other downwards and outwards, surrounding in their course the macula lutea, yellow spot of Soemmering, which is free from all but capillary vessels. We sometimes find a considerable deviation in their distribution; but at all times the arteries may be easily distinguished by their brighter colour and more defined outline, which is attributable to the greater reflecting power of the arterial coats. The observer will also frequently see, indeed may always, by a slight adjustment of the lens, the pigmental interspaces between the choroidal vessels, appearing like stripes of a dusky brown colour. They are most easily seen at the circumference of the fundus oculi, and in the eyes of persons of fair complexion.*

The facility afforded by the ophthalmoscope to examine the appearances of the fundus oculi is well illustrated in the instance of the visible pulse in the blood-vessels of the optic disc. The interest of the phenomena is also greatly increased by being sometimes observed in both the arteries and the veins; but, as far as I am able to judge, only exceptionally and under conditions of an abnormal character. Coccius remarks that he could only observe it where some interference took place in the intra-orbital circulation, such as may be produced by pressing the eyeball with the finger; and his explanation is evidently based upon the circumstance. "The retina is placed within a closed elastic capsule. When moved by the heart's systole, and consequently at the general diastole of all the arteries entering the globe, a pressure is

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* See fig. 1, coloured plate.

exerted upon the ocular capsule. The sum of this pressure must show itself chiefly in those places which soonest yield to the pressure; and inasmuch as these (the sooner yielding parts) are the vessels which convey away the blood—the veins—an increasing pressure must be exerted upon them during the common diastole of all the arteries which enter the globe; and consequently they must be narrowed, and made to empty the blood more quickly." On this subject, however, as usual, the curious spirit of controversy, and conflicting views, that characterize all German observations, quite obscure the facts. Immediately on the expression of this opinion by Coccius, it was opposed by a new observer, Dr. Ed. Jäger, whose investigations were duly rewarded by the discovery of an arterial pulse, which had not been noticed previously. He considered that the idea of the blood being extruded from the veins with a laborious effort, by the additional external pressure beyond that of the ordinary arterial diastole, gives rise to this extraordinary pulse,—is opposed to the fact that the veins empty their blood in a retrograde course from the centre towards the circumference of the optic disc, and refill, of course, in the opposite direction. And, besides, Jäger insists upon a rising and falling movement being clearly seen, distinct from the pulse, in that part of the vein which lies perpendicular to the optic disc—a phenomenon, which, at all events, I think may be fairly attributed to the increased tension and the consequent cumulative efforts of all the vessels of the eyeball to assist in overcoming the difficulty, and relieving an oppressed and laboured circulation. We find, again, that Von Gräfe questions the correctness of Jäger's observations, especially with regard to the visible blood movement, which the latter would restrict to those veins imbedded in the nerve substance, or which are spread over the inner surface of the optic disc. Von Gräfe considers the pulse is confined to veins which are completely enclosed in the nerve tissue; and Donders, an excellent authority, has corroborated this, by showing, in actual sections, that even the larger vessels projected on the surface of the optic disc are covered by a delicate layer of nerve fibres.

Amidst all the discussion, however, that has arisen with regard to this matter, a useful practical conclusion may be drawn from the circumstance, that, in this pulsation of the veins and arteries of the eyeball, we have a very delicate metre of inter-ocular pressure, when produced by some internal abnormal cause, and the presence of which, without such evidence, might be unsuspected and readily overlooked. A natural effort of this kind, endeavouring to overcome simple congestion in many of the tissues, is no doubt sufficient to produce this visible movement; and accordingly it admits, by degrees of perceptibility, of being made some criterion to judge of the success or otherwise of any externally applied means of relief. I must confess to be far from satisfied with the explanations offered by the several German writers upon the subject to account for the phenomenon. The presence of pulsation in the veins I consider to be due entirely to the communicated movements from the closely associated arteries; and the observation of Coccius, correcting Von Trigt on this point, confirms my view; as he clearly proves that the arterial systole is synchronous with the venous diastole, exhibiting no difference from the ordinary appearance of the general circulation; which must be inferred, however, if an independent pulsatory movement be ascribed to the veins of the optic disc. The circumstance of the venous pulsation being discovered by Von Trigt some time previously to the arterial, and its very questionable existence at all, except when produced abnormally, or as a symptom of actual disease, suggests its probable dependance upon the very natural cause I have pointed out, and which is sufficient, without resort to any theory, to account for this interesting phenomenon in the pathology of eye-disease.

Before an estimate can be formed of the pathological changes revealed by the ophthalmoscope, it must be evident that the normal picture presented by the back-ground of the eye demands careful study; and the part borne by the different membranes in the production of this picture ought to be made the subject of particular consideration. Great difficulty will at first be experienced, especially in the appreciation of a depression or a prominence, which depends in part on the alterations produced in the light and shade of inverted images, when a convex lens is used with the perforated mirror. In the examination of objects lying behind the crystalline lens, it must also be borne in mind that we are looking through that body, and consequently what is seen is magnified very considerably. Then, again, by using a magnifying-glass to examine the changes in the retina, or increase the illumination in the interior of the eye, allowance must be made for differences of intensity, as well as the size of the picture presented.

Before we pass on to other investigations and considerations, we must in all cases bear in mind :—

1st. That the crystalline lens reverses the parts on the concavity round the entrance of the optic nerve (placing the yellow spot on the nasal side, &c.). 2nd. That only a limited space round the optic nerve (its radius not extending so far as the yellow spot) is open to accurate examination; and that the choroid forms one uninterrupted red field. 3rd. That the yellow spot is nearest that part of the optic nerve entrance freest from vessels, and which admits of the greatest number of optic nerve fibres being seen.

General Principles upon which to distinguish the Seat of Morbid Changes in the internal Eye.

A FEW preliminary observations upon the morbid changes that take place in the inter-ocular media and tissues will be very useful, for the purpose of preparing the student for those deviations from the normal condition he is most likely to meet with in examinations with the ophthalmoscope, and which must be duly considered and allowed for. Turbidity of the humours, for instance, in various diseased states of the eye, besides obscuring a view of the fundus, may considerably impair the transparency of the retina. On the other hand, some changes of an inflammatory nature much increase its reflecting power, thereby producing only a slight misty indistinctness in the appearances.

The optic nerve entrance piercing the choroid or vascular coat of the eye may be very considerably affected by disease, with very little apparent change appearing on its disc. One condition of the papilla optica produces a singular effect, owing, no doubt, to some parts reflecting more light than others, and which Liebreich points out as being due to a distribution of lights and shadows, as in the representation of a well-executed sphere on a plane surface; so that, although the papilla does not normally present a globular form, in the ophthalmoscope it sometimes appears to do so. In glaucoma, where the optic nerve entrance is cupped or excavated, when examined with a convex lens this appearance becomes very striking; for another optical illusion, depending upon the complete inversion of the image, so alters its natural character, that it appears as a raised, instead of a depressed, surface.

"The most important optical deception," writes Dr. Mackenzie,* "which arises from viewing the fundus in the indirect method, as well as the most puzzling to a beginner, affects the papilla. The student has probably heard that the papilla, in the glaucomatous eye, is cupped or excavated; but to his view it appears quite the reverse. It appears rounded and prominent.

"To comprehend clearly that this is an illusion, all that

* O. H. Reports, April 1860. I gladly make this quotation from the published writings of the Nestor of Eye-Surgery; because I well remember the effect a letter of his produced on the Fellows of the Medical Society of London, before whom I brought my first paper on the Value of the Ophthalmoscope. Mr. Haynes Walton, having exhausted his own arguments against the use of the instrument, took from his pocket a letter from Dr. Mackenzie, which appeared to support his view of the question. I am therefore particularly gratified to find Dr. Mackenzie bearing testimony to the great value of this instrument.

one requires to do, is to impress, with the head of a pin, a small dimple on a bit of paper, and put this under a compound microscope, with the concave side of the impression uppermost. The same appearance will then be seen, which is presented by the papilla of the glaucomatous eye—namely, that of a rounded and protuberant surface.

"This optical deception arises from the inversion which the image suffers from being viewed through the compound microscope. We judge that an object, viewed with a single eye, is convex or concave, solely by the manner in which light is reflected from the body under examination. The light which falls obliquely on a convex surface illuminates that side which is nearer to the source of light; the side farther from it is in shade. The light which falls obliquely on a concave surface illuminates that side which is farther from the source of light; the side nearer it is in shade. Let the source of light remain in the same position, but invert the image of the object illuminated, so that the light which falls on the farther side of it may seem to fall on the near side, which is the case when we look through the compound microscope at the hollow on a bit of paper, or when we examine the optic papilla through the compound microscope formed for the occasion by the patient's eye, *plus* the convex lens held in front of it; and both the dimple on the paper and the papilla, although they are actually cupped or concave, will then appear convex and prominent.

"If, on the other hand, we turn the convex side of the dimple on the paper uppermost, and view it with the compound microscope, it appears concave. The inversion of its image causes the light which falls on its near side to appear as if it fell on its farther side, and thus the eye is subjected to a deception the reverse of the former, and from which it cannot free itself. If there be cases, then, in which the end of the optic nerve within the eye actually projects in a convex form, they will offer, when examined in the indirect method, the appearance of a cup or depression.

"Such facts have long been familiarly known; the apparent transmutation of an intaglio into a cameo, or that of a cameo into an intaglio, under the compound microscope, being a common source of amusement, fully discussed by Sir David Brewster, in his 'Letters on Natural Magic, Letter V.' Important as their bearing is on pathological examinations of the eye, they seem to have escaped the notice of ophthalmoscopists, till attention was directed to the subject by Dr. A. Weber, in a paper in the 'Archiv für Ophthalmologie,' Band II, Abtheilung I, Seite 141."

In a highly interesting communication in the same journal (Band IV, Abtheilung II, Seite I), Dr. H. Müller has directed attention to the normal, as well as to several diseased, states of the optic papilla.

"His account of the entrance of the optic nerve into the eye, and the diagram which he gives in illustration, accord remarkably with the thirteenth figure in Mr. Bowman's 'Lectures,' and the corresponding explanation. From the statement and figures of these two observers, especially those of Dr. Müller, it may be gathered that the lamina cribrosa is normally somewhat concave towards the interior of the eye; that the fibres of the optic nerve, suddenly losing their white substance and dark outline, enter the eye on a level with the chorio-capillaris; that at this point the whole nerve, from the change which its fibres have just undergone, is considerably and rather suddenly reduced in thickness; that the fibres, bending more or less abruptly outwards, and spreading around, become clothed by the exterior or radially disposed layers of the retina; that the edge of the opening through which the nerve passes into the eye, as well as the fibres themselves as they traverse that edge, form a slight elevation or approach to a papilla, leaving in the situation where the trunks of the central vessels of the retina generally make their appearance, a small foveola.

"Dr. Müller points out the difficulties which attend the anatomical examination of this depression, arising from the softness of the part, and its liability to change on being touched; and shows how these difficulties may best be obviated. He directs attention to the varieties which exist in different individuals; varieties in the depth of the depression, from 0·2 to 0·5 millimetre; varieties in its form and position, for it is not always symmetrical, and does not always correspond to the middle of the nerve, but is sometimes considerably nearer to the macula lutea, or has one portion of its edge more raised than the rest; varieties in the disposition of the vessels, for while the large trunks generally emerge from the middle of the foveola, one or more sometimes seek a passage for themselves close to the edge of the chorio-capillaris, so as to make their appearance by the side of the nerve; facts, all of which should be carefully borne in mind by ophthalmoscopists.

"In regard to abnormal prominence of the papilla, Dr. Müller shows that this is likely to arise from an atrophied state of the exterior layers of the retina, a thickened condition of the primitive nervous fibres, as well as infiltration of the nerves by blood, inflammatory exudation, or new formations. He relates a case in which a concretion in the site of the lamina cribrosa caused a protuberance of the papilla. The very earliest stage of encephaloid tumour should show an abnormal prominence of the papilla.

"On the other hand, intra-ocular pressure, and atrophy of the nerve, existing either singly or in combination, are the causes of abnormal excavation of the papilla.

"Morbid excavation of the papilla varies in depth, reaching, in extreme cases, to a millimetre beyond the level of the choroid. In such cases, the sides of the excavation are nearly perpendicular, or are even concave, and its edge, of course, impendent, so as partially, or even completely, to hide from view the course of the vessels as they pass from the bottom of the excavation and over its edge to the retina. In slight cases, the sides of the excavation are convex, and its form that of a funnel. The lamina cribrosa, under such circumstances, keeps its place; but in more advanced stages, it is pushed back, and the excavation is much extended laterally. Such extreme cases of expansion are not the result of uncombined atrophy of the nerve, but must arise from the supporting resistance of the parts being weakened by previous inflammation, whence they come to yield more readily to intra-ocular pressure."

It should be kept in mind that the colour of even the normal papilla varies very considerably, being in some persons of a more pinkish hue, than in others, where it resembles a grey cerebral substance. In several diseases, its vascularity is much increased, and small vessels, not perceptible on its usual pale ground, now come into view.

In cases of congenital insensibility of the retina, the surface presents a greyish-white appearance, and in certain cases an entire absence of blood-vessels has been discovered. The gradual disappearance of the capillary branches of the retinal artery, especially on the inner side of the papilla, has been noticed, as marking the progress of a gradual loss of sight, dependant upon cerebral disorganization. An anæmic or blanched condition (white atrophy) of this membrane is a very noticeable symptom of disease.

Patches of serous exudation, the result of congestion, situated beneath the retina, are recognized by a bluish-white tint, sometimes scarcely perceptible, whilst in others it is very decidedly so; and even vessels of new formation occur, the original ones being destroyed and lost. Some parts of the discoloured portions will appear almost or quite dark, owing to the light reflected not entering the eye of the observer.

Any opacity in the crystalline lens, or other of the refractive media, with diminished power in the optic nerve, manifests itself with varying intensity. Sometimes the opacity is generally diffused, with thickening of the capsule; or it may exhibit well-defined dark masses distributed throughout it; and in others, fine delicate bands of fibrous material appear, adherent to the pupillary margin of the iris. In such cases, the bright yellowish red, or deep rose tint, of the choroid is lost; and its colour, if seen at all, will be a hazy brown; but as the disease progresses, it becomes at length quite indistinct.

If the transparency of the refractive media is only slightly impaired, the light reflected from the mirror will seem to move behind the nebulous opacity; and if the pupil be fully dilated, and the light thrown in obliquely or laterally, with a biconvex lens, we can look as it were behind the opacity; and it will appear larger the nearer it is to the front of the eye. If, on the contrary, a concave lens is used, the object appears smaller the more it lies in front, and more magnified as its situation approaches the fundus. With the lateral movement of the eye, the shadow of the nebula describes a succession of angles of parallax with the optical axis. Those immediately in this line only, appear to be fixed; but in all other situations they seem to move, as described, to the right or left of the line. Dark floating bodies, not unfrequently present in the vitreous body, may also be easily distinguished by this angular precession of their light shadows.

It is different with a more diffused opacity in the vitreous humour, which may be confounded with opacity in the retina, or with a myopic condition of the eye, where an image of the light falls before the retina and produces a shadow. In the former case, however, the retina appears more or less distinct, or the opacity in the vitreous humour more or less decided, as recourse is had to the double test of a convex or concave lens, alternately employed in the examination. If the retina be really the seat of the opacity, the optic nerve entrance appears as if covered with a cloud or veil, and the central vessels as if seen through this cloud. A greater number and a more congested condition of the capillaries will be plainly distinguishable, especially over and around the papilla. The tortuous course of these vessels, and of the vena vorticosa of the choroid, assist in determining the character and situation of these pathological changes.

With respect to opacities referrable to the media of the eye observed in the ophthalmoscope, the following general remarks will be found strictly applicable, and of very considerable diagnostic importance. " When we perceive opaque bodies situated in the media by means of light coming from the fundus oculi, they will appear black, whatever their real colour may be: thus, opacities in the lens, though they may appear grey, or even white, under ordinary circumstances, and contrasted with a black pupil, appear like black spots or streaks upon the illuminated fundus. We may, no doubt, see light reflected from the fundus oculi and light reflected from opaque bodies at the same time, and contrast will then determine, in a great measure, the appearances presented by the latter. Supposing an opacity in the lens to have a power of reflecting light falling almost perpendicularly upon it, equal to that of the fundus oculi, the former would appear dark, in comparison with the latter, if the illuminated area of the fundus were smaller than the area of the pupil; because the fundus would, in that case, be better illuminated than the opacity, and the observer would in general see each with nearly its proper brilliancy, provided the pupil of the observed eye were somewhat larger than his own."*

With regard to the opacities occurring in synchysis, or liquefaction of the vitreous humour, Gräfe has the following remarks: "Diffuse or punctuated opacities of the vitreous merely throw a thin veil over the picture of the retina, obscuring the sharp outline of the optic papilla and the retinal vessels. By more careful investigation, however, this veil will be found composed of a vast number of molecules, which are very difficult to discover, when they are situated, not in the same depth, but in different strata of the vitreous humour. In the first case, they constitute a finely sprinkled, semi-transparent membrane, which, alternately contracting and distending itself by dislocation of the component parts, moves like a net-work of delicate tissue before the background of the eye; if they are situated in different depths, the whole represents a fine dust or rain, which, during the movements of the eye, is often conglomerated into dense masses,

* Rainy. Op. cit.

and, on their cessation, sinks downwards either in an even mass, or in separate showers. The patients complain of a mist, shrouding external objects. These opacities disturb vision far more than larger but well-defined opacities, because in the latter case the intervening parts of the vitreous humour are perfectly transparent." The same obtains for diffuse, semi-opaque capacities of lens and cornea, where the Stenopæan spectacles of Donders have been found so valuable by preventing the diffusion of light on the retina. As to the larger and denser opacities, they occur either as filaments or flakes. Opacities in the vitreous humour are often caused by exudation of lymph, and Arlt and Gräfe describe cases where it was recognised by the ophthalmoscope anteriorly, proceeding, in all probability, from the ciliary processes.

To recapitulate somewhat:—In all examinations of the internal eye, the natural florid red reflection from the fundus may be affected by the transparency of the media, the constitutional colour of the retina, and the quantity of choroidal pigment. The bright red of the choroid is always modified by this latter circumstance; the less pigment, of course, the lighter and more vivid is its colour; on the contrary, a great amount imparts a yellowish or brownish red tinge. I must also remark here, that the pigmental colour of the iris is no guide to that of the choroid; for a brown iris is frequently associated with a fundus of a deeper and more vivid red than when it is blue. Age, too, makes considerable difference, as young and delicate constitutions have the fundus oculi of a much brighter and lighter hue than is found in older and more robust persons. It is also remarkable that the perfection of vision does not always accord with the apparent condition of the retina, as seen with the ophthalmoscope; for at times, when it appears somewhat opaque and cloudy, the vision is in a perfectly normal state. In such cases, no pathological change is to be inferred; as it evidently depends upon constitutional peculiarity, amounting, it may be, to a physiological phenomenon. On the other hand, we often see a considerable amount of disease occurring with tolerable good vision, or which is often much improved without any great apparent internal change; and the inference is, that the disturbance in vision depends upon pathological influences, or results, hidden as yet from knowledge, or only to be discovered by a microscopical minuteness of examination; to do which properly, we require an ophthalmoscope most carefully arranged, and with increased magnifying power.

Lastly, I wish to call attention to the fact, that we must not always look for outward signs of change in internal diseases of the eye. In most cases it is well known the external membranes are unaccompanied by redness, as in choroiditis, retinitis, and detachment of the retina: indeed, the latter membrane may be the seat of apoplexy, without the exterior of the eye showing in the least any increased vascularity. In keratitis, redness is frequently absent; hence we may deduce that increased vascularity of the eyeball has no diagnostic value but when taken in conjunction with the physiological signs of the inflammation of each membrane, and is generally in an inverse ratio to the intensity and danger of the disease, with the exception of traumatic lesions and phlegmon. If we glance at internal inflammation of the eye, we find that iritis, in its early stage, is unaccompanied with any very marked redness, and that amblyopia may be unsuspected at a time when vision is already partially destroyed.

CHAPTER V.

DISEASES OF THE CORNEA, LENS, VITREOUS BODY, RETINA, CHOROID, AND OPTIC NERVE.

Opacities of the Cornea. Nebula, Albugo, Leucoma, and Keratitis; Conical Cornea, Arcus Senilis.

THE cornea, as the most exposed portion of the outer tunic of the eye, is subject to numerous contingencies of accident and disease; opacities frequently arise, and these may be either superficial, confined to the conjunctival covering, or may invade its middle or proper structure; or, lastly, extend to the elastic lamina that forms its internal portion. The opportunity, however, of ready examination which the situation of the cornea affords, and the exactness with which objective symptoms may be examined and estimated, compensate somewhat for its unavoidable exposure.

The great point, in determining the character of an opacity of the cornea, is to discover its seat; and this can be done equally well by reflected as by transmitted light; that is, if the mirror, or ophthalmoscope, be used at all, it must be to throw light obliquely across the eye examined; for which purpose, it should be held slantingly on one side, whilst the observer in front of the patient examines the case, as under ordinary circumstances. In this manner objects are seen in their real situation as well as colour, and not as dark spots, or rather shadows upon the bright fundus. Sometimes it is necessary to concentrate the light still more, by collecting the rays of a lamp by a condensing lens, whilst a magnifying ocular lens is used in addition, to bring out the details of the opacity with clearness.

The slightest degree of opacity in any part of the cornea is called a *nebula*, and, as a class, it includes all spots that have a cloudy or hazy appearance; and sometimes the whole cornea may be involved in this condition. It sometimes indicates the pressure arising from an undue secretion of the aqueous humour, when its seat will probably be the elastic lamina. Deposit of lymph, however, upon the internal lining membrane of the cornea will produce this appearance. When it is the result of muco-purulent ophthalmia, the conjunctival covering will be chiefly affected; but lesion of the proper substance of the cornea, occasioned by scrofulous keratitis, produces much more serious forms of nebula. All are readily distinguished from opacities occurring in the vitreous body by the distinctness with which they are observed by oblique illumination; and being stationary, by their consistent adaptation to the movements of the eyeball.

Where the exuded lymph in process of disorganization has intensified the degree of opacity, and given to it a kind of pearly lustre, it is usual to call it *albugo*. This is observed to be more defined or circumscribed in its appearance than *nebula* in general, and is most frequently seated on the anterior surface of the elastic lamina.

It is usual to describe a third kind of opacity as *leucoma*, and which is simply the opaque cicatrice consequent upon ulceration of the cornea. The history of the case will generally lead to its exact diagnosis, and enable us to distinguish it from *albugo*, which, in cachectic habits, sometimes assumes appearances as if it depended upon solution of continuity in the cornea, and an actual loss of substance.

In all objective investigations of the eye, whenever inflammation of any tissue is present, a particular examination of the vessels around the edge of the cornea cannot be too much insisted upon. Although apparently little to be regarded as likely to be affected by inflammation, experience proves that it is in fact extremely liable, and is very apt to become involved when any of the neighbouring parts are so attacked. Direct injury too will frequently bring on *keratitis*, and it is one of the evils which sometimes arise, to interfere with the success of an operation for cataract. It is true, that in a healthy system there is little to fear; but still I could not acquit myself of proper care to those I am advising, did I not seek to impress the importance of avoiding, whenever possible, any application of the operating knife to the structure of the cornea. It is this consideration which chiefly recommends to my mind division of the ciliary muscle in all cases of inter-ocular pressure, an operation first devised by my friend and colleague, Mr. Hancock, for the relief of glaucoma, and to which I shall presently have occasion to refer more in detail.

Keratitis is generally first observed about the edge of the cornea, where the vessels derived from the sclerotic coat, and the expansion of the recti muscles, anastomose pretty freely with each other. An enlarging zone of these vessels in a congested state, extending for a line or so into the proper substance of the cornea, reveals the presence of this inflammation. Effusion takes place almost immediately; and in the matter thus thrown out, vessels are seen to spread themselves until the whole of the cornea assumes a pinkish red hue, and its transparency is in a great measure lost. A not unfrequent result is suppuration and ulceration. Keratitis is apt also to arise from the irregular thickening of the substance, and which seems to be connected with a disposition in the inflamed vessels to radiate with cumulative intensity towards the centre. This specific determination is also the cause of a cuticular ulceration, which indicates the commencement of a natural cure, and exhibits in the first place a white spot, surrounded by the dense inflammatory condition known as *pannus*, from its resemblance to red cloth.

Keratitis may always be diagnosed from other vascular obscurations of the cornea by the aid of a magnifying lens, when the apparently diffused ecchymosis resolves itself into a very definite and easily distinguished net-work of minute vessels.

Keratitis; opacity of cornea; cyclitis; intense pain and photophobia; operation, followed by almost immediate relief of pain and intolerance of light.—S. W——, aged twenty-one, admitted into the Royal Westminster Ophthalmic Hospital, 15th February, 1861. She first observed dimness of sight on the preceding Christmas day, whilst suffering from a severe cold and sore throat; two days afterwards, the right eye became inflamed, the disease subsequently attacking the left eye. She obtained medical advice, and finding no relief at the end of a fortnight, applied at the hospital; she then complained of intense pain, intolerance of light, and profuse lachrymation of hot, scalding tears. Upon examination, the sclerotic coat of each eye appeared of a pink colour, with a pink zone surrounding the cornea, which were speckled with nebulous spots; the corneæ were unusually reddened by the large blood-vessels straggling through them. Various remedies were prescribed; but she gradually got worse, until the 15th of February, when she could scarcely distinguish light from darkness. Corneæ quite opaque and conical, pain and intolerance of light most severe, and lachrymation profuse.

Feb. 18.—I divided the ciliary muscle in both eyes.

19.—Passed a good night, quite free from pain.

22.—Much better; still free from pain. When the pads were removed, she said that her sight was decidedly improved; and complained of the light being too strong.

25.—Still improving; can now bear the light well; quite free from pain.

She remained in the hospital for another week; before leaving, she was able to distinguish objects, and read No. 12 type-tests.

Keratitis.—J. M——, aged nineteen, was attacked, Oct. 1861, with severe inflammation in both eyes, accompanied by great pain, intolerance of light, and increased lachrymation. He became an in-patient at a general hospital for nearly three months, without deriving benefit, and on Jan. 24th, 1862, was admitted into the Royal Westminster Ophthalmic Hospital. His eyes then presented the usual appearance of long-standing keratitis. He had great pain, intolerance of light, and lachrymation; his vision was so much impaired that he was obliged to feel his way about.

Jan. 27th.—I divided the ciliary muscle in both eyes.

Feb. 14th.—Is much improved; the congestion of the sclerotica and conjunctiva nearly gone. He has had no pain since the operation, and he can now bear the light with comfort.

March 10th.—The corneæ are now nearly transparent, and his sight is much improved; able to read No. 12 type-tests with ease.

Double keratitis, with irido-cyclitis.—William L——, aged 17, admitted Oct. 16th, 1862. Three weeks before, caught a severe cold from an open window; next day found the right eye very painful, which on every subsequent day appeared worse, until he could scarcely distinguish day from night. The left eye was then becoming the subject of a similar attack, and he could only just find his way about when he was brought to the hospital. Both corneæ were highly vascular; photophobia and pain intense. Leeches, cupping, and various remedies had been previously tried, without benefit. On the 17th I divided the ciliary muscle in both eyes. Pads were applied as usual, and he was put to bed; an opiate to be given at bed-time.

18th.—Passed a good night; refreshed, and nearly free from pain.

19th.—Entirely free from pain; vascularity clearing off; with the right eye can distinguish the house-surgeon between his bed and the light of the window.

23rd.—Can count fingers with the left eye; rapidly improving.

27th.—Corneæ sufficiently clear to enable me to make out some slight adhesions in the pupil,; he was immediately put on a mild mercurial plan of treatment, with tonics.

On the 7th February, both corneæ quite clear, and able to read No. 8 type-tests; discharged.

I could transcribe from my note-book twenty similar cases, where medical treatment failed to afford any great amount of relief until division of the ciliary muscle had been resorted to; after which the patients made rapid recoveries, and, what is worthy of especial notice, without the too frequent *sequelæ* in such cases of granular lids.

In that peculiar form of interstitial keratitis, however, which has been so well described by Mr. Hutchinson, and which is so often seen at all the eye hospitals, there is no occasion to have recourse to any operation. I am perfectly in accord with him, that it is the direct consequence of a syphilitic taint, by descent, as it occurs most frequently in children, one or both of whose parents have suffered from the disease. In these cases, almost invariably, a peculiar characteristic has been observed; the upper central incisor teeth being notched and dwarfed in a very singular manner. A mild specific treatment therefore is indicated, and I have found this form of keratitis disappear before a generous diet, the system at the same time being supported by tonics and the use of iodides and cod-liver oil. Sometimes the cautious employment of mercurials is of great service.

Conical cornea is due to a bulging of the structure, from a thinning of its several coats, which alter and destroy the natural focus of the eye. The changes in the anatomical elements are chiefly confined to the laminated tissues; and the bulging of the cornea arises not so much from an increase of fluid producing intra-ocular pressure, as from a diminution in the power of resistance in the corneal substances.

The indications for the treatment of this disease are, to arrest the softening process, and diminish the internal pressure. Various kinds of treatment have been recommended, without more than the very slightest benefit resulting to the patient. Tapping, evacuating the contents of the anterior chamber, I formerly practised under the late Mr. Guthrie's direction, twice weekly for six months or more, without in the least checking the formation of the fluid, or lessening the conical state. More recently, however, myself and my colleagues have seen great success attend upon the division of the ciliary muscle in such cases; and, as far as we are able to form an opinion, permanent flattening has been the almost uniform result. Before and after the operation, it is our practice to improve the general system by tonics, which is indeed very commonly indicated by the symptoms present. The ophthalmoscope without the convex lens readily enables us to estimate the degree of conical cornea. The light must be thrown somewhat obliquely, when it will be seen to betray itself prominently by a luminous centre, surrounded by a circle of more or less contrasting shadow. In leucoma, staphyloma of the cornea, and sclerotica, division of the ciliary muscle has been attended with marked benefit.

Leucoma, produced by conical cornea, nearly total loss of sight.—W. L.——, admitted, April, 1860, with staphyloma of both eyes, and almost total loss of sight, the power of distinguishing light from darkness alone remaining. The cornea of the right eye was so prominent that he could not close his lids; it was white, opaque, and constricted at its junction with the sclerotica. I divided the ciliary muscle, and he left the hospital in a week, and returned to the country. In the following September, he again presented himself, having derived so much benefit from the operation, that he begged me to operate on the left eye, the cornea of which was more conical than the right had been, causing great pain and inconvenience. The cornea of the right eye operated upon in April was now flattened, and the sight much stronger. I accordingly divided the muscle in the left eye; and at the end of Nov. he left the hospital, at which time the cornea was clearing, and he began to distinguish objects.

Staphyloma cornea.—C. F. S——, aged nine years, admitted March 3rd, 1861, with complete opacity of the cornea of the right eye, the result of ophthalmia when two years of age. The eyeball was much enlarged and prominent; nearly the whole cornea was opaque, and very thick and prominent in the centre, but thinner at the margin, where the blue iris was just visible. He had a distinct perception of light. The globe of the eye was unnaturally hard.

March 4th.—I divided the ciliary muscle, and a considerable quantity of fluid escaped at the time.

13th.—The eyeball is much smaller and softer; the cornea is flatter and clearing at the upper portion, where the iris can be distinctly seen through a space one-eighth of an inch in width, whilst the central dense portion is evidently becoming much thinner towards its periphery. He says sight has improved. Discharged, to attend as an out-patient.

Staphyloma sclerotica.—E. B——, a female, admitted March 14th, 1862, into the Royal Westminster Hospital, under my care, and operated upon the same day. She first observed dimness of sight twelve years ago, and fancied it arose from a very bad confinement. On admission, she could discern the light, and just the shade of her fingers passing. The right eye projected so far that she could not close the eyelids. The pigmental coat of the choroid threatened absorption of the sclerotic, which was bulging considerably behind the cornea. The sight of left eye also becoming very dim. I divided the ciliary muscle, both on the temporal and nasal side of the right eye, to relieve the great internal pressure as quickly as possible.

March 25th.—The bulging of the sclerotic has subsided. She can now close the lids completely, and without difficulty; has experienced great relief from the operation, and can see her fingers plainly. Discharged, and attends as an out-patient.

Extirpation or abscission of the eyeball has been commonly practised in such cases; therefore, if for no other reason, it must be acknowledged that a modified and simple operation, such as I here advocate, is a boon of no ordinary kind to the very poor who are quite unable to purchase artificial eyes; by this method, also, vision may be slightly improved.

A very interesting, as it is a most instructive, objective symptom frequently invades the proper substance of the cornea around its sclerotic edge. This is *arcus senilis.*

The significance of arcus senilis, or fatty degeneration of the cornea, was first pointed out by my friend Mr. Canton, who has most ably elucidated every point of interest in connection with the subject, in his book lately published. The arcus shows itself either annularly or crescentically, mostly at the periphery of the cornea as it joins the sclerotica, of an opalescent or greyish-white colour. Vertical sections of such corneæ, when examined by the microscope, are seen to be composed of minute fat corpuscles, and are now considered to be diagnostic of some degeneration of structure going on in other organs of the body, as in the heart, arteries, liver, &c. as well as the muscles of the eyeball, and the ophthalmic artery. Arnold found, in one case, an extensive artheromatos deposit in the ophthalmic artery, and also in the small vessels of the sclerotica. Virchow says that it co-exists with a similar change in the aorta. It has therefore been regarded, by the last-named author, and by Dr. His, as indicating diminished nutrition, atrophy, or a physiological change produced by age; whereas, in the middle period of life, it is a sign of more generally diffused morbid processes in other parts of the body. Chelius believes it to be the result of diminished vascular activity in the eye, and particularly from diminution of the aqueous humour; and this he thinks explains the occurrence of the arcus most frequently at the upper portion of the cornea, for here is placed the chief vascular supply from the anterior ciliary arteries. Arcus is usually developed without any inflammatory condition, although Virchow regards it as very similar to an inflammatory affection of the cornea, "an elementary disturbance which marks those changes which, with a more acute irritation, would take on an inflammatory character." It may, he adds, be regarded as "a chronic keratitis in which the progressive events have gone on so slowly from diminished nutrition."

Dr. Ammon found, in connection with arcus of the cornea, a similar opaque ring round the margin of the lens; and subsequent investigations of Dr. Schön show that *arcus* affects the posterior capsule as well as the lens, the opacity corresponding pretty nearly in form and extent to that of the cornea. Mr. Canton, however, has never met with any change of the kind in his numerous examinations, and is therefore led to regard its occurrence as accidental.

As to the extension of fatty degeneration of the cornea, we find the particles mostly of the molecular form, and between its layers; the anterior and posterior elastic laminæ being entirely free: we therefore have a transparent ring between the junction of the cornea with the sclerotica. I have seen patches of fatty molecules imbedded near the margin of the cornea, and without any annulus or arcus presenting itself at that or any other portion of the structure; in other cases, the substance of the sclerotica, for some distance, has participated in the degeneration. If, as I believe, it be a defect of nutrition, it is remarkable that it should occur just at the termination of the capillaries, and be mostly confined to the periphery of the cornea.

Double arcus; rheumatic attack producing heart disease; fatty degeneration of retinæ.—W. P—-, aged 45, a mechanic, applied for advice Jan. 3, 1863. The account he gave was, that vision had been gradually failing for some months; but that he was quite sure his eyes were good before an attack of rheumatic fever which occurred about six or eight years ago, and laid him up for some months. He was then told by the medical man who attended him his heart was diseased. If he gets wet, his old pains in the joints return: heart disease is very readily detected. The *arcus* is developed in a remarkable manner; it resembles a double crescent slightly divided midway, between a lower and upper arc. The ophthalmoscope shows considerable deposits in retinæ—evidently owing to *fatty degeneration.*

He has been under treatment some three or four weeks, without deriving much benefit. Such cases required long and careful watching, and then only very partial relief or arrest of destruction to sight can be anticipated.

Double arcus, with insensibility of retinæ.—R. W——, aged 40, a furniture dealer, applied to me for advice February 9th, 1863, complaining of rapidly increased confusion of vision, which he thus describes—"If I try to look at your clock, or a picture, with both eyes, it appears to me that I am looking through a mist or a cloud, and then it altogether suddenly vanishes. I close one eye and look at the clock with the other. I can see the face clearly for a second or two only, when it vanishes. The difficulty is increased if I make an attempt to read or write. I then feel very nervous, and a faintness comes over me, especially after tea and during the evening."

The patient, although a thin spare man, has always been equal to his ordinary labour, has lived regularly and soberly, and never had much illness. He is quite sure that he has never suffered from rheumatism, and no suspicion of heart disease. The pulse rather hard and wiry; the arcus in both eyes is as fully developed as that in the former case. A friend well acquainted with cardiac affections was good enough to examine this patient with me, and we both were decidedly of opinion that the condition of the eyes was due to the presence of valvular disease of the heart. The ophthalmoscope revealed a greyish deposit on the retinæ; this evidently much obscured the small and faintly seen vessels. The vitreous and lens were apparently quite free from deposit. The patient is still under treatment for the general disease in the system, and the last report states with only some slight improvement in the symptoms.

Abnormal Conditions of the Crystalline Lens. Pathology of Cataract. Diabetic Cataract. Injuries to Lens.

The slightest abnormal opacity in the lens, its extent, seat, and nature, as well as the size and other relations of the nucleus, admit of exact appreciation by the aid of the ophthalmoscope. Wounds, cicatrices of its capsule, small foreign bodies imbedded in its substance, its position in cases of dislocation, can also be accurately discovered: this facility of diagnosis, combined with the more accurate knowledge which recent investigations have insured for various forms of lenticular disease, cannot fail to be of great assistance, and enable us to fix with unerring precision the proper method of operation applicable to special cases.

Many different forms of cataract are recognized by surgeons; and the distinction of *true* from *false*—one kind from the other—is a point of no small importance. It is well known that the dimness of sight and opacity in the lens usually begin in a very unmarked manner, and increase slowly for perhaps months or years, until the cataract is *ripe*—fit for operation.

Opacity occurring in the substance of the lens constitutes true cataract. The affection is met with in all eyes; but it is most common in old persons. Examined objectively, the opacity generally presents a uniform pearly lustre; but sometimes exhibits a striated appearance, the lines radiating from the circumference to the centre, and in the direction of which it has been known to break up under an operation. There are cases called black cataracts, where the opacity of the lens is of so dark a colour as easily to be overlooked, if not very carefully examined. In these, and in many cases of incipient cataract, Dr. Mackenzie prefers the catoptrical test as a means of detecting their existence. The lighted taper, he observes, "passed in front of the eye, by showing the changed condition of the two deep images, instantly reveals the true state of the lens."

Generally, in lenticular cataract, sight is not altogether lost, the patient being able to distinguish degrees of difference in light and shade; and if the pupil be dilated, a considerable amount of vision may be exerted, where otherwise, in a strong light, nothing can be seen.

Capsular cataract is distinguished as anterior or posterior, according to the situation of the opacity before or behind the lens. The former is far more frequent than the latter, and is commonly a consequence of inflammation in some neighbouring part, and especially in iritis. Threadlike adhesions to the iris seem to take place, on which patches of uveal pigment are often very noticeable, and even remain as a broken ring upon the capsule after dilatation has released the iris. A numerous class of spurious cataracts connected with this condition of the anterior surface of the capsule are enumerated; all, however, being degrees of aggravation attributable to the same cause of neglected or misunderstood local inflammatory action.

Posterior opacity of the capsule appears always in radiating lines pointing from the centre of the lens, and their indistinct wasting outline enables us to distinguish them from the sharp milky or pearly appearance of anterior capsular opacities. The appearance of posterior capsular cataract is always of serious moment, as indicating the approach of lenticular opacity.

Several other specific forms of opacity, connected more or less with the lens, are all described as cataracts, with distinguishing names. Thus several different forms of an effused opaque fluid thrown out between the capsule and the lens supply four or five varieties of Morganian cataract, the most remarkable objective appearance of which is the difference of colour assumed by the opacity according to the position in which the patient is placed to be examined. In the erect position, the cataract appears of an amber colour, or even a darker brown; but when examined in a recumbent posture, it presents a chalky white appearance.

There is a complication of lenticular opacity with glaucoma which presents a green colour, and is called green cataract; and in what is termed bursal cataract, a very rare kind, consisting of encysted pus between the lens and the capsule, the colour is orange. But the most singular, as regards appearance, is the sparkling metallic lustre of what is termed cholesterine cataract, from the glancing crystals of that substance moving up and down, so as to have been supposed to be small globules of mercury in the aqueous humour.

There is a specific affection of the eyes characterised by a green appearance of the pupils, which, when combined with myopia, sometimes leads to serious mistakes in diagnosis. This is now known as glaucoma, and was long supposed, even when plainly distinguished from cataract, to be connected with some opacity in the vitreous humour. The ophthalmoscope, however, has revealed its true character, and enables us at once to determine upon the changes in every case under examination. The peculiar characteristic colour of the pupils in glaucoma is due to a diplochromatic operation which the lens possesses, under some circumstances of altered condition without opacity, such as may be presumed to attend upon an increasing hardness in the centre, and which, reflecting the mean prismatic rays, appears green; but viewed by transmitted light, has the ordinary amber yellow colour of advancing age.

M. Ch. Robin lately published a very interesting paper on the Anatomy of the Lens, and to which he has appended a Résumé of the Pathological Anatomy of Cataracts.

First: *Lenticular Cataracts.* First Species: *Soft Cataracts.* —Alteration seated in the soft, superficial, cortical layer of the lens. This alteration causes either several whitish or greyish opacities under the form of lines, points, &c. variously arranged, or one uniform opacity. In all these cases the lesion is the same, the difference being only in extent. The alteration of the cortical layer of the lens is due to the facts, that, in consequence of derangements of molecular nutritive process of renewal, and the development of its elements, the latter have undergone morbid modifications of structure, of which the following is a description :—These alterations consist principally in a tendency to a more granular condition, with a ribbon-like flattening of the tubes, which at the same time lose their nuclei. This granular condition manifests itself also, at times, in the serrated fibres. The cells of the lens have disappeared, and are reduced to granules, or rather, from being homogeneous and hyaline, have become granular. At the same time, there are produced, between the flattened tubes, free molecular granules, minute limpid drops, and oil globules. These latter have exuded from the substance of the elementary cells, or perhaps have preceded their disintegration.

There is, besides, a formation in this superficial layer of solid corpuscles, rounded or of various forms, homogeneous or granular, imbedded or not in a substance of a waxy, homogeneous consistence. Finally, there is sometimes a deposit of phosphate of lime, mingled with traces of the carbonate of the same base. These various alterations result in a transition in the soft layers of the lens, and sometimes in its hard nucleus from their perfect homogeneousness and transparency, to a heterogeneous condition: to such an extent that the light, instead of passing through these tissues, is reflected by these various particles, and assumes a white or greyish tint, as we see occurring in every granular or heterogeneous substance on which the light falls.

Second Species—*Liquid Cataract.*—This presents a milky aspect, and there is found contained within the cavity of the capsule, as in a cyst, a whitish liquid, in which floats the hard nucleus of the lens. This liquid is composed of a fluid, holding in suspension fat-globules, corpuscles, and solid granules. It is the change of the normal elements of the superficial layer of the lens to the condition of a liquid, holding in suspension and emulsion the aforesaid corpuscles and globules, which causes its reduction from a state of homogeneousness and perfect transparency to one in which the light can only traverse it imperfectly. It reflects it with a whitish colour, as does every liquid holding in suspension solid cor-

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puscles and drops of a liquid heterogeneous as compared with itself.

Third Species—*Hard Cataracts.*—These cataracts preserve to the centre the same anatomical and pathological composition as soft cataracts; and this is not dependent upon the presence of elements essentially differing from those of the normal lens, if we except the solid corpuscles, whether granular or not, and the fat-globules which have exuded from pre-existing elements in a state of alteration. The lesion consists specifically in an intimate modification of the cellular elements of the lens, causing them to become more solid, each one individually, and more adherent to one another than in their normal state. At the same time, the elements, thus modified, become more granular—one of the essential causes of the opacity; the other causes being the production of solid corpuscles and the exudation of fat-globules.

Fourth Species—*Very Hard Cataract.*—This is rare, and is due to an incrustation of the anatomical elements of the soft and hard portions of the lens, which, however, are not destroyed. In this form of cataract the lens is of a greyish or chalky-white colour. It is hard and dense, especially on the surface, and friable, as though granulated; sometimes throughout its entire thickness, while at others it may present the stony-hard condition only on its surfaces, the nucleus remaining little altered. The lesion consists essentially in a calcareous deposit, principally composed of phosphate of lime, with only a small proportion of the carbonate of the same base, incrusting, molecule by molecule, the elements of the lens, but not rendering them unrecognizable, if we dissolve out the salts by means of weak acids. The action of these reagents enables us to recognize here, also, spherical corpuscles, analogous to those of the hard and soft cataracts, which are also incrusted with the calcareous phosphate.

Second Class—*Capsular Cataract.*

First Species—*Pseudo-membranous Capsular Cataract.*—This, as its name indicates, is characterized, anatomically, by the production of filaments, or of a fine pseudo-membranous layer, which probably originates from the iris, having been in communication with it, and ceases to adhere to it while it remains fixed to the iridial face of the anterior crystalloid, to its centre especially, which is its most prominent part. The morbid production consists of a non-vascular tissue, firm, somewhat difficult to tear, of a striated aspect; the striæ being sometimes undulatory, and presenting, on laceration, a lamellar rather than a fibrous structure. This tissue is usually incrusted, but only at a definite period after its appearance, by a quantity of microscopic granules, generally of a rounded form, composed principally of phosphate of lime, with a little of the carbonate of that base.

Second Species—*Phosphatic Capsular Cataract.*—This is characterized by the production of granules similar to those in the preceding class, and of the same nature, which are imbedded in the substance of the anterior crystalloid, but on its iridial aspect only. The opacity manifests itself when these granules are sufficiently large and closely approximated to interfere with the transmission of light, and form masses of sufficient size to be perceived by the surgeon, under the form of spots, lines, or of whitish points. It is more rare than the preceding form.

For some years past the attention of the profession has been directed to the frequent association of cataract with several forms of general disease existing in the system; and this has given rise to investigations which fortunately have been attended with results of a very satisfactory character. In previous editions, I have mentioned that Mr. Jordan had satisfactorily shown that cataract is intimately connected with heart disease; and every one must admit the soundness of his general view: "That there should be an intimate connection between cardiac and ophthalmic disease cannot, *à priori*, be deemed improbable to any one prepared to admit the connection between diseases of the heart and diseases of the brain. Shall the central artery of the retina maintain its integrity amid the ravages of a disease which does not leave the divisions of the internal carotid itself competent to the performances of their duty? The purely mechanical protrusion of the eye attending a hypertrophic heart is a condition now commonly appreciated. But there are other and more delicate conditions of the visual organ, telling of cardiac states so palpably that they shall challenge the credence of the accomplished physician and surgeon."

My own observations had previously assured me that cataract is very often associated with ill-feeding, or an impoverished state of the blood. An anæmic condition of the retinal vessels is almost always present in the early stage of the disease; the fact induced me to push blood tonics, believing that, by improving the blood, and by attending to the general health, I might perhaps arrest the formation of cataract. The treatment I consider to have been very successful, as in many cases I have noticed opacities remaining stationary for four years and upwards; during the greater portion of which time the patients were under my own observation.

Another serious and not uncommon complication of cataract is associated with *diabetes mellitus*. A French oculist, indeed, goes so far as to declare that he has on more than one occasion diagnosed the existence of *glycosuria* from the peculiar anatomical character of the cataract. It is generally of the soft variety, large and full, frequently pressing forward the iris against the cornea, so as to fill the whole of the anterior chamber. The development of this kind of cataract is likewise very rapid. The practical importance of detecting this complication, when present, as stated by M. Follin (of the Necker Hospital), depends upon the difficulty of procuring adhesion of the corneal flap in extraction, and in the danger of inflammation and irido-choroiditis if depression is the course adopted. It is therefore highly necessary, before proceeding to an operation, to learn the state of the urine, as the total want of reparative power which characterises *glycosuria* affords very little prospect of success if its presence be detected. Where circumstances, however, do authorise an operation, as extreme desire on the part of the patient, as M. Follin has properly pointed out, the after treatment must be very different from that in ordinary cases, and consist of the most nutritious food and the generous use of wines.

In a paper, published in the American Journal of Science for January, 1860, Dr. Mitchell asserts that

"Cataract may be produced artificially by overcharging the blood of an animal with sugar." The fact has been established by other experimenters; and it is considered to be purely *osmotic:* that is to say, due to an excessive transudation of water from the lens to the surrounding fluids, upon which the component parts of the lens are disarranged, and opacity is the result. This form of cataract connects itself intimately with what has been made out in the etiology of the disease, as to the co-existence of diabetes and cataract.

Dr. Richardson has more recently confirmed the experiments made by Dr. Mitchell, and arrives at the following conclusions:—1. "In addition to the sugar-cataract, there is producible what may be called a saline cataract. 2. The appearances of the cataracts, as produced by different solutions, vary; thus the cataract, artificially produced by chloride of sodium, differs from that produced by grape-sugar. 3. The cataractous appearance is modified by the density of the producing body, and is removeable by reversing the conditions which have led to it; and as it is producible in a clear lens removed from a body, it is a demonstration that the cataract induced in different animals is a purely physical, osmotic change."

There can exist no doubt as to the frequent dependence of a cataractous condition upon the diabetic malady; and, in fact, the connection between the two diseases has been noticed by many trustworthy observers. Mr. France published several cases, and says: "The characters which the cases in question displayed have been sufficiently uniform to enable me to recognize them, before any complaint of urinary disorder was preferred by the patients. The cataracts have in every example been symmetrically developed on both sides; the lenses have increased remarkably in their anterio-posterior diameter, so as to encroach upon the depth of the anterior chamber, and even to interfere mechanically with the free play of the iris. The opacity has attacked portions of several strata of the crystalline at once, leaving intermediate spaces for a while transparent. The colour and bulk of the cataracts have invariably indicated their soft consistence, which was proved by operation in two persons, though respectively of 'middle' and of forty-eight years of age. Lastly, the ocular affection has only arisen after a considerable duration of the renal malady; and there has, in no case, been reason to suspect further disease of the eyeball.

"My experience would lead me strenuously to deprecate any operative interference with them, so long as a useful degree of vision is preserved; and to adhere to palliative treatment by mydriatics for a longer time than in ordinary cases of cataract would be expedient or right. This recommendation is chiefly founded on the indisposition of the cornea to heal even the minute wound inflicted by a needle, as illustrated by the first of my cases. A period, however, arrives, when all useful vision is extinguished; and then, unless the general powers are rapidly failing, there can be no doubt of the duty of attempting to afford relief. Depression (if not on other grounds to be discountenanced) would be clearly inapplicable here, as indicated by the uniform signs of softness.

"There remain, therefore, only the varieties of the operation for solution available, and keratonyxis should be selected in preference to any other mode. In performing it, the surgeon should be more than usually scrupulous, to employ a needle of the greatest delicacy; to make sure that the shaft will completely fill the aperture made by the point; to confine his first manipulations to a narrow area in the centre of the capsule; to effect his purpose at that spot steadily, in as brief a time as may be; and carefully to withdraw the needle, with the flat surfaces of its point as they were introduced, parallel with the plane of the iris, and thus to avoid the minute crucial wound otherwise necessarily inflicted. The neglect of these precautions, by permitting escape of the aqueous humour, would probably render the whole process abortive."

There has recently been introduced from Paris a process for ascertaining the condition of the retina, where, from opacity of the lens, the ophthalmoscope cannot be used, which its proposer, M. Serres d'Uzès, calls "phosphenic retinoscopy." It promises to be extremely useful, as it enables the surgeon fairly to anticipate the probable restoration of vision as the result of an operation, or, on the contrary, be sufficiently conclusive to interfere and prevent a patient being exposed to useless pain without the chance of any amendment in vision. The mode of investigation is somewhat similar to that which is adopted in examining the eyes by tactile pressure. The patient, with his back to the light, closes his eyes gently as in sleep. Slight pressure is then made in different regions of the eye with the extremity of the fore-finger, or any blunt rounded instrument that may be found convenient. The pressure should be made as deeply towards the back of the orbit as can be done without inconvenience, the eye at the same time being directed in the contrary direction. A luminous circle, or arcs of a circle, if the retina be healthy, will be simultaneously seen by the patient, on the side opposite to the point of pressure; and if the *phosphene* appears in succession all around the eye, according to pressure made, the inference is that the whole retinal expansion is functionally sound, and the prognosis of an operation accordingly would be favourable. If, on the other hand, the pressure produces only blank impression, it may be presumed that the retina is so far implicated in the disease that an operation would be useless, or its success very problematical.

M. Serres describes four phosphene regions where pressure may be made with the best effect. These are the *frontal*, the pressure being made from above; *temporal*, where it is made at the outer angle of the orbit; *jugal*, from below; and the *nasal*, from the inner angle. He has also determined the order in which these *phosphenes* disappear, in cases of progressive disease of the retina, and states it to be: first, the jugal, then the temporal, then the frontal; that observed at the nasal region continuing to be seen after all the others are lost. These phenomena have also been made a measure of the progress of cure; and, it seems, the restoration of nervous power, as indicated by the reappearance of the phosphene, is in the reverse order to that above given.

It is advisable, in all cases of cataract, before proceeding to use either the ophthalmoscope or convex lens, to dilate the pupil with atropine, by which means we obtain a view of commencing striated opacities at the very edge of the lens. Listing extols the entoptic test for discovering lenticular opacity in the incipient stage. The patient is desired to look at the clear sky through a small hole in a card made with the finest sewing needle; in this way the abnormal opacities are readily brought into subjective contemplation as various dark spots and streaks "in the field of dissipation of the nearly parallel homo-centrical light, and in general can be perceived earlier than it is possible to discover them as objects from without; and it is hereby demonstrable that these dark spots, which prevent the course of the rays of light through the dioptric media, are situated at a small distance from the pupil, in the lens or near its capsular covering."

It is quite unnecessary for me to dwell upon the importance of being able to diagnose with absolute certainty the cataractous form of disease. The question of cataract, or other change in the dioptric media, we are expected to decide without hesitation; and the opinion given will implicate the character of the medical man in the issue of the case. In former times, it was very difficult to determine, not only the existence, but the seat of the cataract, and to say whether an opacity was one affecting the crystalline capsule, the lens, the vitreous humour, or depended upon a change of the retina, or of the choroid coat.*

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* Dr. Mackenzie very properly dwells upon the importance of being able to distinguish the early stages of cataract from amaurosis. He observes:

A short time since, a mechanic presented himself to me at the hospital, who had been pronounced amaurotic. No visible change could be detected in the dioptric media by daylight. I examined the eye with the ophthalmoscope, and perceived a grey-coloured central opacity on the posterior capsule of the lens. The vessels of the retina and optic nerve, at first seen with difficulty, were, after a little searching, found in a nearly normal condition. It is not improbable that the opacity commenced after this patient was pronounced amaurotic; nevertheless, the fact is worth recording, and shows the value of the ophthalmoscope in all cases of doubt.

In another case which fell under my observation, the patient was about to undergo a needless operation for the restoration of her sight. Mary F—— came to London for the purpose of submitting to the operation for supposed cataracts. Upon examining the eyes with the ophthalmoscope, the lenses were found perfectly free from disease. In the left eye a crescent of pigment surrounded the periphery of the optic nerve, and a small apoplectic clot covered the centre. In the right eye, a black spot covered the foramen centrale, and dark grey bodies floated in the vitreous. The vessels and optic nerve were much obscured by the large amount of blood in the eye, and by reflection it imparted an apparent opacity to the lenses; this had evidently misled when the ordinary mode of examination alone was thought sufficient to decide the state of the case. The patient, a

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"If a patient with incipient amaurosis presents himself to a practitioner who mistakes the case and supposes it to be one of incipient cataract, the advice which he will give will be to wait with patience till the disease be fully developed, then to submit to an operation. Should the patient return after some months with a fully developed amaurosis, instead of a cataract, the practitioner would necessarily feel that he had lost the only season for treating an amaurotic affection with success. The opposite mistake would probably lead him to the employment of depletion, mercury, and counter-irritation, by which his patient's health might be seriously injured, but which could have no effect in removing an incipient opacity of the lens."—Mackenzie's 'Diseases of the Eye,' 4th Edition.

delicate woman, was suckling; and to this in part may be attributed the deterioration of sight.

A blacksmith, whose imperfection of vision in the right eye had been said to proceed from incipient cataract; the ophthalmoscope showed the opacity to be one of reflection, from internal congestion, and the patient was cured by local abstraction of blood, perfect rest, and brisk purgation, followed by tonics.

Diseases of the Vitreous Body. Cysticercus.

The vitreous humour is frequently the seat of opacities; but some caution is necessary in determining the character of such defects, as they are nearly always associated with either choroidal or retinal disorganization—sometimes thread-like traces of the nourishing vessels becoming more prominent than in the normal state; presenting an appearance not inaptly described as funnel-shaped striated nebulosities. In the healthy eye, this filamentous structure is with difficulty to be discerned, as the delicate fibres are transparent, and possess a refractive power nearly the same as the general mass of the vitreous in which they repose. They may be best observed in the fœtal state, as they consist of the branches of the hyaloid artery, which disappears as its function of developing the vitreous body is accomplished. Their remains, however, may be plainly discerned in certain pathological conditions in the adult.

An interesting case, recorded by Coccius, well illustrates the real nature of this filamentous structure; and also the changes in the appearance of the vitreous produced by disease.

"A woman, 36 years of age, had suddenly remarked, four weeks previously, a cloudiness of the visual field; this in a few hours had so much increased that she lost all power of recognition, and was obliged to be led by another person. Externally, the eyes seemed normal, the iris of a bright green, and somewhat inactive. The vitreous body was fluid, and contained small point-like opacities; some of the particles behind the lens moved over the whole length of the vertical and transverse diameters. Towards the fundus, a number of vessels, which slowly changed their position as the eye was rotated in various directions, in the right more than in the left eye; the longest of them projected as far as the middle of the vitreous body, where it ended in a long white row to a point, and was lost in the upper part of the globe. Many such threads were seen connected with short vessels, which appeared to be terminal capillary loops. The retina was extremely vascular; vessels which appeared to be on the surface of the retina when the eye was at rest were seen to move in small curves by means of violent motions of the eye. The retinal veins were extremely tortuous, and in many parts completely covered by opaque retina."

After watching this case for many weeks, Coccius became convinced that these vessels in the vitreous body were really extensions of those of the retina; they were connected both with the venous and arterial branches of the retina. Their size was about that of the average arterial vessels in the equatorial region of the eye, and they all sprang from near the entrance of the optic nerve. No boundary between the papilla optici and the rest of the fundus could be perceived. In the right eye there occurred, at a subsequent period, a considerable extravasation of blood, which yielded to antiphlogistic treatment, and the vitreous became somewhat clearer.

Effusion of blood into the vitreous is a cause of opacity, a cloudiness extending some distance around the clot. This affection is apt to occur suddenly after violent exertion, and is sometimes called *apoplexy* of the eye. It may also arise spontaneously from constitutional weakness of the vessels. Gräfe describes cases in which he has recognised this condition, and also intra-ocular hæmorrhages, occurring periodically during intervals extending over several months. Opacities due to these causes are best observed by light thrown obliquely into the eye, after the pupil has been properly dilated by atropine; the clot being then examined by a double convex lens.

An instructive case, where a remarkable ossific deposit had obliterated the vitreous body, is described by Spree, an eminent Belgium oculist, and quoted by Mackenzie in his Treatise of Diseases of the Eye. An operation for cataract had failed in restoring sight, and the patient continued to suffer pain in the eye till the time of his death. On dissection, morbid adhesions were found between the choroid and the neighbouring parts; there was no trace of the retina, and in place of the vitreous body there was a long substance, convex posteriorly and concave anteriorly, and half an inch in thickness. It is not improbable that the imperfect means of diagnosing affections of the eye, available at the date of this extraordinary case, led to a false conclusion, and that a useless operation for cataract was the result. It is well always to bear in mind that many cases of opacity due to ossific deposits within the vitreous body are on record; and it frequently happens that a lens depressed into the vitreous becomes ossified, or very hard, instead of being absorbed, and thus interferes with the success of the operation. It may also fall forward through the pupil when the patient happens to stoop, and then it becomes a source of great irritation and local inflammation.

Fluidity of the vitreous body, without myodesopia (floating substances in it), I do not remember to have seen; and the large quantity of muscæ which I have observed floating about in some eyes, induces me to believe that a great portion of the pigmentum nigrum must have become detached, escaping into the vitreous. In a case lately examined, the patient being fifty years of age, his eyes, upon casual inspection appearing free from disease, the immense quantity of floating bodies surprised me; nevertheless the man had been pronounced an impostor.

Irrespective of those numerous false subjective symptoms of fancied obscurity so frequently complained of by glaucomatous patients, and which might be suspected, as occasioned by the presence of floating bodies in the vitreous, it is now known that microscopic corpuscles may exist; and when once a person detects them, such frequent notice is taken of them that they become exceedingly troublesome. Eyes so affected present little or no change whereby the existence of the corpuscles can be detected; but all doubts as to the nature of such cases are now readily cleared up by the use of the ophthalmoscope, which has also led to many important modifications in the diagnosis, and consequently the treatment of many diseases of the eye. An oblique light from the plane mirror shows these changes, as I have remarked before, in the vitreous better than a convex mirror, and there is no difficulty in determining the position of exudations, or of corpuscles between the cornea and focal centre of the eye, or between the focal centre and the sensitive layer. In such changes, we no longer depend on philosophical reasoning for an explanation of the cause, in most cases, of this heretofore obscure disorganization; the ophthalmoscope now clears up the difficulty, and gives a better explanation than philosophers were wont to give, and whose experiments, in some instances, it appears to me, must have originated bodies having no real existence in some eyes when experimented on. I might instance the experiment of causing a person to search for muscæ "through a pin-hole made in a card, or the eye-glass of a compound microscope"—a fallacious mode of procedure, since we find, by placing a card with a pin-hole in it before the eye, external objects, as particles of very fine dust, constantly floating about, or the eyelashes are, in this way, much magnified, and at the same time so ill-defined as to puzzle most patients; and whether the objects seen, are floating outside or inside the eye, they cannot positively say. "Nothing serves so much to increase the perception of muscæ volitantes as often searching for them through pin-holes, lenses, &c. Such experiments seem to rouse them into existence; and he who has thus brought himself to discover them, continues to see them, and cannot get quit of them."*

Although diseases of the vitreous humour are not at all unfrequent, patients often complain of spots, flakes, or shreds, apparently before the eye, where I have been unable to detect the presence of any exudations in the vitreous, but have found a congested state of the retinal vessels sufficiently great to

* Dr. Mackenzie. Op. cit.

account for these supposed shreds or spots. In such cases, the removal or abatement of the probable exciting cause is the first thing to be attended to. Rest to the eyes, if they have been overstrained, relaxation from business, quiet to the mind, a well-regulated diet, exercise, and change of air, afford a wide margin of opportunity for improvement. In the following case, I observed a curious condition in the vitreous body, which was the cause of the muscæ complained of.

S. M——, aged 25, complained that for four years her left eye had been affected with a constant appearance of dark spots obscuring vision, and had never been so strong as the right. On the least exposure to cold, she suffers from ophthalmia, and frequently feels severe pain in the head, with dimness of sight. Can see objects distinctly at a distance; but when looking at near ones, they appear misty and as if covered with black spots, or a veil were interposed. There is very slight diffused opacity of the cornea. Examined with the ophthalmoscope, a floating greyish mass in the vitreous humour could be seen, which at times floated up and obscured the optic nerve; the vessels of the retina could then only be made out with difficulty. Alteratives and a mixture of soda and decot. cinchon. were prescribed, with change of air; and in a month the patient was considerably improved.

Floating bodies, muscæ, are not unfrequently the cause of very troublesome spectral illusions. A young lady suffering from muscæ often imagines she sees persons or animals moving about her room, which is particularly troublesome towards evening, or in a dull light, as then the pupils become dilated. This condition will explain many curious illusions of which we hear, and find associated with particular temperaments, and in hysteria, hypochondriasis, febrile and other affections; mostly curable by judicious medical treatment.

"An optical spectrum is seen when the eye has been strained by looking on any particular object or colour. The ray of white light consists of the three prismatic or primitive colours. Now, if the eye is fatigued by one of these colours, or it be lost, mechanically or physiologically, the impression of two only will remain, and this accidental or complementary colour is composed of the two remaining constituents of the white ray. Thus, if the eye has been strained on a *red* colour, it is insensible to this, but perceives the *blue* and the *yellow*, the combination of which is *green*. So, if we look long on a *green* spot, and then fix the eye on *white* paper, the spectrum will be of a light *red*. A *violet* spot will become *yellow*; a *blue* spot *orange-red*; a *black* spot will entirely disappear on a *white* ground, for it has no complementary colour; but it appears *white* on a *dark* ground, as a white spot will change to black. The colours of objects are also changed in some cases in ophthalmia; the eye, from certain diseases of the nerve, may only see half its object; the same things may appear and disappear alternately; objects at rest may appear in motion, and the spectral images of persons and things formerly seen may be exactly reproduced. Even more than this may occur physically, for material objects may seem what they are not, and especially under certain predisposing causes of a mental nature.

"Optical illusions at times present themselves in very curious and mystic aspects, which is, doubtless, owing as much to some temporary derangement of the organ of vision, or to that of bodily ill health, as to external refraction."*

Cysticercus.—The presence of entozoa in the deeper parts of the human eye has only been demonstrated since the introduction of the ophthalmoscope into medical practice. Numerous cases, however, are now on record, especially in the annals of German ophthalmology. In England they appear to be of much rarer occurrence; and considerable care is required, in the examination of such cases, not to be led into error, as common encysted tumours sometimes bear a very remarkable resemblance. They have long been known to invade the areolar tissue of the orbit and the anterior chamber, where, of course, they admit of a much easier recognition than when they are believed to exist in the vitreous humour; or, as Von Gräfe alleges, who was the first to describe them

* Dendy's 'Philosophy of Mystery.'

in these situations, between the hyaloid membrane and the retina.

In the most favourable cases for diagnosis, the head and body of the cysticercus may be seen through its delicate enveloping membrane; and when this has not been possible by the increased turbidity of the vitreous humour, by fixing the axis of vision, the walls of the vesicle will sometimes exhibit flattenings, or cup-like depressions, alternately produced, and simultaneously in several places, together with the movements which diffused themselves in an undulatory manner. Changes also take place in the choroid, which assumes a pale yellow colour in the vicinity of the entozoon, and an effusion of serum may take place beneath the retina. The transparency of the vitreous becomes affected, and a film-like opacity may be observed. Vision is very considerably diminished; and as it is not unusual in such cases to find the system generally predisposed for the appearance of entozoa, in some form or other, inquiries into the history of the case will materially assist our diagnosis.

Gräfe gives the particulars of many interesting cases of cysticerci occurring in the vitreous humour, in patients whose ages varied from 10 to 53 years. Two cases occurred in males, suffering at the same time from tænia; four cases occurred in females, one of whom only was affected with tænia, and had cerebral symptoms, with paralysis of one arm, co-existing; supposed to have been produced by cysticerci in the substance of the brain. The parasites residing in the vitreous humour were enclosed in a membranous sac; and it seems that they were supported for a long period with comparative immunity of the other structures of the eye; whereas, if developed on or under the retina, they generally excite inflammatory action, producing detachment of the retina by choroidal exudation, development of opacities in the vitreous humour, &c. with consecutive atrophy of the eyeball.

The following case by Gräfe illustrates the appearances presented by cysticercus in the vitreous humour :—

H. M——, from Posen, a boy, ten years old, complaining of amblyopia of the right eye. Slight green discoloration of the iris, but no parenchymatous effusion. Pupil slightly dilated and sluggish. On ophthalmoscopic investigation, a cysticercus is discovered in the vitreous humour, enclosed in a membranous sac, which extends from a point just behind the posterior pole of the lens, and diverges, fan-like, in a system of radiated offsets, towards its posterior surface. Thence the sac extends nearly directly backwards, and is attached to the papilla of the optic nerve, which, with the exception of two narrow segments, is hidden from view. The fundus of the cysticercus itself seems to be situated in the middle of the vitreous humour, where it is distinguished by a sharp contour from the continuation of the sac. Just above the insertion of the sac, on the papilla of the optic nerve, some spots of yellow retinoid and sub-retinoid exudation were visible; the retina and choroid otherwise normal. The undulatory motions of the parasite were distinctly visible. After two months, no change had occurred.

In a similar case, described by Liebreich, no change was visible after nine months.

In No. 45 of the 'Deutsche Klinik' for 1856, Gräfe describes a moveable *Cysticercus cellulosæ* in the vitreous humour of a patient, which exhibited turbidity, in consequence of the irritation to which the foreign body gave rise. Gräfe made an opening through the sclerotic coat, and extracted the *Cysticercus*, with great difficulty. In this operation, the caudal part of the vessel was torn off, and the head and neck only, which were seized by a pair of forceps, could be got out. Under the microscope, the suckers of the *Cysticercus* were seen to move for twenty minutes. The vision of the patient improved; he could read large print, count fingers, go out, &c.

Cysticercus in the retina.—In this case, the patient observed, three weeks before his visiting Gräfe's hospital, a cloud in front of the left eye, in the middle of the field of vision, diffusing itself thence towards the sides, so that he had perfect sight from the sides only, whilst in the axis of vision large and strongly-illuminated objects were seen as if through a thick cloud. In course of time, however, sensibility to light was entirely extinguished. The lens and vitreous humour were clear; but in the retina, a shining greenish body was seen, which was bordered by convex circular margins, and lay a little outwards from the centre of the retina, on the outside of the optic nerve. Examined in the indirect manner, the body appeared as a perfect, roundish, greenish vesicle, four times larger in diameter than the entrance of the optic nerve. It was decidedly attached to the retina, and projected into the vitreous body, in which was perceived a white, button-like, projecting appendage, distinctly marked by its greater opacity and its colour, which shifted its place, and over which vessels ran forwards.

In three weeks the vesicle had increased about one-third in diameter, and reached to the optic nerve. The head had passed from the centre to beneath the upper margin, and appeared to have grown like a small vesicle out of the previous one; that is to say, the enveloping cyst had probably burst, and a small vesicle protruded which reached to the former. The retina had lost its normal colour, and was covered with irregular, blended, pale spots, of which Gräfe did not know whether they lay in or behind the retina. In five months, the first vessel was completely collapsed; and, instead of it, a folded transparent membrane, without determinate outlines, was to be seen moving up and down, and the second vesicle also was less distinctly detected with indeterminate outlines. The animal, however, was still alive, and its head lay towards the nasal side. Cystic worms appeared in no other part of the body, nor did the patient suffer from tape-worm.

Wounds and Injuries to the Eye.

Injuries to the cornea from blows, or by detached pieces of foreign bodies striking it forcibly, are so evident on examination as to require little comment here. The most serious consequence of such injuries is where the rupture of the cornea ensues and the eye collapses, from the escape of the humours. In some cases, however, the laxity of the conjunctiva admits of its yielding without being torn, the tense sclerotica at the same time giving way under the violence inflicted. The lens has, under these circumstances, been observed protruding as a small tumour beneath the conjunctiva.

An ordinary consequence of accidental division of the cornea is a prolapse of the iris appearing; this membrane is seen protruding through the opening. The choroid is also frequently implicated, yet with good management vision will not be wholly lost, as in the following case :—

Henry D——, aged eighteen, admitted November 7th, 1860, under my care. Whilst employed the evening before, a sharp piece of steel, upon which he was at work, flew up and struck his right eye with considerable force. This cut through the nasal side of the sclerotica and cornea to the extent of a quarter of an inch. The iris and pigmental coat of the choroid protruded through the wound. He could not see daylight, and the eye gave him great pain. The anterior chamber and internal eye were filled with blood; no lens could be seen. He was put to bed, and a soft pad applied. To take a quarter of a grain of opium every four hours.

Nov. 8th.—Has passed a comfortable night.

11th.—A small quantity of vitreous humour escaped on removal of the pad. A piece of iris protruded; this was removed, and a drop of solution of nitrate of silver applied.

13th.—Ordered quinine with iron mixture.

15th.—Wound united, and on the 17th he was discharged; to attend as an out-patient.

23rd.—Wound quite healed; has recovered some amount of vision.

There are no cases in which the advantage of the ophthalmoscope is more marked than those where the sight has been injured by traumatic intra-ocular effusions, as the following well illustrates :—

"A young gentleman had been educated for the army, and in due course presented himself for examination before the military surgeons. When the sight was to be tested, the surgeon placed his hand before the youth's left eye, when lo! he could discern nothing with his right. He was a remarkably fine young man, and there was nothing to be seen under ordinary examination which explained his absence of sight. The only circumstance bearing on it which he could remember, was a severe blow on the eye from a cricket-ball some months previously. The ophthalmoscope at once revealed the nature of the injury. There was no retinal reflection whatever; a clot of greenish hue, doubtless blood poured out at the time of the blow, occupied the posterior portion of the vitreous chamber, and completely prevented all vision. I was obliged to express an unfavourable opinion as to the probable restoration of sight. When a clot has remained so long, with little change beyond the loss of the red particles, there is small hope of its removal. The difference between the activity of absorption of blood from the aqueous chamber and the vitreous chamber is very great: I have seen the aqueous chamber cleared in twenty-four hours. Slow, on the other hand, is the disappearance of even a small effusion, when poured into the vitreous chamber."*

Detachment of retina, with coloboma of the iris, the result of injury inflicted by the firing of blank cartridge.—William D——, aged 19, applied to the hospital Sept. 22nd, 1862.—The accident was occasioned in the following manner:—On Easter Monday, being out with his corps, the Wilton Rifles, and some distance in advance of a firing party, he received a violent blow to the nasal side of the right eye from a blank cartridge, which entirely deprived him of sight. He was at once taken to the infirmary, and carefully attended to. At the end of five or six weeks he could distinguish daylight; he now sees the outline of large objects. The pupil is drawn downwards and inwards, and to the nasal side. The iris is of a duller colour than that of the left eye, and bears evidence of an old iritis; there is also an extensive coloboma. The ophthalmoscope renders visible a square-shaped detached portion of retina extending from the iris to the optic nerve, which waves about when the eye-ball is put in motion. No vessels can be seen on the same side. A good deal of chorio-capillary congestion is still visible.†

In penetrating wounds of the eye, the ophthalmoscope is of the greatest use, as the situation of any foreign body that may have entered and been left behind is readily discovered, after the absorption of the effused blood, which in the first instance often fills the aqueous chamber. Dr. Jäger records an instructive case:—

"A workman, engraving steel, was struck by a chip, which, passing through the cornea and iris, lodged in the vitreous humour. Without suspecting the danger of his wound, he consulted Dr. Jäger ten days

* Mr. White Cooper, Lancet, 1862. † See plate 1, figure 4.

after, for a slight affection of the sight. There was only a very small trace of a wound in the cornea and iris. On examining the transparent media, a foreign body was seen enveloped in plastic exudation as a consequence of inflammatory action, the fragment of steel became encysted at the end of another week; the vitreous humour recovered transparency, but the sight gradually declined. Five weeks after the accident, separation of the retina was discerned in the neighbourhood of the cyst. The separation soon extended over a third of the inferior and anterior portion of the retina, whilst a portion of the encysted fragment had moved from its first position, and was gravitating towards the middle of the eye. This displacement was attended with a slight pricking in the external parts of the eye. A plastic deposit then formed, raising the retina and hyaloid in the form of a cone, at the summit of which was the encysted body. In three months the fragment had reached the centre of the globe. At first horizontal, it had now become vertical. The eye retained its form, the lens its transparency, and there was some amount of side vision."

With regard to cases of this sort, more than ordinary care is required in their investigation, to prevent any mistake as to the true situation of the foreign body; for in the illuminated field of the ophthalmoscope it may appear as if in front of the lens when it is actually behind it.

Rupture of the globe, with dislocation of the lens.—William F——, aged 48, admitted Oct. 5th, 1860. The patient, a baker by trade, stated that, five weeks before, he was struck on the left eye by a drunken companion, causing an extensive rupture of the globe towards the nasal side, separation of five-sixths of the ciliary processes, and dislocation of the lens into the anterior chamber. A quantity of coagulated blood filled up the space behind the lens. Ptosis and internal strabismus immediately followed the receipt of the injury.

He was attended by his usual medical man, who ultimately sent him to the hospital. When admitted, vision was wholly lost, and the pain more severe than for some days before. To relieve this pain and restore the part to a more natural condition, I extracted the lens, and with it the coagulated blood. This was done by a small upper section, and with considerable relief to the patient. A soft pad being afterwards applied, he was put to bed, and slept better than he had since the accident.

Oct. 7th.—A little puffy swelling about the lid. Having been accustomed to the use of stimulants, he was ordered full diet, with six ounces of gin daily.

On the 12th, the eye was opened; the patient could see light with it, but the flap had not firmly united.

24th.—Going on well; can see more light; no strabismus, but still unable to raise the lid. To take small doses of grey powder with quinine.

Nov. 6th.—Although gradually improving, the ptosis is still persistent. To change his medicine for strychnine, one-sixteenth of a grain thrice a day.

16th.—Discharged, much improved; vision considerable; has power over the movements of the eyeball, and some over the lid, being able to raise the latter sufficiently to see objects on the floor.

Dislocation of the lens is a very common consequence of injuries to the eye from severe blows, and cases are recorded where, in debilitated or naturally weak constitutions this occurs, from over exertion, and during severe fits of coughing, or even sneezing. The best way of determining whether the crystalline is in its natural situation or not, is by the catoptrical test; for if not in its place behind the iris, neither the inverted nor the more deeply erect image of a lighted taper passed in front of the eye will be visible; only the image formed upon the cornea. An interesting case of dislocation of the lens into the anterior chamber of the eye during a fit of violent sneezing occurred in my own practice.

Dislocation of the crystalline lens into the anterior chamber of the left eye during a fit of sneezing; displacement of lens in right.— A. B——. aged 36, a German, had always been myopic. Two months ago, the sight of the left eye became unusually acute, so much so that objects appeared as though seen through a magnifying glass, the nose seeming to him very prominent, and thereby causing much discomfort. On the 18th of April he was taking a walk, the sun shining strongly on his face, when suddenly he felt as though blinded in the left eye; he immediately put up his hand and rubbed it. It should be stated that just previous to this he had a violent fit of sneezing. The sight of the eye was not lost, but he became very near-sighted. He was seen by Dr. Grasemann soon after the accident, and by his advice he consulted me. The lens was distinctly seen in the anterior chamber, and had a most brilliant appearance. I recommended the pupil to be dilated by atropine, and the patient to remain quiet in the recumbent position; however, as he was in no pain and suffered no inconvenience, he would not consent to the confinement. On the 26th of April, inflammation set in, with photophobia, and the night was one of most intense suffering, so much so that he made an attempt to jump out of the window. Leeches were applied to the temple, morphia given in large doses, and subsequently chloroform administered, but without any alleviation of the extreme pain. On the 27th, nine days after the accident, he was admitted into the Royal Westminster Ophthalmic Hospital, when I extracted the lens, under chloroform. The extraction was made through a small section in the cornea, and was done under somewhat disadvantageous circumstances, as the anæsthetic had already produced very alarming symptoms. At seven P.M. he was comfortable and free from pain.

April 28th.—Had a good night without the administration of an opiate.

29th.—Still remains easy and free from pain.

30th.—Did not pass quite so good a night, but on the whole he was going on well.

May 4th.—To-day the eye was opened, and found to be progressing favourably.

11th.—A small piece of the iris has cicatrized in the wound of the cornea. To be gently touched with the nitrate of silver.

13th.—Being very anxious to go out, he was discharged, and has quite recovered, with tolerable sight, requiring the usual convex glass.

The lens, after extraction, was perfectly transparent, and apparently uninjured, except in form. When the eye was first examined—that is, two days after the accident—neither the vessels of the retina nor of the choroid were at all changed, or in any way congested. The lens in the anterior chamber pressing upon the iris, making a considerable concavity and acting as a foreign body, was the cause of the ciliary neurosis and torturing pain. "It should be mentioned," says my patient, "that both eyes were myopic, and more especially the right, which has been weak for several years;" accordingly I determined to make a careful examination of that eye also, and at once discovered that the lens was absent. Complete displacement had taken place, though it was with some difficulty I assured myself of the fact. By placing the patient, however, in a reclining posture, the lens came into view, and then, by employing oblique light, both Dr. Grasemann and myself made out to our satisfaction that the lens was quite transparent and perfect. It may be as well to note that, until this examination with the ophthalmoscope, although he had been under the care of more than one ophthalmic surgeon in Germany, the displacement of the lens of the eye had not been suspected.

Some details of vision under such circumstances will be interesting and new. As being the subjective observations of an intelligent man reporting upon his own case, I give in his own words what he aptly terms an analysis of his sight, and which he drew up for my information:—Nov. 1862.

"After the lens of my left eye had been extracted by you, in April, 1860, I made use of a pair of spectacles with convex glasses for reading and writing, of equal strength for both eyes, although the lens of the right eye still remained. For distant sight I made use of a second convex glass before the right eye, which was much assisted by the use of these glasses, as well in regard to clearness as to distance. During the latter part of the summer of 1860, I observed that I could no longer see so well through the glasses with my right eye; the glass of the spectacles in front of it seemed to have some dark spots upon it, which impeded vision, whereas other spots allowed me to see more clearly. I began to clean the glasses, but as all my endeavours were in vain, I changed them for others, but obtained no relief. Soon afterwards I could distinguish nothing with my right eye by the aid of spectacles and a lorgnette that I used at times. Then again it very soon began to gain its natural power of vision, so that I was enabled to read at a greater distance without spectacles than I had ever before been able to accomplish with or without spectacles. This appeared to me to be the consequence of over-excitement. Soon afterwards, this increased power of vision became interrupted, and I frequently saw objects double and triple, especially if at some distance off. This was again obviated by using the lorgnette with a convex glass before the right eye, but only for a short period. In November, 1860, an inflammation attacked this eye, which nearly deprived it of vision. By the use of warm fomentations, aperients, and iodine, the inflammation was at length arrested, and

I was again able to see—but, without the aid of spectacles, worse than ever; and with them, rather clearer than before. One day, whilst attempting to use my lorgnette, I was much surprised to find that I could see most remarkably clear with it. Nevertheless, I was very much annoyed by a very disagreeable appearance before my right eye, which has since continued. Whenever I lie down upon my back or stoop my head, a figure of an oval shape with a dark centre appears before my eye,* *the whole presenting the picture of the eye with the eye-ball.* This figure sinks from above downwards, and seems to float before the middle of the eye: it is transparent, and allows the right eye, when it is obliged to look through it, to see clearer than through a lorgnette. This vision troubles me more or less, as my health is better or worse. It seems to me, that this transparent figure has by degrees obtained a somewhat darker colour. As long as I look straight forward I do not observe it. I even now see rather better with my right eye than with my left, and can recognize all objects at a given distance without glasses; but I still want a clearness of outline, and especially when I do not feel quite well, or after exerting my eyes too much; objects, as human faces, appear to me to have taken another form. For about six months I have also observed that the pupil of my right eye has become much smaller, which has interfered with my vision. The use of belladonna always gives me great relief, and the day after its use I see things in their true and natural form."

March 8th, 1863.—This patient applied again this day, the lens having accidentally passed into the anterior chamber, whilst stooping. Upon dilating the pupil, and placing him in the horizontal position, it went back without giving him further annoyance, and only a very slight degree of pain.

Still more recently a case came under my care, where a displacement of both lenses occurred in a child, the result of severe fits of whooping cough.

The patient, J. A——, a boy, five years old, whose father had died of consumption. The mother also was exceedingly delicate. The child had suffered from a succession of infantile diseases, the whooping cough

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* The lens rising up and occupying the pupillary aperture would produce this appearance.

having supervened upon an attack of measles. His sight, always weak, now failed him so much that he could only distinguish large objects, and those in a strong light; he was continually running against the chairs and tables. In general appearance the little patient was decidedly strumous, small in stature, the legs bent and generally deficient in bony material, the teeth being decayed and deficient. A careful examination proved that the lens of the right eye was displaced, without doubt displaced by the violence of the cough, which usually produced bleeding of the nose. In the left eye, still further mischief had resulted: the lens had in all probability been dissolved, as no trace of it could be seen after a most careful search; a portion of the retina had also become detached.

That a very severe injury to the eye, accompanied with dislocation of the lens, sometimes occurs, with a singular facility of reaction in the parts, which might suggest the ordinary phenomenon of healing by the first intention, is evident from the following case :—

Jane S——, aged 46, applied for relief July 16th, 1862. She states, two days ago she received a blow from her husband with a candlestick, and found herself suddenly deprived of sight, attended with considerable pain and uneasiness, for which she was recommended poultices. The left eye is softer to the touch than the right, and rather swollen at the inner canthus; the cornea is transparent; the iris irregular and dilated; the lens can be seen moving in the vitreous humour; it is still transparent, and admits of the retinal vessels being observed; they appear to have lost their outline, from an effusion of blood, which is floating about in patches; the optic nerve is also observed to be covered by a clot. Ordered: Pil. hyd. cum opio. om. noct., and aperient draughts; to apply three leeches, and use warm fomentations. On the 23rd, much better; vision in a great measure restored to right eye. In a fortnight this patient recovered sight in the right eye, and partially in the left, when she left the hospital.

Cases such as the following cannot in future occur, with the ready means now possessed of detecting displacement of the lens. Immediate action, after first symptoms have subsided, must be taken to remove the lens, with every probability of saving the sight of the injured eye. All the evils arising from sympathetic irritation extendiug to the other eye will also be obviated or prevented.

Dislocation of lens into anterior chamber; sympathetic irritation of opposite eye.—W. A——, aged 60, a mason, admitted Aug. 29th, 1861. Injured the left eye with a lath 35 years ago. No doubt at this time the lens was displaced by the blow; for, immediately after, he suffered from severe inflammation of the eye, and when he recovered, could barely tell light from darkness. About six months later, some lime fell into the eye; although this did not give him much pain, he has since been perfectly blind. For the last ten or twelve years, a hard yellowish-looking lens has been lying against the cornea. In front of the lens, and as if adherent to the cornea, is some cretaceous-looking deposit. Pupil dilated and fixed. Retinal vessels of opposite eye congested, and sight much impaired.

Aug 30th.—I extracted the lens by the upper section; it was adherent to the cornea, and some adhering portions were with difficulty scraped off.

Sept. 1st—Pain less; no swelling. 7th—General health improving. Gutt. Atrop.: Mist. Ammon. c Cinchon. 11th—Discharged. Vision improving.

DISEASES OF THE RETINA.

Retinitis, acute and chronic—Hyperæmia—Congestion—Apoplexy, simple and complicated, with Retinitis Pigmentosa, Albuminuria, and Syphilitic Disease—Effusion, Œdema, Detached Retina, Anæmia, Hemeralopia, Nyctalopia, Hemiopia, and Asthenopia.

Now that the ophthalmoscope gives such sufficient opportunity of distinguishing between functional disturbance of vision due to general and remote causes, and those positive objective appearances by which local disease may be almost unmistakeably known, the necessity has arisen for a complete revision of ophthalmic nomenclature, with corresponding distinctness of definition, so that totally different diseases may not be confounded together, as was formerly too apt to be the case. This may be especially observed of a large class of symptoms which formerly occupied so much of the attention of surgeons under the vague and indefinite term of amaurosis, and of which one distinguished practitioner in eye disease has observed, "both the patient and the doctor were blind." Without attempting, however, the arduous task of taking up the several varieties of amaurosis which have been invented to meet the extraordinary nature of the various cases which were classed under this head—or endeavouring to reconcile a few of the more prominent and persistent symptoms with specific appearances in the ophthalmoscope, for the purpose of perpetuating what can only be now considered a superseded term—I have sought to base my remarks upon the principle of connecting with the name of the chief seat of the objective symptoms the usual affixes indicative of inflammation, congestion, &c.

The use of the tongue in determining the condition of the stomach is not more available now, than the corresponding resource in affections of the brain which the possession of the ophthalmoscope affords. The different phases of congestion, from the first sense of fulness, weight or heat in the eyes after exertion, to the more distressing symptoms of retinitis, appears to me a wide field for further observations in this direction. As has been justly observed by Mr. Swan,* "In diseases the retina sympathises directly] with the brain through the visual track producing either an increased susceptibility from excitement, or a dulness from debility and oppression. It sympathises through the involuntary tract with the par vagum in disorders of the lungs or stomach, and in a less degree with the par vagum in disorders of the heart and part of the intestines which are more fully supplied by the sympathetic nerve. It sympathises with the sensitive

* Swan 'On the Visual Powers of the Optic Nerve.'

tract through the sentient nerves in disorders of the skin and conjunctiva. It sympathises least of all with the parts chiefly supplied by the sympathetic nerve, and, only, through the filaments of this nerve given to the ocular artery in common with the rest of the internal carotid supplying the brain."*

Before exact knowledge was possible, retinitis or inflammation of the retina was a matter of very difficult diagnosis; and the very different descriptions of the disease given by various writers were accordingly a source of much inconvenience, especially to young practitioners. And, at first sight, some embarrassment may still arise, unless great care is taken to distinguish between the appearances of increased vascularity in the retina, and the choroid with which it is so closely associated. In the former, however, the opacity induced is more general, and of a misty foggy-looking pinkish grey, through which the small blood-vessels of a deeper red are indistinctly perceptible. The periphery of the optic nerve becomes ill defined, and the central vessels enlarged, the veins especially so; nevertheless, their course is traced with difficulty. It may be also observed, as useful, that in eyes with a scanty pigmental deposit this opacity is not so well discerned as where the fundus presents a comparatively dark ground. Sometimes the loss of transparency may be traced to serous transudation into the vitreous humour. In choroiditis, the effusion would be under the

* "A man possessed of a sound mind in a healthy body, endowed with organs of sense of perfect construction, and keeping in all things within the bounds of temperance and moderation, would be absolutely free from illusions and hallucinations. His eye would present to him none but real sights; his ear would convey to him only real sounds. His sleep would not be disturbed by dreams. The only sensations not exactly corresponding to external objects which he would experience, would consist in the substitution of the complementary colours for each other, if he fatigued the eye by fixing it too long on some bright object. The golden sun would appear to his closed eyes like a violet-coloured wafer; a window frame would seem to have dark panes and light sashes, and a dark picture with a gilt frame would have its light and dark features transposed."

retina, lifting it up in distinct patches. When the capillaries of the retina are ruptured, owing to over distension, the usually hæmorrhagic points are also visible. Sometimes, when the case has become chronic, deposits upon the choroid can be discerned, of a peculiar character, as a narrow zone of a whitish colour surrounding a central spot of a pearly lustre. When the optic nerve entrance is undistinguishable from the rest of the fundus, its position is best determined by the point of exit of the larger veins. Serous effusion often takes place when retinitis occurs in connection with a syphilitic disease, or in strumous habits. The earliest symptom of the disease is a gradual loss of sight; this increases until objects are recognized only with difficulty. The pain accompanying the inflammatory stage may not be sufficient to direct the patient's attention to the threatened mischief; so that the excessive photophobia and photopsia, upon which much reliance was formerly placed, is now known to be of little value or assistance in our diagnosis of retinitis.

Retinitis.—J. B——, aged 34, a clerk, admitted Sept. 6th, 1855. First noticed a remarkable reflection of the gas in church; saw two distinct rows about a quarter of a yard from each other. Upon making a further effort, found he could not see to read with the left eye; there was a mist immediately over the spot he looked at, and the lines, instead of appearing straight, were zigzag, and every upright object diverged from the perpendicular to the right; thus the sight became gradually more and more indistinct, until at last he could only discern large objects. He was more or less troubled with flashes of fire.

Ophthalmoscopic examination.—The central vessels of retina much congested, and optic disc nearly obscured by an apparently overhanging cloud or capillary web. Ordered Plummer's pill, five grains, every night; and sulphate of magnesia, half an ounce, the following morning. This treatment was occasionally discontinued, and then again resumed.

On the 20th of October, he said, "I can now see a considerable distance; but every object appears to be in two places, the one not so distinct as the other. I cannot yet see to read other than very large print; for instance, the heading of a newspaper. The lines are, however, much straighter than formerly." At the end of another month, he reports of himself, "by a steady adherence to your plan of treatment, I am much improved, and able to return to my duty."

Retinitis.—John W——, aged 26, a plumber, admitted Sept. 5, 1861. Always had good health and sight up to the commencement of the present year. He then received a blow on the forehead, and from that time his sight has been growing dim, especially that of the left eye, in which he first perceived a change. The right eye remained perfectly good until March, when, after the application of a few leeches to the left temple, vision in this has been gradually getting weaker; and, later, flashes of fire, with considerable pain in the head. The globes are hard to the touch; pupils slightly dilated and inactive. With the right eye he can only count fingers and make out a few letters, No. 20 type-tests; with left he cannot do this—even No. 20 is seen as a black patch.

With ophthalmoscope the fundus is seen to be dotted over with very red spots of blood; a dark crescentic ring nearly surrounds the optic nerve; the vessels are distended, but very ill defined. As the treatment he had been the subject of during a greater part of ten months had effected so little for him, I resolved, first to try division of the ciliary muscle, for the relief of a considerable intra-ocular pressure, and afterwards a mild course of mercury. On Sept. 6th, I divided the ciliary muscle in both eyes. On the 16th, the mercury was changed for iron. Four days later, he was able to read No.12 type-tests, and became an out-patient. Great relief to all his symptoms, with amendment of sight, took place in a month from the time of his admission.

Hyperæmia of the retina is a disease very frequently met with among persons engaged in occupations requiring constant and close use of the eye on small objects, such as engravers, jewellers, watchmakers, &c. who for the most part become presbyopic at a comparatively early age. The earliest inconvenience arises from a sense of heaviness in the eyes, with dimness of the sight, an oppressive fulness in the brain, and flushing heats over the scalp and face. At first, these are relieved by temporary rest, but only to return on resuming work. The ophthalmoscope reveals distension of the blood-vessels, the capillaries being enlarged, and the circulation through them impeded. The congested condition of the retinal papilla is perhaps due to the direct compression of the veins by a corresponding condition of the vessels of the choroid. These appearances give way to proper measures of relief, as perfect rest to the eyes, &c. Some consider hyperæmia explained by the fatigue of the powers of accommodation occasioned by the continued effort of the ciliary muscle to shorten the visual focus.

The second variety of hyperæmia is most commonly met with in adult age, where the system has become debilitated by long-continued abuse of tobacco and alcoholic stimulants, and illustrates how naturally the fundus of the eye assumes conditions indicative of the general state of the body. The patients present the usual symptoms of incipient cerebral disorganization, in the tremulous movements of their tongue and general appearances. Here, on examination, will be found congestion much more considerable extending over the retinal field, and concealing in a great measure the papilla by a uniform deep red hue. When the optic nerve entrance is thus undistinguishable from the rest of the fundus, the course of the vessels which are still visible enables its situation to be made out.

I have met with many cases of hyperæmia arising from over-work of the organ, exposure to cold and fatigue, and also from concussions produced by falls or blows, accompanied by some slight amount of cerebral disturbance. The ophthalmoscope reveals the slightest degree of effused blood, and we can watch day by day its gradual absorption, and the restoration of suspended vision. Hyperæmia is usually characterised by increased vascularity, chiefly arising from the capillary injection over the optic disc, and a greater degree of venous congestion, which rapidly produces loss of transparency in the retinal membrane and vitreous humour. When these changes are associated with capillary hæmorrhages, then I consider the case is one of apoplexy of the retina, and consequently of a more serious character, often ending in disorganization of the retina. A good example of the simplest form of hyperæmia occurred in a shepherd lately under my care. He was much exposed during the cold nights watching his flock; at the same time his food was insufficient in quality and quantity. His first annoyance arose from an inability to count his sheep: this was soon followed by more alarming symptoms, for he could no longer see them, and had great difficulty in finding his way home. There was little or no pain, and when sent up to the hospital, the vascular distension was considerable over the whole fundus. Under good diet, nursing, alteratives, and tonics, in about a fortnight he was discharged, cured.

Hyperæmia frequently occurs in young persons; among schoolboys I have met with several cases.

Master M. B——, aged 12, a fair delicate-looking boy, not very robust, after long fatiguing play, came home complaining of dimness of sight. Next day he was unable to read his lessons; but as there was no objective sign indicative of any change in the eyes, his statement was discredited, and little or nothing was done for a week or more, when the boy's state became more alarming, and the medical attendant recommended the master to bring him to me. He could only see the largest of Jäger's test-types, there was great uncertainty in his walk, with an evident dragging of one leg. On examination with the ophthalmoscope, I found hyperæmia affecting both eyes. My treatment consisted in rest, alteratives, iron, and counter-irritation. I saw him again in a fortnight; he was then improving, and could read No. 12 test-types; and at the end of a month, the retina was restored to health, and he has since remained perfectly well.

Master H——, aged nine, a delicate-looking boy, with a fair complexion, during a railway journey kept his head a good deal out of window of the carriage: when he got home he complained of being unable to see. He tried to read, but found all the letters running into each other; he could only make out a part of very large type. Except a slight strabismus in one eye, and somewhat dilated state of the pupils, nothing could be made out of his case, and, therefore, a little opening medicine was given the first week. The boy still persisting in his first statement, his friends brought him to me. The hyperæmia here was very considerable; under a similar kind of treatment as that adopted in the former case, he quite recovered.

I could multiply these cases, and quote numerous examples, with some slight variations, more especially occurring, I would observe, among children of the poor: but, as my object is to direct attention more to a class of cases which have been quite unintelligible, and must have remained so without the aid of the ophthalmoscope, I content myself with the recital of a few well-marked instances.

Chronic Retinitis.—In chronic retinitis, the symptoms are of the same character as in hyperæmia, but more strongly marked. The uneasiness and aching in the eye are much more troublesome; frequently the pain is severe; in many cases there is violent headache. The vision has lost its clearness; small or distant objects, in particular, are no longer sharply defined. The field of vision is sometimes encroached upon in various directions. Light is unpleasant, and the patient finds comfort in the shade. The sight fluctuates much and rapidly; sometimes it is lost altogether for a few minutes. Most patients complain of a haze or fog before the eyes, which may increase in density until the sight is destroyed. In some, any sudden concussion of the body—as that produced, for instance, by stumbling, coughing, or sneezing—produces flashes of light, as if the eyes had received a blow; others see brightly-coloured spectra, in the form of rings, spots, &c. For my own part, I look upon this disease as one, more of a *recurrent*, than a chronic character; it is also very often complicated by some change in the choroid coat, and exudation between the two membranes.

Ophthalmoscopic Appearances.—At the first glance, we see that the optic nerve is not in a normal condition, and that the fundus of the eye in its immediate neighbourhood has undergone some change in colour. In very slight cases, a portion of the margin of the disc is concealed by a fasciculus of vessels. In more advanced cases, one-half or more of the papilla may be concealed; in confirmed cases, the whole of the papilla is so covered that it requires some attention to make it out. The situation can always be discovered by the converging point of the central veins and arteries, which retain their distinctness, although it is frequently very difficult to trace any part of its circumference. The retina may preserve its natural appearance, but occasionally we find an ill-defined spot, in which the colour has become somewhat changed and brightened, the hue being yellowish red, with a slight glaze of a bluish or greenish tint. The region about the *macula lutea* is generally very red.

Chronic Retinitis.—Thomas R——, aged 29, dissenting minister. Two years ago, a speck appeared in each eye, and so annoyed him that he was obliged to consult a medical man, who pronounced it incipient cataract; not feeling satisfied, he was induced to go to a homœopath, who had him under his care for three months; but not the slightest benefit resulted. He was subsequently blistered and subjected to other treatment; still his sight became worse, and he was then sent to me. At the time, September, 1857, his general health was good, with the exception of occasional headaches.

Examined with ophthalmoscope.—In right eye a few very slight bands of lymph adherent in the anterior chamber, partial synechia; this eye he believes "to have been much inflamed during first attack, two years ago." Vessels of retina obscured by a dark-red spot surrounded by a greyish ring. The left is rather paler; has also a red cloud surrounded by a ring, and tortuous and congested vessels. The pupil of the left eye is dilated. In this case the congestion gave a greyish opaque appearance to the lenses; the patient experienced much relief from attention to his general health, with improved diet, rest to the eyes and over-worked brain. On the 27th of January, 1858, he thus writes to me:—"I have been compelled to leave London to attend to my ministerial duties; but during the time I was under your treatment my eyes improved so much that I am quite sure, if I could have remained near you, they would have continued to improve, and perhaps by this time been quite well; nevertheless, I am able to pursue my avocation."

Chronic Retinitis.—A. B——, aged 29, law-clerk, a thin, tall, pale-looking, nervous man, applied to me June 29th, complaining of insensibility of retina of the left eye. During several months past, his eye has given him pain and annoyance; at present time he cannot see to read or write with it; general health tolerably good; but frequently suffers from bilious attacks. The iris of left eye slightly changed in colour; the lens by daylight appears opaque; but upon making an examination with the ophthalmoscope, it was seen to be perfectly clear, the colour being evidently due to congestion behind the lens. The vessels of the retina irregular, and so much congested as to conceal the entrance of the optic nerve; slight serous effusion between choroid and retina. Pil. Hydrargyri with aperients were ordered continuously. Under this treatment he improved; tonics were then prescribed for a fortnight, and at the end of a month he was able to resume his occupation.

These cases illustrate the value of the ophthalmoscope in deciding the question of opacity of the lens, thereby enabling us at once to direct attention to the seat of disease; hence the favourable results. I have lately seen this last-mentioned patient, who has had no return of the affection. He has, however, strictly followed the advice given him as regards rest to the eyes and attention to his general health.

Chronic Retinitis, from an old apoplexy.—E. V——, aged 31, states that in his left eye he has three or four deep brown scales, and one much larger than the rest. They are enclosed in circles by day, and at night resemble spots and a network of blood; occasionally long streams of light flash over the sight. Believes the disease was produced by a blow on the temple about seventeen years ago, for which cupping, leeching, and salivation were resorted to, but did not quite remove the dimness of vision. With the ophthalmoscope the retinal vessels of left eye are seen to be much congested; these give off a circular zone of vessels, which mask the entrance of the optic nerve. In the right eye there is less congestion; but many vessels run over the entrance of the optic nerve, and are no doubt the cause of the web-like appearance complained of. Small doses of Hyd. cum Creta at night, and a mixture of Ferri. Cit. with Quinine and Sulphate of Magnesia twice a day, were prescribed, and regularly taken for three months. I then examined his eyes, and found the congestion had considerably diminished, and the entrance of the optic nerve, with its vessels, was in a healthier state: he was able to resume his former occupation.

Dr. Anagnostakis relates of one: "Beillaud, a bookkeeper, aged 42, of a sanguineous habit, who, during recovery from an attack of dysentery, experienced, without any known cause, a remarkable weakness of sight; at the end of a month the left eye could scarcely distinguish day from night. With the exception of a greenish opacity, a slight dilatation of the pupil, and some injection of the conjunctival vessels, there were no other symptoms to account for the blindness. The ophthalmoscope revealed congestion of the vessels of the retina, with many small hæmorrhagic patches of different shades of colour distributed over the retina."

In several cases of congestive amblyopia, which came under the care of Dr. Anagnostakis, as well as in a few advanced cases, in which the eyes presented a peculiar glaucomatous appearance, he observed blood effused beneath the retina; in other cases, hyperæmia of the retina was the only alteration he could positively make out, and in no instance was there any change in the crystalline, or vitreous body.

Apoplexy of Retina.

The constant association of a critical phenomenon affecting the fundus of the eye, with a general epileptic seizure in the system, and producing the ophthalmoscopic appearances of congestion, rupture of small blood-vessels and slight opacity in the retina, would warrant the supposition that a premonitory stage exists, advantage of which might be taken to arrest the progress of the constitutional evil, if means were taken to discover its existence by an early examination of the eyes. Loss of vision mostly confined to one eye is associated with other symptoms of paralysis affecting the same side of the body, and is occasionally seen in the plethoric as well as in the anæmic subject; the local circulation being affected in one case with positive, in the other with relative, plethora. The loss of sight is frequently preceded by some kind of fit, or confusion of the senses, of which the patient has retained a very imperfect recollection, and therefore can give no very satisfactory account of the attack. In some cases which have come under my observation, the symptoms have given so small an amount of inconvenience and uneasiness, that, but for the loss of vision and ptosis, these persons, in all probability, would not have placed themselves under medical treatment. In apoplectic or paralytic ptosis, the orbicularis palpebrarum, preserving its power, keeps the eyelid constantly closed, so that the patient can see nothing unless he raises the lid with his finger; when he does, he sees everything around him double; and if he tries to walk, he is immediately affected with an amount of vertigo that may cause him to fall to the ground. Upon raising the lid, the pupil is seen to be fully dilated, or much more dilated than that of its fellow. This is associated with an amount of obscuration of vision varying in kind and degree with the extent of the retinal hæmorrhage.

Dr. Brown Séquard writes—" But few persons are aware how completely certain cases of paralysis, from alterations of the blood, may resemble the paralysis due to an organic disease of the brain. I have seen several cases of paralysis of most muscles of the body accompanied with symptoms of an organic affection of the brain, such as ptosis, diplopia, amblyopia, giddiness, loss of speech, occasional delirium, loss of memory, &c.; in other words, such a group of symptoms, that, had not proper care been taken, a mistake of diagnosis would have been made. The influence of the treatment in those cases confirmed my view of the nature of the affection, and the patients were cured or much benefited by iron, quinine, strychnine, ammonia, cod-liver oil, wine, cold douche on the spine, shampooing, and other means of tonic treatment. The many causes of alteration in the quantity and quality of blood, such as dysentery, typhoid fever, measles, scarlet fever, diphtheria, albuminuria, intermittent fever, &c. are all able to produce paralysis; and, as a general rule, the paralysis, owing to an alteration in the blood, extends to the muscles of the trunk and limbs."

The ophthalmoscope shows a considerable amount of capillary congestion, which nearly hides the optic disc from view; the fundus is studded with clots, and it is in vain to expect to see the ruptured vessel. The only guide we have, and whereby we are enabled to say whether the effusion be recent or otherwise, is the colour. We can distinguish the crimson colour of fresh blood from the older apoplectic clots, which closely resemble the dark colour of venous blood; or, from having become rusty, leave dark, hæmatine stains in the meshes of the retina. The most noteworthy part of the treatment in such cases is the speedy relief of the more urgent symptoms by the division of the ciliary muscle, especially when effused blood is seen in the vitreous humour, or making its way towards the anterior chamber. The pressure on the retina is at once relieved.

Apoplexy of the retina; clot covering the macula lutea.—Margaret A——, aged 39, admitted August, 1862. On the Monday previously to applying, had fallen asleep after several days' suffering with headache and giddiness. Upon being suddenly roused, she found the sight of the right eye completely gone, and could not distinguish daylight. Had three attacks of paralysis when a child, and is still unable to use the right leg, which she drags after her, and requires a stick. Has had no attack since she attained womanhood. Two years ago, lost her mother suddenly, and has suffered much from domestic troubles and bad health.

The ophthalmoscope shows a large number of extravasated clots of blood over the fundus, and one in particular covers the macula lutea. The vision of the left eye is also dim, and she cannot see to read medium types. The treatment consisted of small doses of calomel, with iodide of potassium, and a seton in the temple. In a few days the mouth became tender from the calomel, and she was obliged to discontinue taking it.

Sept. 6th.—Mouth still affected. Sight of right eye very materially improved; can distinguish faces, but unable to read, even largest type.

26th.—Sight improving; can now see large type. Last report, M. A. is making slow but steady progress.

Retinal Apoplexy; Ptosis and Paralysis of same side.—William C——, aged 31, mariner, after long exposure at sea, in the beginning of 1861, was seized with pain and numbness down the right side. This continued for some weeks, when, after a sudden unconsciousness of everything around, which appeared to him to last but for a few minutes, there remained considerable pain on the right side of the head, and he found he had lost the power of raising the right eyelid; he saw double, and his vision was much confused and very imperfect. As soon as he landed, he made his way to the Royal Westminster Ophthalmic Hospital. He was in a low state of health, pulse weak, which he said arose from salt food and long exposure during bad weather at sea. He had still numbness in his arm and leg, with some dragging of the latter. When the eyelid was forcibly raised, the pupil was seen to be dilated to the fullest extent, and directed outwards. The ophthalmoscope showed a number of apoplectic clots in the meshes of the retina, considerable capillary congestion covering the optic disc, and a few floating masses in the vitreous. The eyeball appeared harder to the touch than its fellow.

The treatment consisted in good diet, and small doses of Hyd. cum quina, with Mistura ferri sulph. At the end of three months he was able to resume his occupation, having nearly regained the muscular power of the eyelid and limbs, and vision was much improved.

Retinal Apoplexy; Ptosis of Right Eye; Partial Paralysis of same side.—William M——, aged 38, labourer, had an attack of rheumatism after working in damp and wet; this was followed by a fit, and he was taken to a general hospital. Four months afterwards he had another fit, and found he could not lift his right hand, nor open his right eye. When he applied for advice, the numbness of the limb remained; could not protrude the tongue without it turning to the right side; upon raising the eyelid, there appeared a slight external strabismus, and fully-dilated pupil. Vision almost lost; could scarcely distinguish the daylight. Pulse small; in a low state of health; apoplectic clots cover more than half of the optic disc; retina much congested; vision in left eye imperfect; can read only large type. After having this man three weeks under treatment as an out-patient, and finding he did not improve, I admitted him into the hospital. He was put on full diet at once; and this, together with warmth and a comfortable bed, to which he had not been accustomed, and a mixture of iodide of potash in dec. cinchonæ, in three weeks restored the muscular power of the eye: he can now read No. 12 test-types at 18 inches, and grasps the hand firmly. Good food and rest no doubt effected as much in this case as medical treatment.

Apoplexy of Retina; Ptosis of Right Eye, and slight general Paralysis.—John D——, aged 33, a carman, generally enjoyed a fair amount of good health, although exposed a great many hours to the cold in his daily occupation. About three months before, suffered a good deal from pain across the forehead; this was followed by dimness of sight, which however passed away. The day previous to his admission, he was driving in the city, when he felt a numbness in all his limbs ; his sight became suddenly dim, and he was obliged to give up the reins to a youth who was with him at the time. The right eyelid immediately became closed, and when he got home he could not find his way about. This was accompanied by much pain over the brow, and great inability to raise his arms and walk about, and protrude the tongue. On the following day, a good deal of the paralysis had disappeared, and he was brought to the hospital ; the ptosis and dimness of sight were about the same. Upon raising the right eyelid, the pupil was seen to be completely dilated, and the fundus much obscured by apoplectic clots ; the left eye shared in the congestion, although with this he could read the largest test-types.

The treatment consisted in giving small doses of Hyd. cum quina every night, with the iodide of potass and bark mixture three times a-day. Full diet, warmth and rest. At the end of two months, he perfectly recovered his health, his sight being quite restored.

Apoplexy of Retina ; Ptosis of Left Eye ; Partial Paralysis.—Henry H——, aged 34, a shoemaker ; a pale-faced, sickly-looking man ; has had several slight paralytic fits ; lives irregularly, and cannot afford to eat meat often. Was treated for the fit in a general hospital, and regained the use of his limbs ; but the ptosis of left eye remains the same. He has no power over any of the muscles of the eye ; it, therefore, remains immoveable, and directed slightly outwards. The pupil is fully dilated ; a few apoplectic clots seen distributed over the fundus, as well as in the meshes of the retina, with considerable capillary congestion. The optic disc appears to be whiter and larger than in the normal eye. The treatment adopted in this case has been counter-irritation, with strychnine, iron, and quinine. He has been a little more than a month under treatment ; but no great amount of improvement has as yet taken place. We here lack the good and sufficient food required to second the efforts of medical aid.

With the gradual absorption of the effused blood, a corresponding restoration of vision is expected ; otherwise the case becomes chronic ; we have then remaining partial insensibility of retina, and a form of disease which has been termed by some, *retinitis pigmentosa*, the fundus retaining its confused patchy appearance, having dark-coloured masses entangled in the retina, as well as in the vitreous humour.

The sudden loss of vision, the dilated pupil, the special and general paralysis, are so many well-marked symptoms of paralysis due to alteration in the quality or quantity of blood; and, assisted by the ophthalmoscope, there cannot now be much danger in confounding such cases with those arising from an irritation of certain parts of the cerebellum, acting upon some portion of the nervous apparatus of vision, and thus producing paralysis of the retina. The cases narrated are not selected, but taken casually from among numerous others, the same in their general characters, and go far to show that " disease is in all cases not a *positive existence*, but a *negation ;* not a new excess of action, but a *deficiency ;* not a *manifestation of life*, but partial death ; and, therefore, that the business of the physician is, directly or indirectly, not to take away material, but to *add ;* not to diminish function, but to give it play; not to weaken life, but to *renew life*.*

Retinal Apoplexy, from Kidney Disease.

The interstitial substance of the retina, formerly believed to be nervous fibres, is now known to consist of a highly developed connective tissue, which supports the grey nervous layer and its delicate capillary system. It is in this connective tissue that, in *albuminuria retinitis*, fatty degeneration is first developed. A congestive stage of the vessels of the retina leads to minute extravasations, which become centres of induration. These seem to follow some order of progressive production, as the patches gradually enlarge, with a disposition to form an elevated zone round the optic disc, as if due to some deposit or exudation beneath the retina.

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* Dr. T. R. Chambers, 'Medical Times,' Nov. 1861.

According to development, there is also a proportionate degree of insensibility to light, up to complete loss of vision. Other appearances may be also frequently observed, such as the formation of large granular corpuscles, with a certain swelling up of the nerve fibres, causing them to look like ganglionic cells. The fatty degeneration will sometimes be found to extend to sclerosis of the choroidal vessels.

At the beginning of 1861, a young lady, twenty years of age, came under my care, with unmistakeable symptoms of albuminuria; but at that time I was unable to make out the characteristic changes in the retina. There was some congestion of the fundus with a slight haziness, which gave a little appearance of muddiness to it. Although at this time the sight was not impaired, I perceived a small amount of effusion between the retina and the choroid in both eyes. Before she died, however, I had ample opportunities of noting the progress of the disease, as revealed by the effects upon the retina in such cases. The blood is so altered by the disorganization in the kidneys, which separates and discharges in the urine the albumen and red corpuscles, whilst the urea is conveyed into the system, that almost every organ suffers from this circulating poison; but it is only in the retinæ that the subsequent progressive changes of structure are visible. Ten days before the death of this patient, she saw with difficulty, and at length could scarcely distinguish night from day. (See fig. 7, plate 2.)

Another interesting case was that of Mr. U——, aged sixty. The loss of vision was confined to the left eye. The disease of the kidneys had been diagnosed for upwards of two years. When he consulted me, the sight of the left eye was considered to be lost; but by a course of medical treatment he regained about half vision; for when he turned his head towards the left shoulder, he could see a dim outline of half my face, and large objects generally. At the time, however, he seemed to be progressing most favourably, an attack of hemiplegia suddenly carried him off. The first symptoms of the fatal attack were pain in the head, followed by slight twitching of the face and impediment of speech. After a few weeks' care and medical attention, these symptoms passed away—only, however, to be followed, in three or four weeks' time, by a more severe fit, depriving him entirely of the use of the left side. Insensibility of retina, still confined to the one eye, was now complete; the patient became comatose, and died in forty-eight hours.

The following cases are instructive, inasmuch as I was led to believe in the existence of albuminuria from the ophthalmoscopic appearances of the retinæ. The value of such a means of diagnosis therefore cannot be estimated too highly, when the treatment depends so materially upon the nature of the constitutional disorder.

Daniel F——, aged forty, admitted August, 1861, a gas-fitter, complained of very defective sight in both eyes. Had been rather a free liver, and twice under the influence of lead poison. For two years, had noticed swelling of the legs; but, as he felt no inconvenience, had neglected to attend to it, nor did he notice whether at the time he passed less urine than usual. About three months since, he suffered a great deal with headache, and had frequent calls to pass his water during the night; the legs again swelling; undoubtedly œdematous. Slight pain in the loins, urine scanty, albuminous and of low specific gravity.

Ophthalmoscopic examination.—Pupils normal; numerous hæmorrhagic spots distributed over the fundus, especially around the optic discs; in the left eye more apparent than in the right. Interspersed throughout were also observed several white patches, having a granular appearance and highly refractive, and which I pronounced to be fatty degeneration of the retina. The urine was subjected to a closer examination, and found to contain albumen. A course of compound jalap powder, with preparations of iron, re-established the health of this patient, with improved vision, in two months after the date of his admission. (See fig. 10, plate 3.)

John W——, aged 26, admitted September, 1861. Always enjoyed good health and sight until the previous Dec. when he received a blow over the left eye, and shortly afterwards dimness of sight commenced, which chiefly annoyed him towards night. Three months ago, when his right eye first became affected, he went to a medical man, who leeched and blistered him; but his sight getting worse, he applied at the Royal Westminster Ophthalmic Hospital, and was admitted. The eyeballs were much harder than natural, and the pupils somewhat dilated and inactive. With the right eye can count fingers and place his finger on the largest test-types. With the left, the fingers and test-types appear like black patches. With the ophthalmoscope, the retina of each eye was seen to be covered with hæmorrhagic spots and white patches, especially around the optic discs. The retinal veins were remarkably tinged, and dark in colour. With these indications, I was led to examine his urine, and found it of a very low specific gravity and albuminous, which directed the course of treatment.

In this case, from the evident turgidity, and intra-ocular pressure which accompanied it, I was induced to divide the ciliary muscle in both eyes, and had the satisfaction to find vision very much improved the third day after the operation. In about three weeks from the date of admission, he was able to read Nos. 10 and 12 test-types.

Dr. R. Liebreich relates an interesting case of retinal apoplexy associated with Bright's disease, in the 'Archiv. für Ophthalmologie,' 1859. He gives likewise a summary of the diagnostic appearances to be looked for. "It commences with retinal hyperæmia, the veins being fuller and more tortuous, becoming dark-red, and sharply outlined on the comparatively dulled retina. Blood, frequently in the form of radiating streaks, is deposited between the nerve-fibres, sometimes as oval or round spots, which still more obscure the vessels and fundus. The optic disc is ill-defined, appearing but faintly under the effused blood. Small white round elevated spots are subsequently seen in different parts of the fundus oculi; these increase in number around the optic disc; there is, however, a greyish part of the retina left, somewhat circular in form, and rather larger than the optic disc. From its periphery, a thick, milk-white layer of granule cells is deposited and continued along the course of the larger vessels. Later changes take place in the retina on the edges of the layer; the granule cells do not appear in large white spots which have coalesced, but as groups of smaller ones, which arrange themselves peculiarly in the form of rays, while the middle of the macula lutea appears dark-red, contrasting with the white patches which surround it. In the normal parts of the retina, small ecchymoses soon take place, and more extensive extravasations cover a great part of the layers of fat, and transform the whole into a dark-red surface, or the retina becomes detached in its normal parts."

Virchow regards the white patches of fatty degeneration described, as enlargements of the ganglionic cells, and not hypertrophy caused by fatty degeneration. Further microscopical research will alone decide this point; in the meantime, when such appearances present themselves to the eye, we should be led to investigate the state of the heart and kidneys.

Other German writers have given us rules whereby this form of the disease may be the more readily diagnosed. It is said that "Retinal apoplexy arising from albuminuria may be distinguished from that produced by other causes. 1st. In apoplexy from albuminuria, the two retinæ are commonly attacked at the same time, although in a more or less degree. In apoplexy dependent on other causes, one eye alone is generally affected. 2nd. In albuminuria, the effusion takes place around the optic papilla, in the form of a fan, but only rarely so in other cases, where also the effusion is situated at the lower part of the retina, behind or above the papilla. 3rd. In albuminuria, besides the apoplectic clots, and the injection of the papilla, there is a marked muddiness of the whole central part of the retina, dependent on commencing fatty degeneration; on the contrary, when the apoplectic spots, although, perhaps, as numerous as those dependent on albuminuria, arise from another cause, the retina is transparent, even in their immediate neighbourhood. 4th. In albuminuria, most of the apoplectic spots are arranged along and close to the veins, and generally behind these vessels, so as to present a linear striated appearance. In other cases, *un*-connected with renal disease, the rupture of the vessels take place at their bifurcations, and the spot has a triangular or irregular form. 5th. A peculiar phenomenon is manifested, in retinal apoplexy from kidney disease, in the whitening of the red patches at an advanced stage of the disease. In other cases, the fluid part of the blood is absorbed, and the spot may thus become of even a deeper tint than before."

I have, however, seen several cases of symmetrical apoplexy of the retinæ where no symptom of kidney disease existed. A case in point was also reported in the pages of the 'Medical Times' last year. In this instance there was partial paralysis of the left side, preceded by head symptoms, which were persistent. The urine was carefully examined, and found perfectly normal. Unfortunately the pupils were dilated by atropine before their condition was noted. The ophthalmoscope showed a small apoplectic effusion just below the yellow spot in each eye. The above case supplies us with an interesting example of symmetrical extravasation of blood from the retinal vessels occurring with other symptoms of disturbed cerebral circulation. The following note is appended to the report :—

"From these cases it appears there are two groups of cases in which retinal apoplexies are observed. In one, the effusions take place in connection with albuminuria, and are, perhaps, quite as nearly allied to purpuric ecchymoses as to those forms of hæmorrhages usually designated as apoplexies, and occurring in patients of all ages. In the other group, the retinal affection occurs coincidently with other indications of cerebral disturbances, in elderly people chiefly, and without any abnormal state of the kidneys co-existing. In these it is in all probability dependent upon disease of the coats of the vessels; and the rupture, no doubt, occurs during a temporary congestion of the whole cerebral system, the pressure of which the weakened vessels of the retina are unable to sustain."

Insensibility of Retina due to Syphilitic Poison.

It is now ascertained, with the ophthalmoscope, that where a defect of vision has accompanied or supervenes a syphilitic attack, the retina presents an unusually pale anæmic appearance, with irregular patches of exudation, fixed or loose flocculi, in the retina or vitreous. Frequently there is great intolerance of light, and a sense of heaviness and pain in the globe of the eye. The retinal circulation shows evidence of considerable disturbance, as the vessels are observed frequently to be very unequally dilated. The most interesting cases of this class indicate serious complications in the cerebral, or spinal system, paralysis in various forms, especially paraplegia, being present; and it is inferred that pressure, due to some abnormal condition connected with the disease, is the principal cause. There is a case on record of paraplegia originating in constitutional syphilis, where a gelatinous tumour was found pressing upon the spinal cord. The pain that frequently accompanies attacks of this kind affords some indication of its exciting cause, as it comes on rather late at night, as from 11 p. m. to 2 a. m. Rheumatic pains come on earlier in the evening, and neuralgic usually occur in the morning. In this circumstance an important aid to diagnosis is obtained, which will assist in distinguishing between syphilitic and other forms of retinal disease.

A case of paraplegia from syphilitic poison, which occurred in the practice of M. Ricord, affords a very useful and interesting illustration; and I therefore quote it, as an extreme case certainly, but also as including all the chief symptoms and ophthalmoscopic appearances which mark retinal complication with syphilitic disease.

X——, aged 36, of strong constitution and healthy family, contracted syphilis, with indurated chancre in 1856, followed by secondary symptoms. These yielded to ordinary treatment; but in 1858 there were mucous patches on the lips, alternately disappearing under mercury, and returning when treatment was suspended. Towards the end of 1858, he remarked increasing weakness of lower limbs, with difficulty of retaining urine. At the time he consulted Ricord, there was general debility, syphilitic psoriasis, and evident paraplegia. He could hardly walk for ten or fifteen minutes. No abdominal tightness, constipation, and retention of urine. Bladder and sphincter both partially paralysed. From two to four grains of iodide of mercury were given daily, inunctions and tonics were also exhibited. In six or seven weeks, power over the limbs and bladder had greatly increased. Some debility, however, remained during that year and the next. In April, 1860, the sight became dim, the pupils sluggish, and words appeared less obscured in what he was reading. On examination, the ophthalmoscope discovered choroiditis, and an effusion beneath the retina round the papilla, of a dirty-white colour, with an irregular margin. The mercurial treatment which had been omitted during the last year was renewed, and the biniodide substituted for the iodide. In six weeks, vision became clear, and the ophthalmoscope proved the entire disappearance of the effusion. The power over limbs and bladder had been nearly restored, and by the end of the year the patient was quite well in every respect.

The following case of amblyopia, arising from syphilitic taint, came under my care, and, perhaps, is remarkable from the absence of the more decidedly marked symptoms of chancre or bubo; the patient admitted, however, that when his sight first began to grow dim, eighteen months before, he was suffering from a neglected gonorrhœa. This case, as well as the next related, appears to have been associated with retinitis, or congestion of retina.

E. R——, aged 22, a carpenter. A very suspicious-looking copper-coloured eruption covers his body. A bright object like a star continually floats before his eyes; can scarcely see to work, and only read the largest letters on the side of an omnibus. General health not good. No headache, but some pain in the orbit. Eyes full and tense, and reflected from the fundus an opalescent appearance.

Examined with the ophthalmoscope.—Pupils contracted, and were therefore dilated with atropine. In the right eye, a small black spot covers the foramen centrale, the vessels of the retina are large, irregular, and congested. In the left, a similar fixed black spot; but neither so large nor so well defined as in the right eye. The peculiar opalescent reflection is due, no doubt, to congestion of retina.

The patient was ordered a dose of grey powder every night, with an aperient draught the next morning. Under this treatment for a fortnight, vision improved considerably; but as the eruption remained troublesome, a mixture was ordered, containing the usual doses of the biniodide of mercury in decoction of bark. The case steadily progressed, and in a few weeks he was discharged cured, the peculiar reflection from the fundus having also entirely disappeared.

Another case, nearly similar in all its symptoms, exhibited some variation of appearances in the ophthalmoscope.

W. H——, aged 35, engineer. About twelve months previously was living a very irregular life, and contracted gonorrhœa. His eyes at this time became affected with inflammation, since which his sight has been very dim and imperfect. First noticed the dimness in his left eye, and dark spots frequently appearing before vision. Subsequently the right eye became similarly affected. If he made any attempt to read, one letter seemed to run into the other. Had been obliged to give up his work in consequence of his sight failing him. The eyes are full and hard to the touch, with a greenish reflection from the fundus.

Examined with ophthalmoscope.—Lenses perfectly clear; fundus of right eye presents a deep red appearance; vessels of retina large, and capillaries very numerous; optic nerve of an irregular form, and studded with minute dark spots. Left eye, optic nerve oval in shape, a yellowish grey-coloured film covers the vessels; choroid of a dull reddish colour; and grey patches in vitreous. In this case, the bichloride of mercury in decoction of bark was prescribed, from which he derived much benefit, and was enabled to resume work in two months from the date of his admission.

I have had an instance of considerable swelling of the bone about the base of the orbit. The history of the case and certain nodular appearances, with a misty haziness of the retina and congestion, led me to diagnose the true character of the otherwise obscure symptoms, and unaccompanied by pain. The generally beneficial effect of small doses of mercury and the bromide of potash proved the connection of the retinal affection with syphilis. Such cases also confirm the suggestion of Mr. Hutchinson, that many of the recorded instances of amaurosis cured by a course of mercury, and which, before the introduction of the ophthalmoscope, were attributed to some thickening of the membranes of the brain, or some effusion pressing on the optic nerves, were perhaps really due to a syphilitic taint.

Charlotte R——, aged 29, admitted February 10th, 1863. Has been living a very irregular life, and is now in bad health, and very weak. Had good sight until the previous November, when she was admitted into a general hospital, labouring under syphilitic disease. With the left eye can only distinguish day from night, and the sight of right is very dim; a good deal of pain comes on every night about twelve o'clock, which prevents sleep. The globe is hard to the touch ; pupils fully dilated.

Examined with the ophthalmoscope.—The fundus of the left eye exhibits a considerable amount of retinal disorganization ; peculiar white irregular patches surround the optic nerve, represented in fig. 6, plate 2. The right, although anæmic, bears evidence of having suffered from some hæmorrhagic effusion ; and numerous flakes were floating in the vitreous. She was put under a mercurial plan of treatment ; but as her constitution soon began to show signs of intolerance of the drug, it was changed for the iodide of potassium and the syrup of iodide of iron. An opiate was given every night at bed time. In six weeks the vision of the right eye began to improve, whilst that of the left was scarcely changed at all for the better at the end of two months. Still under treatment.

Another instance where the defective vision was not supposed to be connected with a syphilitic taint, but in which the ophthalmoscopic appearances and the result of the treatment were fully confirmed by the history of the case, came under my notice lately.

Mary W——, aged 28, was a servant, and at the time of admission in good general health. Suffered from syphilis about twelve months ago, but considered herself cured. Six months since, she noticed a dimness in the right eye, which gradually increased, and at length the left eye also became similarly affected with pain and partial loss of sight. The ophthalmoscopic appearances exhibited deposits upon the retina of a greyish colour, with floating bodies in the vitreous. In this case I observed a very apparent approach to the characteristic condition of the fundus in *retinitis pigmentosa*. The treatment consisted of small doses of mercury, followed by the bromide of potassium, and in three months she was discharged cured.

Retinitis Leucœmia, produced by a secondary syphilitic taint.—" Eliza M——, aged 36, a pale, feeble-looking woman, applied at the hospital, complaining that for months back her sight had been failing. She carried in her arms a stout baby, ten months old, and stated, on enquiry, that it was her ninth, and lived almost solely upon the breast. She had suffered no pain whatever in her eyes, and there was not the slightest congestion of any part to be seen. The pupils were of moderate size, and freely mobile ; indeed, as far as the unassisted eye could discover, the eyes were perfectly normal. Her account was, that for four months the sight had been dim, as if smoke were before her eyes ; muscæ volitantes had also been troublesome. At no time had there been either pain or redness. She could still see large print, but not sufficiently well to read it ; and she could not tell the time by a large clock at the opposite side of the room. With such a history and such symptoms, could any one have been blamed for pronouncing the origin of the disease to be asthenia lactanicum, and ordering the woman to wean her baby, and take stout and quinine? Five years ago, we question whether one surgeon in a thousand would have arrived at any other conclusion. It was deemed best, however, to employ the ophthalmoscope before prescribing ; and with the light which that instrument threw upon it, the case assumed a totally different aspect. In each eye the vitreous humour was seen to be hazy, and to have numerous white flakes and films floating about in it. This condition having been previously often noticed in conjunction with secondary syphilis, the woman was at once questioned, and as quickly admitted that she had contracted sores, and that at the present time she had a rash on her chest and shoulders. This rash proved to be syphilitic psoriasis. Here then was a case in which the stress of the syphilitic inflammation had fallen upon the vitreous, and the iris had wholly escaped. The obscurity of the vitreous prevented the state of the choroid from being accurately ascertained. The patient was ordered to wean her baby, and a course of mild mercurials prescribed."*

We owe to Dr. Zambaco a useful summary of the conditions of the fundus that may be traced by the ophthalmoscope, in cases of insensibility of the retina, accompanying some cases of syphilis. The lesions chiefly observed are congestion and inflammation of the choroid, with deposits on or underneath the retina. When the exudations do not mask the retinal vessels—are, in fact, beneath the membrane—they rapidly disappear under proper treatment: hence considerable value attaches to the use of the instrument to note the action of remedies and the progress of relief. When the

* Medical Times and Gazette, July 17, 1858.

deposits appear on the retinal surface, they generally prove more obstinate. In the cases recorded by Dr. Zambaco is one of choroiditis, where the pigment had disappeared in patches, allowing the sclerotic to be seen. In another, detachment of the retina, and atrophy of the papilla; and he observes, that in every case examined some appearances of lesion could be distinctly seen.

Syphilitic Paralysis of the Externil Motor (abducens) Nerve.

The importance of recognising this somewhat rare affection in connection with syphilitic disease, has been pointed out in an excellent paper on the subject by Dr. Beyran, in the *Bulletin de l' Académie Impériale de Médecine;* nor can the advantages of a correct diagnosis be overrated, when we take into consideration the great value which is to be attached to prompt and early treatment.

As may reasonably be inferred, the diagnosis is attended with some difficulty; we must take into consideration the age, sex, temperament, and previous history of the patient; the co-existence of syphilis, particularly in its secondary and tertiary forms, the presence of nodes, pains in the bones, and the peculiar headache, will go far to confirm our suspicions of its syphilitic origin. We may state, however, that two distinct classes of phenomena characterize it:—1. Permanent deviation inwards of the globe of the eye; 2. A disordered condition of vision, such as double-vision, diplopia, or indistinctness of sight.

When the adduction of the eyeball has once become established, all the efforts of the patient to restore it to its normal position are unavailing; he can only move the eyeball either upwards or downwards towards the roof or the floor of the orbit, and that only to a very limited extent. On examining the eyeball from a lateral direction, we can scarcely perceive any part of the cornea, as this membrane is almost entirely concealed in the inner angle of the eye; at intervals it may show itself, but only shortly to disappear again. The pupil appears rather less dilated than that of the healthy side. With this deviation of the eyeball, there naturally arises a disordered state of vision. The patient is unable, when the sound eye is closed, to perceive clearly objects, such as the fingers, which may be placed before him, or imagines that they are twice or thrice as many as the actual number, according to the distance at which they are held.

The commencement, progress, and duration of the paralysis of the external motor nerve bear a corresponding relation to the accompanying syphilitic affection, and the paralysis is modified in direct proportion to the progress of the latter, and consequently according to the effects upon it of the remedies employed. In the cases detailed by Dr. Beyran, the invasion of the paralysis was preceded by pains in the periosteum and bones, and especially by headache, which was chiefly referred to one of the temples; the paralysis manifested itself on the same side as that on which the headache was felt, and only attacked one side at a time.

The treatment which is requisite is evidently that indicated for the elimination of the syphilitic virus. Dr. Beyran speaks highly in favour of the simultaneous administration of the biniodide of mercury and iodide of potassium, in cases in which the patient has not previously undergone any mercurial treatment; if mercury has already been employed, the iodide of potassium alone should be ordered, and in every case this medicine should be regarded as the basis of the plan of treatment. Numerous blisters should be applied successively to the nape of the neck, and to the temple if the headache is limited to that part; should the headache be absent, the blister may be applied to the temple corresponding to the side on which the paralysis exists. For the periosteal pains, blisters, the vesicated surface to be subsequently dressed with poultices sprinkled with laudanum, are recommended, and when nodes are present, methodical pressure by means of slightly stimulating plaisters should be resorted to. The use of electricity, in the event of weakness of the motor muscles of the eye being present, will greatly aid in completing the cure.

Retinitis Pigmentosa.

A chronic form of retinal apoplexy it is usual to describe as retinitis pigmentosa, from the special character of the exudations in the membrane, consisting of pigmentary deposits, sometimes appearing as black spots distributed over the retina in short radiating lines, which, when viewed by an oblique ray of light, may be likened to the black stripes on a tiger skin. It differs from the results of colloid degeneration of the pigmentary cells of the choroid, which presents in the ophthalmoscope appearances somewhat similar, but from which it is readily distinguished by the perfectly white spaces seen in the choroid, indicating the bloodlessness of its anæmic condition very different from the universal sombre colour and the confused appearance of the fundus which characterize a congested retina. The changes, commencing anteriorly, extend slowly towards the optic nerve entrance: where exudation patches, at first scarcely perceptible, ultimately form irregular dark blotches. As the disease encroaches very gradually upon the field of vision, good sight is exercised until the macula lutea becomes involved. Gräfe has shown that this symptom sufficiently enables us to distinguish it from a similar progessive contraction of the field due to atrophy, or other cause connected with cerebral disease; in which, however, sight diminishes in exact progression with the loss of power in the nerve.

It not unfrequently happens, in cases of retinitis pigmentosa following retinal apoplexy, that atrophy of the membrane, and other organic changes extending to the optic nerve, are a complication that quickly shows itself. This diseased condition is also often seen in connection with syphilitic retinitis, when the patches are more numerous, and nearly always accompanied by myodesopia.

Dr. Mooren has met with seventeen cases of this affection. In all, the patients first complained of imperfect vision in bright light, and, after a while, of tension and a sense of pressure which almost seem to forcibly close the eyelids. Next, symptoms of hemeralopia were observed towards evening, with subjective luminous sensations in the day-time. After sunset, the patients could scarcely guide their steps amidst surrounding objects. A continual movement of the eyes was observed, but not a convulsive one as in nystagmus. Examined with the ophthalmoscope, a number of blackish spots were found on the retina; and, as the disease progressed, they became deposited at the posterior portion and over the yellow spot. The papilla of the optic nerve, already atrophied, and of a dirty-white colour, was not only more or less effaced, but often covered in part with pigment. The vessels of the retina gradually became more or less obliterated, and appeared as yellowish-white cords, in part concealed by pigment. The choroid became affected accordingly, and the lens lost some of its transparency, especially at its posterior portion. One of the first symptoms is a progressive diminution of the calibre of the vessels. This obstacle to the circulation not only impairs nutrition, but leads to chronic inflammatory action; and, as a consequence, the transformation of the colouring matter of the blood into pigment, the exudation of this being a mere secondary phenomenon. The origin of these pathological conditions must be referred to material changes taking place in the vessels of the retina. The prognosis is always unfavourable, and the treatment can only be palliative.

Retinitis Pigmentosa; extravasation about the macula lutea. Hemiopy. (*Figs.* 11 and 12).—Eliza A——, aged 39, married; always had good health and sight until twelve years ago, when a rash, which she said looked like measles, broke out over her body; she had also a sore throat, which was bad enough to prevent swallowing; but does not remember having had any pain or redness in the eyes. She first discovered muscæ in her left eye, which moved up and down like little specks of soot; and found also, when reading, that the letters appeared to be on one side. A short time after, a semi-transparent blue veil, about the size of a shilling, appeared in the left eye, which partially obscured vision when she looked at anything; but was not sufficiently dense to preclude her reading moderate-sized type. The sight of this eye has lately become worse, so that now she loses objects immediately in the axis of vision, and anything situated at the outer side she can

FIG. 11.—*Left Eye.*

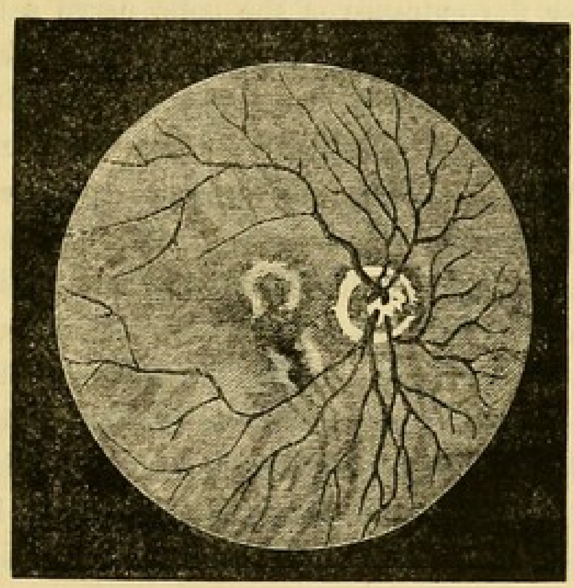
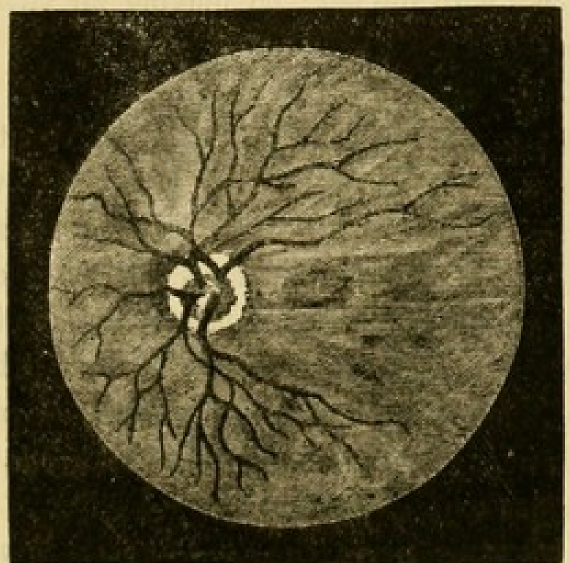


FIG. 12.—*Right Eye.*



barely see well enough to recognise. The right eye was healthy until the last week in Nov.; then she felt some slight shooting pains through it, but did not discover any diminution of sight until three days ago (Dec. 19th), when she found it so dim she could not read the newspaper. Before the sight of her left eye failed, she often noticed flashes of fire upon closing her eyes. This patient, during the past twelve years, had several miscarriages, and three healthy living children. Was subject to bleeding at the nose when suckling; during the menstrual period, the bleeding was more severe. The epistaxis has ceased about twelve months.

Examined with ophthalmoscope.—Left eye, cornea, lens, and vitreous clear; over the entrance of the optic nerve a brownish, dull-yellow tint; vessels distinct, though small. About the yellow spot, macula lutea, is an irregular patch, rather larger in size than the optic nerve, the ground of which somewhat resembles that of the optic nerve; in several parts patches of brown and black pigment are seen; the margin of the large patch appears of a deep brownish-red. There are also some bright-red streaks running parallel to one another at the inferior portion. The whole of the fundus of the eye has a brownish-red colour; the vessels of the retina are distinctly seen, but smaller than in the healthy eye. Right eye, humours clear; optic nerve much the same in appearance as the left; fundus of a brownish colour, with a bluish-white floating membrane in the vitreous; the yellow spot is covered by a fixed dark patch. The vessels of the retina are small, and not so distinct as in the left eye. The wood-cuts imperfectly represent the appearances noted.

Dec. 30th, 1856.—Can now read largest print with the right eye, if looking down with the left; on making an effort to read for a moment or two, a *spot* the size of a threepenny piece appears to come over the sight and partially cover up the page; it does not, however, entirely obscure the type, but renders it indistinct. Bichloride of mercury in decoction of cinchona was prescribed, which she continued to take until January 16th, 1857; a slight diarrhœa then set in, when this medicine was changed for small doses of mercury with chalk every night, and a tonic mixture of iron and quinine twice a-day.

Feb. 2nd, 1857.—Again examined with the ophthalmoscope; the black spot not quite so large, but a large quantity of pigment still obscures the vessels in the left eye; the right improving.

9th.—*Examined with ophthalmoscope.*—Right eye still improving; can see better; left optic nerve clearer, and freer from spots. Catamenia scanty. Ordered compound iron mixture, one ounce, thrice a-day.

25th.—Improving, when she desired to leave for the country.

Detached Retina, congenital retinitis pigmentosa.—Ellen P——, aged 14, consulted me, Oct. 1862, for nearly total loss of sight in right eye, and considerable decrease of power and myopia in left. Can only read largest type-tests at three feet, and No. 8 at four inches. With the ophthalmoscope the right retina appears to be almost wholly detached, the vitreous is muddy, so that no portion of the fundus can clearly be made out; has a slight perception of daylight from the inner or nasal side. Left eye, the chorio-capillary circulation much congested, as well as the vessels of the retina, which are evidently in a varicose condition. Striæ of greyish-blue pigmental deposits throughout the retina, with a large black fixed deposit at the outer side of the optic disc, which is also ovid in shape.

The most remarkable part of the history of this case is, that the mother of the patient is suffering from a nearly similar condition in both eyes, sight having been entirely lost in the right many years ago. The aunt and uncle, both blood relations, are likewise afflicted in the same way; and, furthermore, the girl's maternal grandfather became rather suddenly blind some years ago, first of the right eye, then of the left. I therefore look upon this case as one of congenital *retinitis pigmentosa*, ending in total disorganization of the retina in the right eye; and, consequently, gave an unfavourable prognosis of the left.

Continental surgeons have recently directed attention to many very curious facts connected with a congenital disposition to a form of *retinitis pigmentosa;* the importance of which, as affecting the happiness of families, is so great, and so necessary to be known as interesting society generally, that I feel it imperative to introduce here some remarks of Liebreich's upon the subject, accompanied with valuable statistical details of one of the many evils that are apt to result from intermarriage with near relations.

When children are observed to see very imperfectly about twilight, and that the field of vision generally seems limited, it may safely be presumed that retinitis pigmentosa of the form I am speaking of is present. The disease advances with age, so that about the thirtieth or fortieth year complete blindness ensues, previously to which fine print was legible in certain parts of the field of vision where the retina still continued sound. The ophthalmoscope shows extensive changes have taken place, especially in the appearances of the choroid and optic nerve entrance. Around the latter, a number of intensely black spots, frequently star-shaped, are sometimes observed. In other cases, a more decided reticulated arrangement spreads a thick network over the parts. Exudations also take place on the retina, which becomes more and more atrophied with increasing years. In a patient affected with this disease, Dr. Liebreich, learning that the parents were cousins, instituted an examination, among other cases of a similar nature under his care, and found that more than one half were children of relations in very close degrees of consanguinity. He extended his inquiry to discover whether *retinitis pigmentosa* was generally associated with the diseases well known frequently to follow, as congenital among the issue of close marriages among relations, such as cretinism, idiotism, deafness, and dumbness. M. Maffei, a French surgeon, had previously remarked, that among cretins it was a noticeable symptom, that they did not seem to perceive small objects, although the eyes appeared perfectly healthy; and he ascribed it to their constitutional apathy and indifference, and to not being accustomed to occupy the eye with small objects. Dr. Liebreich, however, by ophthalmoscopic examinations, has shown that this limitation of vision in cretins is due to changes in the condition of the retina. In fifty idiots he examined, he found three suffering from *retinitis pigmentosa;* but among these the parentage of only one could be ascertained. He was of noble descent, and his parents cousins. Marriages between near relations in this family had occurred for many generations, and its history as regards the physical condition of the offspring is both useful and instructive. The grandfather of the idiot just mentioned was married to a stranger, and had three healthy children. Of these, the eldest son was also married to a stranger, while the two daughters, one after the other, married the same cousin. The eldest son has had eleven healthy children, of whom nine are alive, and part of them married, and have also begotten healthy children. Only one of these married a cousin, and he has one idiotic child and six healthy ones. Of the two daughters just mentioned, the elder, who married her cousin, died while giving birth to her first child, which was still-born. Her husband then married the deceased wife's sister, and had by her thirteen children. Of these, two died in the first year; the third died somewhat later, from dysentery; a fourth, who was completely paralysed, lived to the age of sixteen; a fifth and sixth are quite blind: and, according to the description given, most probably in consequence of retinitis pigmentosa. The seventh, whom Dr. Liebreich has examined, is idiotic and affected with retinitis pigmentosa. The other six children were healthy; one of them is married to a stranger, and has no children; another is married to a cousin, and has one idot child among seven. A third, who married a cousin, has only one feeble child; the other three healthy ones are unmarried.

Of 34 deaf and dumb persons in Berlin, examined by Dr. Liebreich, fourteen were affected with retinitis pigmentosa; and among these there were no less than eight Jews, whose affliction may be ascribed to the frequency of marriages of consanguinity. Among them was a family of five children, sisters and brothers, whose history is also remarkable. The father is a healthy soldier, but given to hard drinking. He married the elder of two sisters, by whom he had six children, three of which were deaf and dumb. By a subsequent marriage with the younger sister of his wife he had a son, who was also deaf and dumb. All the children suffered from retinitis pigmentosa; and Dr. Liebreich has always found that, if deafness and dumbness and retinis pigmentosa are prevalent in a family, the children who suffer from one are also affected with the other; and that those who are free from the one, are free from the other. Of 35 other cases of *retinitis pigmentosa* examined by Dr. Liebreich, fourteen were the offspring of marriages of consanguinity. Gräfe has since observed, in eleven cases out of twenty-five of retinitis pigmentosa under his care, that the circumstances were such as confirmed the statements of Dr. Liebreich.

Detached Retina.

The retina is subject not only to the ordinary hazy obscuration, the result of inflammatory action, but also to a more permanent condition of disease, due to extravasation. This, when followed by traumatic injury, though more distinctly marked, is not more serious than when consequent upon continued inflammatory action. In its first stage, as has been pointed out by Dr. Jäger in chronic retinitis, "the fundus of the eye seems to reflect less light than usual. To a practised eye it resembles somewhat those cases in which the vitreous humour from some cause has lost a little of its transparency, with this distinctive difference, that in the latter cases the cloudiness is uniform throughout the medium, whereas in retinitis it is confined to the vicinity of the optic nerve. The cause of this phenomenon is probably that the colour of the fundus of the eye is changed. Instead of being, as in health, of an orange-red, it has assumed a blood-red hue, especially around the optic disc, and that this more sombre colour reflects less light." Patients in this stage complain of a hazy dimness in their sight. Any sudden concussion of the body, such as is occasioned by stumbling, coughing, or sneezing, produces flashes of broken light, as if a blow had been received on the eye. Sometimes vision is constantly interfered with by brightly-coloured spectra in the forms of rings or spots.

As the disease advances, the margin of the optic disc is seen to be encroached upon by a fasciculus of vessels starting from a central point, and the circumference extending to include the retina; but with such an indefinite gradation of effect, that it is difficult to determine where the yet unaffected portion meets the congested membrane. The papilla is early involved, and in advanced or confirmed cases is entirely covered, so as to require considerable care in making it out. The central arteries and veins being larger than in health, enable the observer to mark the situation of the optic disc. In the worst cases of all, however, the large central vessels even disappear in the general sombre hue of the fundus, upon which short radiating lines of a deeper tint may be discerned, where the texture of the retina appears of a firmer consistence.

These alterations on the aspect of the retina are accompanied by corresponding changes in the condition of the choroid, and consequent extravasation between these membranes. When the retina becomes quite detached by the effusion, it projects towards the lens. The periphery of the optic nerve apparently limits the further extension of the effusion at that point, and the infiltrated or detached part becomes raised around and hangs over it. The raised portion has a more or less opaque and pinkish appearance, and sometimes admits of the choroid being seen through it.

Gräfe directed particular attention to the detachment of the retina from the choroid by extravasation or exudation; as well as by exudation of plastic lymph, the production of tubercular disease, and by malignant growths. Donders has carefully investigated and represented colloid degeneration of the pigmentary cells of the choroid. Congestion of the choroid (choroiditis), and sclero-choroiditis, so frequently met with, always exhibit a peculiar train of subjective symptoms; so that we may, by the more careful examinations we are now enabled to make with the ophthalmoscope, readily recognise such organic changes from those before mentioned.*

* In retinitis and choroiditis, the appearances, as hitherto observed with the ophthalmoscope, are more frequently those of past inflammation, than of an active state; they are congestions, spots of extravasated blood, opacities of various degrees, and pigmental deposits. Some of the opaque appearances are indications of exuded matter deposited between the choroid and retina, producing adhesion of the two membranes, with alteration of their textures, including the pigment membrane of the one and *stratum bacillosum* of the

Detached Retina, from exudation.—Gräfe, who frequently observed cholesterine in the lens, or suspended in the anterior chamber, adhering to opacities in the vitreous humour, or glistening on the surface of the detached retina; has also observed it where exudation separated the retina from the choroid. The following case is interesting, as one of complete detachment of retina :—

"In a delicate girl, ten years of age, blind nearly from birth with the right eye, the eyeball being abnormal. The pupil gave no reaction when light was thrown into the eye, but moved on rotation of the eyeball, and sympathetically with the pupil of the left eye. At a certain distance, and under favourable illumination, particularly if the pupil was dilated by closing the left eye, the white reflection from the background, characteristic of retinoid detachment, was apparent. After dilating the pupil, this could be made out without the ophthalmoscope, and even the arborescent retinal vessels could be distinguished.

"The ophthalmoscope showed the lens and vitreous humour to be quite transparent, and a nearly total detachment of the retina, presenting the usual funnel-shape, converging towards the optic papilla, which was still plainly visible. The walls of the funnel were formed by elevations of retina, separated by furrows and projecting in different heights into the vitreous humour. At first Gräfe was struck by a number of white, glistening, club-shaped, cylindrical bodies, the appearance of which justified him in coming to the conclusion that they were cholesterine crystals, but not, as in similar cases, adherent to the anterior surface of the detached retina, but partly situated on its posterior surface, and partly floating about in the fluid effused between retina and choroid."

Detached Retina.—A porter, aged 40, suffered from hemiopia of the right eye, which for about a year remained stationary, when a gradual diminution of sight came on. The patient saw objects only from the inner and upper portion of the retina, and then but faintly. The eye presented a slight divergence from the optic axis. Pupils

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other; and this has been frequently confirmed by dissection. The retina bulged forward and tremulous is an indication of serous exudation between the choroid and it on the one hand, and dissolution of vitreous humour on the other.—Wharton Jones's 'Ophthalmic Medicine and Surgery.'

sluggish. The ophthalmoscope showed a separation in the retina towards the lower and outer portion, stretching somewhat over to the inner side. It had the appearance of a greyish-white folded membrane; and with every motion of the eye it waved too and fro. The veins appeared very dark and thick, taking a serpentine course towards and over the retina. The arteries were apparently split up into numerous fine branches, deeply colouring the retina, and the optic nerve had a bluish centre.

Retinal exudation, with Myodesopia.—November, 1853, Filliond, a cook, aged 29, presented himself at the hospital, complaining of imperfect vision in the right eye.

"On examination, the eye appeared normal; no injection in the conjunctiva, nor in the sub-conjunctival tissue. The colouration of the iris natural; the pupil free, transparent, and dilated. Six months ago, this man received a contusion by running against a wall. It was only four months afterwards, when, by chance, in closing his left eye, he perceived that he was nearly deprived of sight in the right, and from that time he saw a large cobweb before his eye.

"*Examined with ophthalmoscope.*—In the posterior segment of the vitreous there are three large brown flaky bodies, connected together by several fine filaments, forming a sort of lace, spread athwart in the ocular cavity, and situated rather close to the retina, intercepting the luminous rays and preventing the formation of images. During movements of the eye, the mass moves from below upwards, and again sinks to the bottom of the organ. What is most striking in these movements is that they are confined mostly to the fundus of the eye; the disease no doubt affects only the posterior segment of the vitreous body."*

Retinal Effusion, and Œdema of Retina.

Partial effusion beneath the retina may be recognized by the characteristic pale bluish tint of the affected portion, whilst the rest of the fundus exhibits its usual normal aspect. In a case of this kind, if the eye is turned in one direction, the optic papilla exposed will appear

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* Dr. Anagnostakis, 'Essai sur l'exploration de la Rétine.'

whitish, if this be occupied by the detached portion of the retina; whilst, turned in the other direction, the fundus becomes rose-coloured as the sound part is offered for observation. Another prominent feature is the very palpable line of demarcation between the healthy and unhealthy portions, formed by the passage of the vessels over these contrasted conditions of the membrane, being sometimes transverse and more or less oblique, and at other times undulatory and even convex. Partial effusion may be complicated with chemosis and synchysis.

The causes of sub-retinal effusion are involved in much obscurity. M. Gräfe, who considered it generally the consequence of hæmorrhage from the choroid, based his opinion upon cases in which patients suddenly observed an appearance as of red blood interfering with vision, becoming in a few days yellow, and then as suddenly losing all sense of colour. The same observer remarks, that effusion frequently accompanies penetrating wounds of the sclerotic in parts distant from the cornea. It has been found to follow the sudden application of cold to the eye; and, in cases of erysipelas of the face, such symptoms appearing have been considered to indicate a like complication.

Hemiopia is the principal sign of partial effusion of the retina. A kind of misty veil or screen obstructs the upper portion of the visual field, which gradually increases in intensity until finally it becomes quite black. It must always be considered a very serious affection; but it sometimes affords instances of successful practice where correct diagnosis in the first instance has led to proper care and treatment. Absorption of the contained fluid is the object to be obtained, and which of course suggests, according to character of constitution or the history of the case, whether a purely tonic or counter-irritant course of practice is to be followed.

Plastic Exudations on the Retina are distinguished from the white spots of the atrophied choroid by their shape, which is generally elongated and narrow, forming irregular bands, or, sometimes, fine white lines along the course of the vessels:

by their colour, which has a greenish or bluish shade, instead of the silvery white of the choroidal spots; by the disposition of such of the retinal vessels as may pass their situation; these cross, unchanged, the choroidal spots, but are covered and concealed by the exuded matter. Where the deposit is recent, it forms a fine bluish glaze over the surface of the retina.

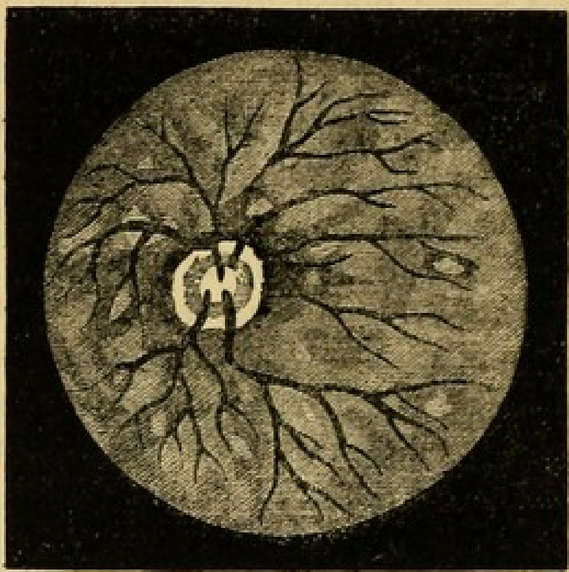
Retinal Effusion; Hemiopia.—"Mme. Gondalier, a needle-woman, aged 26, had enjoyed excellent health till the month of February, 1853, when, after working during a great part of the night, she rose in the morning with considerable dimness in her eye-sight. This state grew worse from day to day, and, since the month of October, with the left eye, which is the one most affected, can hardly see large objects; and of these she only distinguishes the lower part, the upper part escapes her.

"The sub-conjunctival tissue is injected, the pupil dilated, but perfectly translucent; the iris retains its natural aspect; the patient has never experienced myopia.

"*Examined with ophthalmoscope.*—The vitreous humour is full of brown flakes, floating during every movement of the eye. At the inferior part of the ocular cavity is seen a greenish mass, in appearance rather solid. It is free, and always sinks down to the bottom of the eye. In all probability this is an old hæmorrhagic exudation into the vitreous. The retina is not altered; the (half-vision) hemiopia, of which the patient complains, seems to be owing to the obstacle which the opaque masses oppose to the rays of light as they pass to the retina."

Insensibility of Retina from effusion—(Fig. 13).—S. E——, aged 27, schoolmaster. Gradual dimness of sight came on in both eyes, so much so, that since May last he has been obliged to resort to strong magnifying glasses, which have barely enabled him to continue his duties. Being a nervous man, he suffers much from a dread of loss of sight; is frequently troubled with headache and constipation of bowels; candle-light distresses him much; he is compelled in consequence to discontinue reading at night. Pupils dilated—mydriasis; with this exception, there is nothing to indicate the existence of disease. With ophthalmoscope, the dioptric media appear to be perfectly clear; fundus of eyes alternately pale and red in colour, with a few irregular white patches. A pale bluish cloud suspended as it were before the optic nerve, and partially obscures the retina; the periphery of optic nerve, at upper two-thirds, presents an irregular raised appearance. To take two of the Pil. Hydrarg. cum Galb. every night.

FIG. 13.—*Left Eye.*



July 12th—Improving; bowels sluggish. Continue pills, and, in addition, sulphate of magnesia, one ounce, dilute sulphuric acid, two drachms, infusion of calumba, twelve ounces, one ounce three times a day. On the 30th this patient was discharged, improved, and able to go to the country; he has since had no return of the affection.

Retinitis, with effusion.—W. S——, aged 16, a spare-looking lad, came to me February 18th, 1857, complaining of imperfect vision in left eye, which obliged him to give up school; when reading only for a few minutes, one line runs into another, especially if anxious to read; his head "feels as if something floated about in it;" pain and occasional loss of power over the left arm and side, with loss of appetite; the only apparent change in the eyes was a slightly dilated state of the pupils, with considerable tension, and a peculiar greenish-looking vitreous.

Examined with ophthalmoscope.—Vessels of retina large, congested, and irregular, veins particularly so. A few vessels running horizontally from the papilla over the foramen centrale. Hæmorrhagic patches, with a pigmental deposit near superior and inner periphery of optic nerve; fundus of the eye of a brick-dust red colour. The retina appears of a bluish grey colour, and is pushed out apparently by effusion between it and the choroid. Lenses quite clear. The pain in head, with other symptoms of cerebral irritation, induced me to prescribe mercury, chalk, and rhubarb powders, night and morning.

On the 25th, the boy was much better; at the end of March, had improved so much that he could read steadily for some time without fatigue.

Œdema of the Retina indicates as much disturbance in the circulation of the membrane, as does serous chemosis in that of the conjunctiva. The fundus of the eye is pale, and the retina appears as if raised in the form of a wall around the optic papilla. A yellowish tinge of colour in the retina renders it less brilliant than in the healthy state. It is easily distinguished, after a few observations, from turbidity of the vitreous humour, with which it is liable to be confounded.

"E. W——, aged 19, resident in a low, marshy part of the country, had suffered many months from amennorrhœa, with anæmia, intercostal neuralgia, palpitation, &c. She was then attacked with intermittent supra-orbital neuralgia; and shortly after, the sight of the right eye suddenly failed, "everything being concealed as if by snow." She had not seen any muscæ, nor any flashes, of light. There was no external appearance of disease. With the ophthalmoscope, the fundus of the eye was found to be unusually pale, and the retina appeared as if infiltrated with fluid: in fact, it very much resembled serous chemosis as it occurs in the conjunctiva. At the first glance, I confess to have mistaken it for turbidity of the vitreous humour; but more attentive observation, and the fact that the retinal vessels were clearly visible, demonstrated the true nature of the case. The œdema was greatest round the optic disc. It appeared to be connected with congestion of the choroid. She completely recovered in about six weeks."*

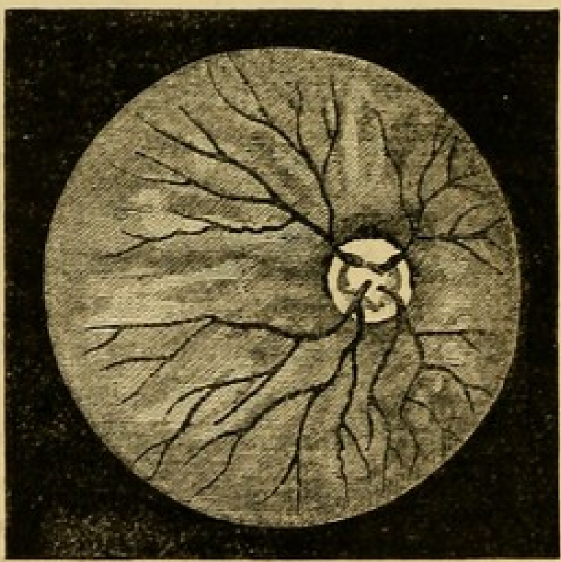
James G——, aged 19, mariner, applied January 16th. Complained of his sight being defective when a boy, and in consequence recommended to take to a sea-faring life. The last 12 months, been getting worse, dark specs and a web continually before his eyes; can only make out large objects, cannot even read large print; general health good; a drop of atropine applied to the eyes, two days before he came to me, very

* M. Desmarres' 'Traité des Maladies des Yeux.'

much increased the confusion of vision, particularly in right eye. A dull light suits him best.

Examined with ophthalmoscope.—Dioptric apparatus clear; optic nerve somewhat exposed, with a pinkish-grey inner ring raised and surrounding optic papilla, pigment exposed, retinal vessels very irregular. The fundus generally has a raised, mottled appearance (*Fig.* 14). A few patches darker in colour than the rest; no spots or specs to be seen, either floating or fixed, in the vitreous. The uncoloured woodcut very imperfectly represents the appearance of the fundus.

FIG. 14.—*Right Eye.*



He could not be persuaded to give up his employment, or take rest. A tonic plan of treatment was ordered; the usual mixture of iodide of iron with quinine was continued for a month.

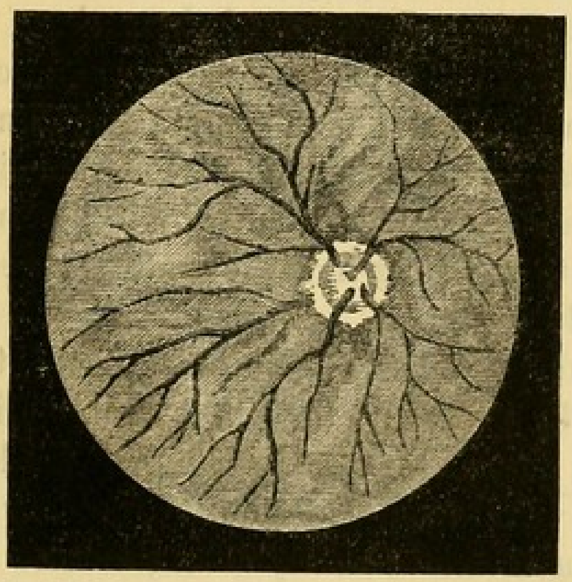
Feb. 19th.—Much improved; wished to have his medicine continued; and when last seen, said he scarcely felt any inconvenience from an imperfection once so troublesome to him.

John M——, aged 23, a discharged soldier, applied February 4th. Served several years in India during the war, and, on his return, entered the Land Transport Corps for the Crimea; while there, hard worked, and constantly employed in writing and keeping the journal; smoked a great deal, but never lived fast. When he returned to this country, the corps was disbanded, and he was discharged. His sight, which during the latter part of his service was growing dim, became very imperfect, and he can now scarcely see the largest print on the hospital letter. Had suffered a good deal from swelling of the legs.

Examined with ophthalmoscope.—A grey ring occupies the central part of the optic nerve in the right eye, the peripheral margin of which is very irregular. Retinal vessels small; retina appears displaced, and œdematous (*Fig.* 15). The man is very pallid and nervous, and much dejected about his present impoverished condition; he is also badly clothed and ill fed.

Under a tonic plan of treatment, he began to improve; country employment at this time was offered to him, which he accepted, and left the hospital.

FIG. 15.—*Right Eye.*



Hemeralopia and Nyctalopia.

Night Blindness.—There is a peculiar affection of the retina which renders the eye insensible, except to a strong degree of light. It frequently occurs suddenly, and as it first betrays itself on the approach of darkness, it has been called night-blindness. With the light of day, sight gradually returns; and, again, at sunset, the patient perceives symptoms of a returning failure of vision. Exposure to an unusual glare of light has been known to induce night-blindness, even in this country.

This disease appears frequently in tropical climates. Mr. Bamfield has recorded in the Medico-chirurgical Transactions more than a hundred cases of idiopathic and two hundred of symptomatic night-blindness, which had occurred in his practice in different parts of the globe, but chiefly in the East Indies, all of which recovered. Hence he infers that, under proper treatment, the prognosis may be generally favourable.

De Servières records a case in which fixedly looking at the rising sun produced an attack. Other cases on record are said to have been owing to spermatorrhœa, and similar debilitating causes. In most of them there appears to be scarcely anything remarkable in the appearances of the eyes from those in health. The pupils are sometimes dilated, and do not contract on exposure to a moderate light: whilst in others they are contracted, and exhibit a painful irritability on exposure to a strong light; even the reflection from the sea will produce pain.

Hemeralopia — night-blindness — seems to have been more generally prevalent than that of day-blindness during the Crimean war, as appears by a Report made to the Director General. Bad food, exposure, with scurvy, were the precursors of the attack in nearly all the men so affected.

Hemeralopia, Night Blindness in the Crimea.—"Private John Grady, of the 9th Regiment, was admitted into the Regimental Camp Hospital before daylight on the morning of the 13th February, 1855.

"He stated that he formed one of the advance on the Woronzoff road the previous night, and that he and a comrade were directed to keep a sharp look-out, which they agreed to do by turns; that, about half-past three, he fell asleep for a few minutes, and on awaking was surprised to find that he had totally lost his sight.

"He was immediately taken up to camp, where he was attended to; he stated that he had no pain or ailment with the exception of the total, and to him unaccountable, loss of sight. When a candle was brought into the tent, some vision returned; but he could not see the flame distinctly, and said it seemed as if surrounded by motes. The pupils were very much dilated, more particularly the right; both acted freely. No abnormal vascularity of any of the textures of the eye was visible. The entire cornea seemed prominent; but this was said to be their normal state.

"As the daylight returned, he recovered his sight; but all through the day he complained of a sort of haze and a dimness, with constant symptoms of muscæ volitantes.

"The nights at the same time were very dark, and there was about four inches of snow on the ground.

"There were no remarkable symptoms preceding his attack, which came on regularly as night approached. On very bright moonlight nights, he could see a little; but could not discern any small or dark object, and the looking at them caused him severe pain in the eyes for rather more than six weeks. It then began gradually to wear off; but he had occasional relapses, both on dark nights and when exposed to a very bright light. He was always near-sighted, and this did not seem to be increased by the attack.

"This man, in common with his comrades, was and had been for three months enduring the greatest privations, exposed to constant night-work in the trenches; his clothes were scarcely ever dry, and his food consisted for the most part of salt meat and biscuit. He had been suffering from that diarrhœa which in the Crimea was considered scorbutic, as it was neither true diarrhœa nor dysentery, but a state of the bowels which was induced by the bad living.

"The treatment consisted in the administration of quinine and ipecacuanha to try and promote the action of the skin; blisters to the temples, with belladonna round the eye; but good living with fresh meat and vegetables being soon afterwards procurable, these seemed to benefit the patient more than anything else."*

Hemeralopia: Retinitis Pigmentosa.—Eliza W——, aged 30, a glove-maker, applied Nov. 19th, 1862, stating that about five years ago she discovered her inability to go about at night, and which for the last three years has been so very troublesome, that if she attempts to walk out after sunset, a "kind of shade comes over her eyes, and she runs against everybody." This affection has been on the increase

* Mr. J. C. Ovens. 'Op. H. R.' July, 1859.

since her last confinement, now five months since (her infant only surviving its birth three months); a leucorrhœal discharge has also troubled her up to the present time.

The ophthalmoscope disclosed, in right eye particularly, retinitis pigmentosa, with a saucer-like cupping of the optic nerve; this is not so well seen in the left; in both, the retinal vessels are congested. Reads with some difficulty, the letters running into each other.

Looking upon the disease as one of debility, I ordered her to take the Pil. Hyd. cum Ferro. every night, with the iron and quinine mixture three times a-day; to use an astringent injection night and morning. Under this treatment her sight and health very much improved, and she was able to resume her occupation at the end of January, 1863.

Nyctalopia, Day Blindness; Retinitis Pigmentosa; from exposure and scurvy.—T. J——, aged 46, a sailor in the Queen's service, was sent home from Constantinople. He stated that his health had been always good, except on one occasion when he suffered from syphilitic disease seventeen years ago. In the month of March, while in the Crimea, after having lived entirely on salt provisions without vegetables, he had symptoms of scurvy. At the same time was exposed to the cold winds and hail, and, during three weeks' work in snow, he was attacked with a bleeding at the nose which lasted five hours, which ceased when he was made warm and comfortable. Four days after this, his eyes were much inflamed and ran with water; this attack lasted about three weeks, during which time he found he could only see about night-fall; he was unable to find his way about, and was sent to hospital, where he was cupped, blistered, and bled from the arm until he felt much weakened, his sight not being in the least improved; he was then sent to the hospital at Constantinople, and a tonic plan of treatment prescribed After a short lapse of time, he was able to resume his work by night, but not at all during the day. He tried several kinds of spectacles without benefit.

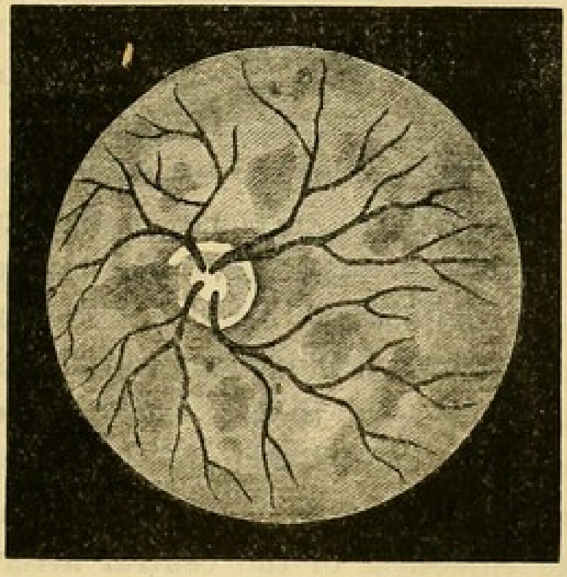
Examined with ophthalmoscope.—Lenses perfectly clear, vessels of retina large, and distinctly seen; over papilla optica a bluish patch, and a general greyish appearance of the optic nerve; the fundus has a curiously mottled appearance, rather dark in colour, like greyish pigmental masses seen through a red gauze. One spot larger and darker, fixed near the inner side of the optic nerve (*Fig.* 16). Many floating specks of a dark-grey colour.

External vessels of conjunctivæ larger and more numerous than in normal state. Continuously looking on the snow, he was told, brought on the first attack of inflammation. Prochaska speaks of a man who was attacked in a similar way, and during the inflammation could see by night, but lost that power as the inflammation subsided. A few similar cases are on record. My patient was pale and weak, and I considered the administration of tonics would give him the best chance of recovery.

Mist. Ferri. Co. was prescribed three times a-day; this he continued to take with advantage, up to the 16th Feb. 1857; he then said he could just make out persons passing before him by daylight, and had great hopes of regaining sufficient sight to go about alone.

The Admiralty at this time decided upon sending him home to Hanover. The further progress of the case was consequently lost; however, he was satisfactorily progressing when he left the hospital.

FIG. 16.



Anæmia of Retina.

A condition of the retina very frequently observed, and properly to be considered as a symptomatic stage in the progress of disease, generally terminating in atrophy of the optic nerve, is *anæmia*. Liebreich considers its more correct designation to be *retinitis leucæmia*, and the diagnosis of which chiefly depends upon the colour of the blood-vessels and blood:—"The blood and veins, which are very dilated, are of a pale pink, the arteries are contracted and of bright orange colour, and the vessels of the choroid of a pale yellow." Duval alleges that the disease depends upon a diminution of the number and calibre of the retinal vessels.

Anæmia indicates serious disturbance in the circulation of the retina, and the ophthalmoscope shows that in all or several of the arteries it has altogether ceased. The vessels are observed to be thin, and partly filled with thick and dark coagula. The central artery, however, is empty. The venous circulation is also retarded and irregular. In a few days after loss of vision, the macula lutea is undistinguishable, and the optic papilla becomes pale or opaque, and small red points of extravasated blood may be observed lying between them. Efforts are evidently made by nature to supplement the weakened trunk-vessels by calling collateral branches into increased activity and size. In some cases, I have seen considerable changes of this kind in the unusual distribution of the arteries and veins, especially in the lower part of the fundus of the eye.

Where anæmia of the retina occurs, a weakened state of the action of the heart may almost always be suspected; and this symptom present, like many other similar instances connected with the aid to general pathology afforded by the ophthalmoscope, has frequently led to the discovery of an organic affection which had not previously been diagnosed.

Paracentesis of the eye has been recommended in cases of anæmia, where embolism of the central artery existed, and where atrophy of the retina was threatened in consequence of the inactivity of its vessels. The idea was, that the vacuum caused by the escape of the fluids would produce congestion, and excite the vessels to renewed action. In one case reported, the operation was very successful, as the dilated pupil immediately contracted, and in six days the sight of the patient became materially improved. Any course having for its object to determine blood to the retinal vessels is obviously indicated.

In many cases of anæmia, division of the ciliary muscle has been attended with marked benefit, during the past year, in the practice of my colleagues, as well as my own, at the Royal Westminster Ophthalmic Hospital.

Anæmia of Retina; Hemiopia and Muscæ.—W. R. aged 30, engineer. Six years since, the vision in right eye was much impaired; and lately, the left eye has become affected, and sight is gradually falling off. Works a great deal by gas-light; is a strong, healthy looking man, married, and of sober habits. Both eyes becoming affected, was advised to apply to a general hospital; but derived no benefit whatever from the treatment. Is troubled very much with small bright stars floating in both eyes. Dilated pupil, with side vision only in left eye; first and second molar teeth, in left upper jaw, much decayed and troublesome, producing headache, &c.

Examined with the ophthalmoscope.—Lenses clear, optic nerve pale and slightly cupped; vessels of retinæ small, and irregular in both eyes, the left eye appearing the worst. During motion of the eyes, pigmental masses float about; other patches of a light colour remain fixed, with intervals or spaces deficient in choroid. To the lower and nasal side of the left eye, a large black patch of pigment, partially covering the optic nerve. The early history of the case led me to suppose that the dimness arose from a former congestion, or retinitis; and that now I had a secondary or chronic stage to deal with. I therefore prescribed alterative doses of hyd. cum cretæ every night, followed by a mixture of rhubarb and infusion of quassia twice a-day.

January 19th.—I found the teeth very troublesome, and advised extraction of two, much decayed.

March 1st.—Much improved; medicine not very regularly taken; but able to resume his work.

Anæmia of Retina; Atrophy of the Optic Nerve.—Louisa S——, aged 26, a married woman, without children, applied June, 1861, and complained of nearly total loss of sight in both eyes. The history of her case is as follows:—As an artificial-flower maker, she is obliged to remain very late at work to obtain a living. About a year since, whilst reading, a sudden mist came over the book; this was followed by a bright dazzling starlight appearance. The mistiness has continued ever since, and day by day grows worse. The right eye is much affected; she is almost constantly annoyed by flashes of fire.

"The left has a black spot with a tail hanging to it, directly in the axis of vision; this is very troublesome to her in bright weather, and appears to be always two or three feet in front of her. She occasionally suffers from orbital pain, and a good deal with bilious headaches."

The ophthalmoscope discloses anæmia of both retinæ, with atrophy of the optic nerves. The vessels of retinæ are very small, the choroid is also anæmic. The optic disc in right eye is very white and dilated; it has a pale-looking greyish patch to its outer periphery, probably the remains of a former effusion. The saucer-like cupping gives to the vessels the appearance as if suddenly breaking-off, as they pass over the periphery of the optic nerve.

Sight is now very dim, and she reads with difficulty the largest type-test. There is no symptom to lead me to think the disease one of cerebral origin. The action of the heart is very weak. Blood tonics were prescribed and continued for several months, without any very great improvement. In November, however, she could still see to go about the house. A drawing of one eye was made by the artist for me at this date (Figure 5, Plate 2).

Softening of the Retina.

Some cases of a peculiar condition of the retina, with complete loss of sight, and for which the previous history could offer no definite solution, have recently attracted considerable attention under the designation of *softening of the retina;* that membrane, although still transparent, being considerably changed from its normal character. In the eyes examined after extirpation, the arrangement of the retinal vessels were found normal, the veins large, and the capillaries very numerous; the vascularity, in fact, being described as enormous. Where the nerve cell layer was dimly seen, a delicate system of black dotted lines appeared, which, overlying the retinal vessels, resembled very much the arrangement of the optic nerve fibres; which, however, were nowhere visible.

The peculiar bluish-grey watery appearance of the fundus, which becomes more marked as the disease progresses, appears to be due to the changes in the tissues admitting of the sclerotic being seen through them. The condition of the optic papilla is another interesting point for observation. Instead of presenting a slight prominence about the level of the retina, it forms a cup, around which the sclerotic, projecting beyond the choroid forms a white rim, over which the vessels may be seen to bend, disappearing at the deepest part. The shadow of this rim can be plainly seen, giving a deeper tint of bluish-grey to the parts of the cup it passes over, when the eye is made to move from side to side.

Dr. Bader, who was the first to describe this disease, gives the following case, interesting from the careful microscopical examination made (after the removal of the eye) upon which its pathological character is chiefly founded:—

"E. G——, aged 55, observed, nine years ago, before the right eye a greyish mist, which, commencing at the nasal side, steadily advanced, and within two years became so thick as to destroy all perception of light. Since then the eye had remained in a stationary condition. Two years ago, during an attack of rheumatism, the same kind of mist, also advancing from the nasal side to the temporal side, appeared before the left eye, and, steadily increasing, had reduced vision to mere perception of light. Neither before nor during the loss of vision had there been any pain or inflammation of the eyes or the head. The patient has had two attacks of acute rheumatism: one eleven, another two years ago, each of four months' duration. His health has always been good, with this exception. No hereditary taint could be traced.

"*Ophthalmoscopic examination.*—Left eye, the media transparent, excepting the pigment ring on the lens; the red choroid and islands of pigment well seen; the optic nerve at its entrance round and well-defined; the periphery formed by a narrow white ring surrounding its surface, the outer portion of which formed a bluish-grey semicircle, its inner nasal portion having a dirty-white finely dotted appearance. Through the latter the vessels passed in normal number and colour, but more than usually bent over the narrow white ring."

In the right eye, the lens was found perfectly opaque. It was removed by an operation, and Dr Bader, after an elaborate microscopical examination of the retina, found "the rods and bulbs normal in shape and transparency. In the nerve cell layer an amorphous light-grey and translucent substance (much resembling, in consistence, colour, and appearance, that in the conjunctiva in 'granular lids') in irregular patches, with a quantity of brown pigment, some of which has the shape of former vessels, so that, when looking on a piece of retina from its choroidal or hyaloid surface, these grey patches are found in the nerve cell layer, interfering with its transparency, and giving the whole a greyish translucent appearance. The nerve cell layer, with its grey patches, overlaid by an exquisitely dense network of angular unequally-dilated capillaries and large vessels; their dilated state and angular arrangement indicating a very slow current of blood. Instead of finding on this nerve cell layer the transparent optic nerve fibres, the field is sprinkled with fine black pigment-molecules, some deposited in irregular patches, others showing most distinctly the linear arrangement of optic nerve fibres. The vessels are a little out of focus when this pigment is seen, and, judging from the distance of the pigment from the vessels, it is probable there is a transparent amorphous substance which supports the pigment, and fills the space between the thickened though transparent hyaloid and the vascular layer." The appearances of this affection are shown in Figure 8, Plate 2.

The optic nerve, Dr. Bader goes on to observe, up to the fascia cribrosa, and the resisting tissues surrounding the optic papilla, were normal and *in situ;* but the optic papilla and the optic nerve fibres in their further course had been destroyed—by pressure or extended disease—by the peculiar amorphous mass, into which the nerve cell layer was transformed, or which had been deposited in it.

White Atrophy of Optic Nerve and Retina.

A very white glistening aspect of the papilla may be regarded as a sign of progressive degeneration of the optic nerve. In a post-mortem examination, conducted by Gräfe, on a man who had been blind for some years, without any evidence of cerebral disease, and who died of pulmonary consumption, he found the optic nerves atrophied, of a dark grey colour, and of a gelatinous consistence, till they reached the chiasma. From there they had degenerated into dense white fibrous cords; the papilla also consisted of tendinous tissue, only a few nerve fibres being discerned. Structural changes were evident even in the thalami and corpora striata.

Besides the pearly whiteness of the papilla, the sharp well-defined outline of the atrophied optic disc distinguishes the approach of this condition, which is a frequent consequence of that form of glaucoma due to cerebral congestion. In more hopeless cases, the distinctly marked circumference of the optic disc is broken up, and it becomes jagged and irregular. Many interesting cases are on record, showing the connection of an atrophied state of the optic disc, with some anomalous internal condition of the parts in immediate juxtaposition with the optic nerve. In the eye of a child two years old, a scrofulous tumour was found firmly adherent to the posterior capsule of the lens, extending to, and pressing upon, the optic nerve at its entrance. Pau found a large hydatid cyst in the optic nerve of a child, producing atrophy and blindness. In the left optic nerve of a maniac, just before it passes through the optic foramen, Walther found a calcareous concretion, of a rounded and flattened shape, and of two lines in diameter. A similar case is recorded by Morgagni: on opening the head of a blind woman, who complained of excruciating pain in the head, he discovered "a stone the size of a pea in the very substance of the optic nerve." Atrophy of the optic nerve is associated with, or quickly followed by, some corresponding change in the retina; first partial, then total insensibility is the invariable result.

"The loss of vision," says Tyrrell, "which results from organic cerebral disease, more commonly affects one eye previously to or independently of the other; and if both are attacked, the loss of sight is more rapid in one than in the other; but frequently at the commencement of the disease the field of vision is not equally obscure." In a case recorded by Dr. Risdon Bennett, of a girl thirteen years old, in whom echinococci were found in one hemisphere of the brain, there was no loss of sensation anywhere, yet she could not walk or stand; when lying down, she moved her legs freely. There was complete blindness, and she was subject to epileptic attacks. The optic discs, examined by the ophthalmoscope, appeared white and atrophied. In this patient, tumour of the brain was diagnosed; but on examination after death, the cerebellum was found perfectly healthy. Dr. Gall gives a case of tumour in the brain, in which he found the optic discs white and atrophied. Defective nourishment, here also, has been assigned as the proximate cause of the changes observed; but not so much from deficient vital power, as from the mechanical pressure of the tumour upon the vessels proceeding to the parts, so that they do not receive their proper supply of blood. And, certainly, there does not seem to be so great a defect in the supply, as an obstructed distribution, embolism; for it has been observed that the optic papilla is enlarged and ill-defined, swollen, and blood extravasated near it, as if the vessels had been ruptured by over distension.

By far the greater number of those patients who become gradually or suddenly blind—stated by the old writers on diseases of the eye as presenting the "peculiar characteristic *amaurotic stare*"—the ophthalmoscope shows are sufferers from what is now termed *white atrophy* of the optic nerve.

Atrophy of the optic nerve is a process of gradual and painless loss of sight. The only outward and visible sign of this intractable and obscure disease, is a vacant stare, accompanied by sluggish or dilated pupils. The optic nerve is pearly white, and its periphery encroached upon by irregular patches, while other portions of it are either slightly hyperæmic, or appear to be so by contrast. As the atrophy progresses, the whole optic disc becomes white and dilated; less blood is circulated in the choroid, and the calibre of the central vessels diminish as vision decreases. The disease appears to pay no respect to age, sex, or condition of life. I have seen it in quite young children, middle age, and in the old; in the strong and weak, rich and poor. In numerous instances I have been unable to trace any symptom of cerebral disorder, or physical obstruction, such as orbital or intra-cranial tumour would oppose to the blood supply.

In an eye removed by Dr. Jacobson, the retina was perfectly transparent; the entrance of the optic nerve was of a pure white colour, and was sharply bounded by the black choroidal margin. The macula lutea could not be distinguished. Very soon, however, the intra-ocular portion of the nerve became of a dirty-white hue; the clearly defined margins were lost, and whitish-grey lines passed at the same time on to the retina. When these had extended about half a line from the choroidal margin, the macula lutea suddenly disappeared, and now from these two points, macula lutea and optic entrance, the change in colour gradually spread over the rest of the retina. Since the entrance of the optic nerve was affected, while the central portion of the macula lutea remained free from this opacity, it is clear that this process commenced in the cerebral substance or nervous fibres within the cranium.

Insensibility of retina, the result of cerebral effusion.—" I may mention an interesting case of amaurosis of both eyes in a boy, who has had some disease of the brain (most probably effusion into the ventricles). From being perfectly blind, he is now recovering his sight with one eye, and I have found that the dilated and perfectly fixed pupil can be made to act, and that almost as completely (though rather more slowly) as a healthy one, by repeated and long-continued use of the light thrown upon the retina by the ophthalmoscope. I look upon this as an indication, if such were necessary, that the retina is not much out of order, but that the cause of the amaurosis is more central in its origin, and I think the use of light in this manner may be made available as a means of *diagnosis*. Moreover, it may be useful as a method of *treatment*, and, by means of quickening or keeping up the reflex function involved in the action of the iris under the stimulus of light, it may answer the same purpose which galvanism does when used to maintain or resuscitate the function of muscles and motor nerves in paralysed limbs."*

* Dr. Ogle, 'Medical Times and Gazette,' June, 1860.

Atrophy of the Optic Nerve and Retina.—Wm. P——, aged 32, a policeman, in an affray with burglars about four years ago, received a violent blow on the left side of the head, which rendered him insensible for a few hours. He was severely beaten about the head, the face presenting many deep cuts, and nose broken. For several days he was nearly blind. When he recovered sufficiently to move about, he found that he could not raise the left leg and arm with the same freedom and power as before the injury; the sight of his left eye was almost lost. He has since been unable to see with either eye perfectly, and has double vision. With the ophthalmoscope the usual appearances of atrophy present themselves in the retina and optic disc. In this case, I consider that cerebral effusion followed the severe injuries received; and, as a consequence, apoplexy of the retina, with loss of sight. Although the effused blood in the internal eye has been absorbed, there is still some amount of pressure, which seriously interferes with the circulation, and therefore the nourishment of the optic nerve. This opinion is in some measure confirmed by the beneficial effects produced, after a treatment of only two months. By the use of iodide of iron, he is gradually recovering, and can at the present moment read the largest letters of the type-tests.

Colloid growths, producing atrophy of the optic nerves; total blindness.—The following case, Maria C ——, aged two years and a half, came under my observation as an out-patient, for about six months, at the Royal Ophthalmic Hospital. The colloid growth was doubtles a congenital disease, then proceeding with great rapidity; as from the first it appeared to threaten the life of the child. Several remedies were employed, but with unavailing effect; at length, opiates alone were used for keeping the child quiet, and producing sleep. The head and body were examined about twenty hours after death. The body was greatly emaciated, and, excepting the hands, there was no rigidity in the limbs. The left eye, the seat of a recent hæmorrhage, was blackened, and protruded fully an inch and a half from the socket. The right eye much less black, and slightly swollen. The skull was thin and vascular, the anterior fontanel open. Membranes of the brain healthy, but paler than usual. The brain was also pale and semitransparent, presenting a gelatinous appearance. The ventricles were found full of serum. The corpus callosum was soft, the optic thalami unusually hard and atrophied. The superior lobes in front were adherent. Left optic nerve nearly twice the size of the right, and about half an ounce of pus was found beneath the cerebellum in the posterior fossa. The bones of the socket were perfectly healthy.

The most important affection of the optic nerve is excavation of its entrance (*papilla nervi optici*). H. Müller distinguishes two species of this disease: one caused by simple atrophy of the nervous fibres, the other a result of the intra-ocular pressure, the true glaucomatous form. The former is characterized by the shallowness of the *saucer*-like depression, which does not extend beyond the inner surface of the choroid. The second form presenting a deep *cup*, which extends beyond the level of the choroid. Atrophy commences at the central part of the nerve, which is formed by the papilla, central vessels, and connective tissue. Ammon considers that excavation of the optic papilla depends entirely on atrophy of the retinal vessels.

The following points should be noted with reference to excavation of the optic nerve:—

"1. The sclerotic and cornea possess considerable elasticity.

"2. The vitreous body is very little compressible or expansible.

"3. The increased tension in the vitreous body does not necessitate compression of the choroidal vessels: they may even be congested when the pressure of the vitreous space is augmented.

"4. The retinal vessels at the entrance of the optic nerve become compressed and atrophied, when the pressure is increased in the vitreous body. Thus the arteries contain too little blood, the veins too much, and we find retinal venous pulsation.

"5. The increased pressure in the vitreous body must be supposed to be caused by a functional affection of the vitreous cells, especially those at the root of the hyaloid; and this affection is itself owing either to senile changes, or to long-continued, far-advanced hyperæmia."*

* Virchow's 'Archives,' Vol. 19.

Insensibility of retina, or functional amaurosis, as it is called by most authors, is a disease proceeding from irritating causes in connection with changes in the cerebellum and also of the spinal cord. Dr. Brown Sêquard has collected sixty-two cases in which it was most likely excited by injuries to the latter. As it is difficult to account for this form of paralysis of the retina in connection with lesions of the cerebellum, that not being the origin of the optic nerve fibres, the same indefatigable observer concludes that the defect of sight is the result of an irritation of certain parts of the cerebellum acting upon the nutrition of some portions of the nervous apparatus of vision; and that, like all other reflex paralyses, it is characterized—"1stly, by appearing of course only after the irritation which is considered its cause. 2ndly, it is not accompanied by any evident alteration of the nerve, or of the tubercular quadrigemina. 3rdly, it increases or diminishes in perfect correspondence with the corresponding progress of the irritating cause. Lastly, it is quickly cured or ameliorated when the supposed cause is removed." The illustrations given are fully confirmed by my own observations, especially those cases of amblyopia due to gastric or intestinal disorder. It is also well known that some cases of blindness consequent upon attacks of neuralgia in the face and head, have been cured by division of the irritated nerve. It is worth noticing here also, that photophobia is a frequent accompaniment of neuralgia, showing the intimate relationship of the retina, by reflex sympathy, with distantly irritated nerves.

Andral, in his Clinical Medicine, quoted in the 'Medical Times,' Aug. 30, 1862, comments upon a case reported by Dr. Michelet as being remarkable. A girl, ten years before her death, had had an attack of apoplexy, the result of which was blindness from paralysis of retina; there was no other paralysis, but habitual headaches. On examination after death, a cavity of old standing was found in the cerebellum. He also confirms the observations of Dr. Brown Sêquard, in speaking of another case where there was hemiplegia as well as blindness, and in which, after death, softening of one lobe of the cerebellum was discovered. Andral, however, suggests that an explanation may be found for the blindness which, in the first place, appears to have nothing to do with disease of the cerebellum, by reference to the anatomical relations established between this part of the brain and the tubercular quadragemini, by means of the prolongations known as the *processus a cerebello ad testes.* It is a fact sufficiently well known that all forms of paralysis lead to emaciation and atrophy of the affected parts; and this result is generally ascribed to want of action caused by the paralysis; but the close connection of the brain and spinal cord with the sympathetic, by affecting the nutritive energy of this latter—the vegetative portion, so to speak, of the nervous system—seems to offer a much more reasonable solution of the question.

Insensibility of retina dependent upon congestion of the brain, is marked by some of the following symptoms:—dilated, sluggish, or immoveable pupils, ptosis, strabismus, diplopia, flushed face, sense of weight, pain of the scalp, lethargy, noise in the ears, disordered and irritable stomach. The patient complains of photopsia, particularly in stooping, coughing, or straining; of seeing luminous sparks and flashes, spectral illusions, as the circulation of the blood in his own eye would present, and which to him is a cause of much distress.

Hyperæsthesia, "a morbid exaltation of the sense of sight, is occasionally observed among the premonitory symptoms of cerebral disease, the patient complaining either of an acute and sensitive condition of the retina, or of an abnormal expanded visual capability. A young gentleman, a few days before an attack of inflammation of the brain, had a painful condition of sight. If his eyes were exposed, even for a minute, he shrieked with pain. In another case, the symptom was precursory of an attack of apoplexy for at least ten days."*

Photopsia.—I have before alluded to the diagnostic value

* Dr. Forbes Winslow 'On obscure Diseases of the Brain.'

of photopsia, under the name of Phosphenes, as a test of the sensibility of the retina, in cases of cataract. When associated with cerebral amblyopia, the patient complains of stars of fire, or bright glittering sparks, descending in a shower before the eyes, and sometimes to such a distressing degree as to appear as if the eyes were, against the will of the patient, directed to the surface of a glowing red-hot basket of coals. The seat of photopsia is evidently in the retina, and a material element of its production is the current of the blood as it circulates through the capillaries of that membrane or of the choroid. It nearly always denotes a congestive condition of the retina; and is not, as I have before said, an uncommon symptom of acute disease of the brain.

The late Dr. James Johnson recorded the following case:

"A distinguished artist for several years suffered from photopsia, to which afterwards headache and diminution of vision were added, terminating in complete blindness. Nevertheless, the luminous phenomena continued night and day, occasionally assuming the appearance of angels with flaming swords, whose movements were apparently accompanied by an electric light. The forms, however, frequently varied. The mental powers of the gentleman remained unimpaired, and whenever he went out he was very attentive to everything that did not require eyesight. In the spring of 1835, he had an apoplectic seizure, which deprived him of movement, consciousness, and speech. There was complete paralysis of the sphincters, and the pupils were dilated. He recovered from this condition, and after a few weeks was again able to go about the town and attend to his business. But the visual phenomena returned, and the sight was as painfully dazzling, and more continuously so than before. Pressure at the back of the neck caused great uneasiness, extending to the lower trunk and extremities. It was not pain, but a horrid feeling that was induced. This pervaded the whole frame, and it was only by the greatest entreaty that he could be induced to permit a repetition of the manual examination. The sensibility had now so much increased, that simply touching was sufficient to renew these distressing sensations.

"A pint of blood was taken from the arm, and during the operation vision returned. He said he saw three women standing behind the gentleman who was bleeding him. Being asked, were they as large as life? he replied, 'that they were rather low,' and pointed to the place where they stood. The sense of feeling was quite as much disturbed and illusive, as that of sight, for in a few moments after looking behind him he called out, 'that somebody had hit him two or three times on the back.' All this was very different from the ravings of insanity, as he scarcely felt the impression before he was himself aware of its being an illusion. In fact, his chief distress arose from the alarming nature of the disordered perceptions. 'Rid me of these sights and sounds,' was his entreaty, 'and get me some sleep, or I shall lose my senses.'

"Active purgatives were exhibited after venesection was performed. Subsequently a blister was applied over the ninth dorsal vertebra with great benefit, and he recovered under the continued use of gentle alterative aperients, combined with counter-irritation.

"He had a recurrence of the attack some months after in consequence of hard drinking; but though he complained more of the head, especially the back of it, there was no material fulness or frequency of the pulse, or febrile irritation. He was again relieved by purgatives and blistering, and was afterwards treated with camphor and other nervine medicines. In the month of August, an apoplectic attack occurred, and death ensued in three days.

"A post-mortem, disclosed in the right lateral ventricle of the brain nearly three ounces of clear fluid. The left was full of bladders resembling hydatids of various sizes, and containing fluids of varying consistency. This accumulation sprung from the floor of the ventricle by a kind of pedicle, and penetrated into all the recesses of the cavity, pushing its branches forwards so as to extend the thalamus of one side into the opposite half of the brain, destroying everything that opposed its passage. Both thalami optici were converted into a pulp, as well as the whole anterior lobe, which was so diffluent as scarcely to bear the slightest pressure. The optic nerves were compressed by the hydatids, so as to present a mere thready appearance."

Hemiopia, half-vision, has always been a subject of interesting inquiry, as it is considered to be a useful illustration of the physiology of the optic nerves, and especially of their decussation in the optic thalami; for when hemiopia is associated with some injury or disease confined to one hemisphere of the brain, it has been observed that it is the eye of the opposite side of the body which is affected.

Usually it is the right or the left half of objects that is invisible; but it may happen that it is the upper or lower portion of the retinal field that thus becomes insensible. The celebrated Dr. Wollaston, for years before his death, had frequently recurring attacks of hemiopia; and as he could always connect them with some sufficiently disturbing cause in the general system, such as fatigue, indigestion, or other slight indisposition, it occasioned him little anxiety, and with philosophic calmness he undertook its investigation. He had had the opportunity of observing it in others; for, in his paper "*On Semidecussation of the Optic Nerves*," published in the Philosophical Transactions, he remarks that he had frequently known others besides himself similarly affected. "One of my friends," he says, "has been habitually subject to it for sixteen or seventeen years, whenever his stomach is in any considerable degree deranged. In him the blindness has been invariably to his right of the centre of vision, and, from want of due consideration, had been considered a temporary insensibility of the right eye; but he is now satisfied that this is not really the case, but that both eyes have been similarly affected with half-blindness. This symptom of his indigestion usually lasts about twenty minutes, and then subsides, without leaving any permanent imperfection of sight."

In his own case, Dr. Wollaston describes hemiopia as it most frequently appears. "When I was first attacked with this peculiar state of vision, it followed violent exercise I had taken for two or three hours before. I suddenly found that I could see but half the face of a man whom I met, and it was the same with every object I looked at. In attempting to read the name JOHNSON, over a door, I saw only SON, the commencement of the name being wholly obliterated to my view. In this instance, the loss of sight was to the left, and was the same whether I looked with the right eye or the left. This blindness was not so complete as to amount to absolute blackness, but was a shaded darkness, with definite outline. The complaint was of short duration, and in about a quarter of an hour might be said to be wholly gone, having receded with a gradual motion from the centre of vision obliquely upwards towards the left."

Dr. Wollaston lived twenty-four years after the attack here described, and four years after the publication of his paper in which the details of another attack is given. "It is now about fifteen months since a similar affection occurred again to myself, without my being able to assign any cause whatever, or to connect it with any previous or subsequent indisposition. The blindness in this instance was the reverse of the former, being to my right instead of the left of the object to which my eyes were directed, so that I have no reason to suppose it in any manner connected with the former affection." After death, on making an inspection of Dr. Wollaston's eyes and brain, it was found that the optic thalamus of the right side was of an unusually large size; and that, on making a section of it, little or no vestige of its natural substance was perceptible, with the exception of a layer of medullary substance on its upper part. It had been converted into a tumour, as large as a hen's egg. Towards the circumference it was of a greyish colour, and harder than the brain itself; but in the centre, of a brown colour, soft, and in a half-dissolved state. This diseased condition was not confined to the thalamus, but extended to the neighbouring portion of the corpus striatum. The right optic nerve, where it passes on the outside of the thalamus, was of a brown colour, more expanded and softer than natural.

Dr. Forbes Winslow relates the case of a patient who complained, a few hours before a paralytic attack, of being able only to recognize half of everything he saw. If he looked at a person, there appeared to be but one eye, half a nose and mouth. In another case, every part of the body was enveloped in a thick mist. These were among the premonitory signs of an attack of phrenitis, and existed some days before a severe paroxysm of headache excited alarm as to the state of the brain.

These and other facts of a similar nature sufficiently prove that hemiopia arises from partial paralysis of the retina, where certain portions of that membrane become insensible to the action of light. The patient mentally refers the blotted-out appearances to external impressions; it is as if something was actually before his eyes. The insensible retinal spots have been likened by some to Marcotte's dark spots, cut out as it were in the field of vision; they readily become apparent, if the patient looks up to a white cloud, or to a sheet of white paper held before his eyes.

To test the sight of a patient suffering from hemiopia, Ruete directs a bold white cross to be placed upon a black ground, previously graduated or divided into eighths of an inch. Let this be held up before the eyes of the patient, and request him to look steadily to the centre of the cross, and at the point of decussation of crossing; then ascertain how much of the arms of the cross can be seen on either side. Note the extent, and then rotate or turn the cross gradually on its axis, again noticing the measurement in the oblique and horizontal positions. In this way a tolerable idea of the amount of insensibility of the retina may be obtained. The exact distance the cross is required to be held from the eye must be previously measured and noted, and each eye tested and examined separately.

If the spots are confined to one eye, the disease is monocular, and will be found frequently associated with cyclitis, choroidal exudations, or hydropthalmia. If it occurs in both eyes, it is called *binocular hemiopia*, and it probably arises from disease of the optic nerve and retina.

Hemiopia and myodesopia not unfrequently co-exist; so that in one eye we may have the former defect, and in the other, the latter. These fixed muscæ are the result generally of a loss of sensibility in the retina at particular points, more or less according to the character of the case. Langenbeck relates the case of a patient long troubled with muscæ, which deserves attention:—

"The eyes presented little or no change, whereby the existence of such an affection could be detected. [This, it must be observed, was written before the invention of the ophthalmoscope.] After death, these organs were examined, and neither the aqueous humour, nor the lens, nor the vitreous, all examined microscopically, showed anything unnatural. The retina and the other tissues of the eye also seemed normal; the vessels were not enlarged, nor any evidences of congestion present. On examining the retina microscopically, however, the whole of the internal surface was seen to be covered with blackish or brown points, formed apparently of molecules of pigmentum nigrum, in globules about ten times larger than the medullary globules of the retina. They were dispersed equally and in some sort of order over the whole membrane, and followed the course of the blood-vessels. They were found in both eyes.

"The patient was never altogether free from myodesopia, although, at certain times, especially after drinking spirits, the disease increased. Certain of the spectra which he saw, floated before his eyes; others, and these the more numerous, remained fixed. In writing, he complained that the paper seemed sprinkled over with snuff; and so similar were the spectra which he saw to grains of snuff, that he often tried to brush them away."*

Astigmatism.—When rays of light falling upon the eye are brought to a nearer focus in the vertical than in the horizontal plane, the consequent defect in vision is called astigmatism This inability to collect light on one exact point of the retina is a very common occurrence, and in the great majority of cases is due to some irregularity in the refracting surfaces of the eye. For instance, such as would be produced if the corneal curvature, instead of describing in all directions arcs of a circle, lines drawn from every part of which to its centre would be equal, were of such a form that lines drawn on the vertical plane would be longer than those in the horizontal; in fact, a segment of a cylindrical surface. This was the conclusion arrived at, after an elaborate study of the circumstances in his own case, by the astronomer royal, Mr. Airy, and now

* Mackenzie, Op. cit. page 968.

generally acquiesced in; although there can be little doubt that the defect might also arise from a want of uniformity in the density of the crystalline lens throughout the whole of its substance.

The existence of astigmatism may be readily detected by the patient being directed to close one eye and examine with the other the cross lines of a window frame, as suggested by Fischer, of Berlin. Any deviation in the distinctness with which these may be observed, or in the apparent length or breadth, as looked at with the head in an upright or inclined position upon the shoulder, betrays irregularity more or less in the refracting media or surfaces of the eye. My friend, Mr. Wharton Jones, F.R.S. instituted an inquiry into the cause of this incapacity of the eye to collect all the rays of light which enter, into one exact focus, and an interesting paper by him, for the purpose of individual analysis, will be found in the 'Proceedings of the Royal Society,' vol. x. He has also devised glasses of a certain form to correct the defect.

Chrupsia.—A very early symptom of the more serious affections of the internal eye, as insensibility of retina, or glaucoma, and also a frequent occurrence in cases of dyspepsia and general debility of the system, is a peculiar iridescent halo or coloured appearance surrounding bright objects when looked at. This is called chrupsia, as a general term for coloured vision; and many remarkable cases are on record where the affection appeared under circumstances that could not possibly connect it with the retina, except secondarily. Thus we have Dr. Mason Good's own case, who, after an attack of jaundice, saw all objects as if coloured yellow. A patient, in whose eye a prolapsus of the iris had occurred, is mentioned by Mackenzie, with whom everything around appeared of a greenish hue; and Dr. Conolly gives an instance, where, for some time after an attack of paralysis, the same symptom appeared. In the latter case, perhaps the retina might fairly be presumed to have been the immediate seat of the disordered vision; but as chrupsia, or its most frequent form, iridescence, occasionally arises from derangement in the dioptric media, by which the achromatic power of the eye is disturbed, some degree of caution is necessary to guard against being betrayed into an erroneous diagnosis.

In the Ophthalmic Hospital Reports (vol. iii, 286), Dr Jackson has given an interesting case of coloured vision, where everything looked at seemed yellow, so much so that it prevented the patient from pursuing his business, of buying wood, as he was unable to distinguish red from yellow pine. The particulars of a similar case that followed a severe railway accident has lately excited some attention, and a medico-legal question of importance was raised. The sufferer, a corn-dealer, brought an action against the company for compensation, inasmuch as that after the accident everything appeared yellow, and all qualities of flour therefore were alike in colour. The evidence chiefly depended upon the man's own statements, as it appeared the eyes were carefully examined, and yet none of the medical witnesses could give any explanation as to the cause of the yellow vision. The jury awarded £1200 damages. Dr. Jackson took advantage of the case, which came under his care, to inquire into the nature of such affections of vision. The ophthalmoscope showed disease of the optic nerve, without any evidence of disease in the other structures of the eye. There were symptoms present, however, such as temporary tremblings of the legs, without evident cause; jerking up of the left leg, and a sensation of "pins and needles" in the toes, which sufficiently betrayed impaired nutrition in certain parts of the nervous system. Dr. Jackson hence concluded that the defect in sight was owing to this general affecting cause, and that the anæmic condition of the optic discs indicated impairment of the blood supply to the whole retina. The inability of this patient to receive correct impressions from light admitted to the eye was therefore due to some change in the retina itself consequent upon impaired nutrition. Further observations, however, are still necessary, as cases of anæmia of the optic nerve entrance frequently occur in which there is no complaint of coloured vision, although, as Dr. Jackson truly observes, in many others there is, and that sometimes red and sometimes green "fogs" are mentioned. In connection with this subject, the effect of santonine, the active principle of artemesia santonica, in producing green vision, deserves to be noticed. M. Franceschi has made several careful experiments to determine the nature and cause of this effect; and his opinion is, that the phenomenon is not associated with any symptom indicating an over-excited action of the nervous system, but to a colouring property it possesses, which produces analogous effects to the well-known instances of madder and rhubarb in colouring the fluids of the body.

Dyschromatopsia.—Insensibility of the retina to certain colours, not in any way allied to chrupsia, is a defect of vision nearly always congenital or hereditary. In some persons the colour-blindness is complete, while in others it exists only to a limited degree. Those unable to distinguish and appreciate the various differences or shades in reds and greens, are by far the most numerous class. Dalton, the celebrated chemist, suffered from this defect; and therefore it has been called, after him, *Daltonism.*

Till within these few years, this affection of the eye was supposed to be confined to a small number of individuals; but it appears, from the calculations of various authors, that *one* person out of every *fifteen* is colour-blind. According to the experiments made by the late Dr. Wilson upon 1154 persons at Edinburgh in 1852-53, *one* person in every *eighteen* had this imperfection.

1 in 55 confound *red* with *green.*
1 in 60 confound *brown* with *green.*
1 in 46 confound *blue* with *green.*

Hence, *one* in every 17·9 persons is colour-blind.

Surprising as the phenomenon is, and amazed as we must be to learn its frequency, the existence of colour-blindness might almost have been predicted from analogous defects in the other organs of sensation. In the senses of Touch, Taste, Smell, and Hearing, such defects certainly exist. The sense of *touch* has not yet been sufficiently studied; but we have reason to believe that it is not only capable, in certain persons, of distinguishing colours, but incapable in others of distinguishing particular colours. Both Prof. Wartmann and Dr. Wilson have examined individuals who correct by the touch the erroneous judgments which they form regarding colours. In the sense of *taste* the same defect exists. Some persons are highly sensible to certain tastes, and not to others. Some cannot distinguish *sour* from *bitter*. In the sense of *smell*, the same incapacity exists of recognizing the presence of particular odours, though others are quickly perceived. But it is in the sense of *hearing* that we have the most perfect analogy with colour-blindness. Certain ears that hear all ordinary sounds most distinctly, are deaf to grave sounds, while others are deaf to shrill sounds, like the chirp of the cricket and the grasshopper, just as the colour-blind see the colours at one extremity of the spectrum, and not at the other.

"Although it is known that when the eye is sound it can receive the normal sensation of colour, yet it is not generally known that the sensation can only be prolonged for a *limited time*. Thus, whenever any one looks fixedly at a bright object placed on a surface of a dark tint, and then closes his eyes, or transfers them suddenly to another ground of a white colour, he immediately perceives an image more or less clear of the object beheld, but presenting a colour complementary to its own. It arises also when the eyes have been fatigued by the prolonged observation of a coloured and very bright object, and then suddenly turned to look at another object of a different colour. In both instances this ceases at the end of a given time, during which the primitive impression in its turn takes the place of the secondary impression.*

The first case of colour-blindness that occurred in my practice was that of my late talented friend, Mr. Angus Reach, whose untimely death has been so much and so justly

* Professor Wartmann, 'Scientific Memoirs,' 1846.

lamented. He was incapable of distinguishing green, and only partially red. With him, both were nearly the same. The former would sometimes appear more of a pink than even red. He had altogether but a very poor conception of the primary colours. This I detected on an occasion while endeavouring to demonstrate the gradation of beautiful colours displayed by some objects made to depolarize light when placed on the stage of my microscope. After a long endeavour to convince him of the fact, as he could see nothing wonderful in it, I discovered that he was unable to name the colours correctly; and he then told me he had always been indifferent about them. To prevent error, he had been accustomed to avoid describing them, except relatively, as light and shadow, or black and white. He remarked, one day, of the *vin ordinaire* of France, that to him it appeared so like ink that he found himself endeavouring to write with it. He saw no red in it.

At this time, unfortunately, my attention was not so much drawn to ophthalmic disease as it has been since; and I omitted to make such an investigation of this remarkable affection as, in one so fully capable of affording accurate information as to the phenomena observed, would have been so valuable. Very soon after, he was attacked with the first symptoms of softening of the brain, which gradually progressed during the two years his life was prolonged.

It has since several times occurred to me that the defective condition of sight might have been connected with the early development of the disease in the brain. The extreme condition of colour-blindness in which I found Mr. Reach's eyes must have been a progressive aggravation; for, otherwise, it is most probable more notice would have been taken of it than seems to have been the case. Indeed, it might have been induced as the first symptom of an over-worked brain. I have had opportunities since of observing instances of partial colour-blindness arising from general disturbance of the system, and disappearing as this was corrected and relieved. The following case will sufficiently illustrate this :—

Ann G——, aged 38, a healthy-looking widow, who had never over-used her eyes. Has always enjoyed good health; but, since the death of her husband, has suffered greatly from nervous depression and lowness of spirits. Two years ago, whilst reading the paper, her sight suddenly became dim, so as to prevent her reading or seeing any object at a distance. She only lately discovered that she could not distinguish colours, with the exception of blue. Having placed before her, successively, red, green, orange, and blue, she could only distinguish between them as dark or light, and could not tell what they were. She thought it arose chiefly from the effort made in straining her eyes to look at them, which gave her considerable pain.

An opportunity was taken of examining the eyes with the ophthalmoscope. The lenses were found perfectly clear. In the right eye a small black patch was visible on the upper and inner portion of the periphery of the optic nerve entrance, the greater part of which appeared abnormally pale. There was cupping. The retinal vessels appeared to break abruptly off after leaving the nerve. All the vessels are partially obscured and irregular. In the left eye, the retinal vessels emerge from two separated points. The optic nerve very white. Mist. Ferri was prescribed to be taken three times a day. Under this treatment she considerably improved; natural vision returned, and in two months she discontinued her visits to the hospital.

Unilocular Diplopia.—There are some forms of retinal disorder that, unlike softening of the retina, the infiltration of pigment into the membrane, atrophy, &c. admit of little explanation from any observed structural change, and which therefore it is usual to assign to irregular refraction. Such are cases of *unilocular diplopia*, where objects are seen out of focus, so as to produce double images in the affected eye. It is much more frequent than is generally supposed; for it is seldom noticed until the sight of the other eye is considerably impaired. The effects of unilocular diplopia are much the same as is produced in myopic and presbyopic eyes, when the object is placed beyond the proper point of sight; but its important characteristic, distinguishing it also from temporary indistinctness of vision due to some disturbance in the general health easily rectified, is the suspicious circumstance of only affecting one eye. It is necessary, however, to be cautious in determining the character of this form of diplopia, as it may arise from some accidental condition of the surface of the cornea, or even from a dislocated lens. A layer of mucus upon the cornea will produce not only a double, but a multiple effect of images upon the retina. Defective correspondency in the curvatures of the cornea and lens, so that their vertices are not on the same line or axis, may also occasion the illusion, as rays of light will thus be brought to a focus at different points; and, in some cases of strabismus, an anomalous form of diplopia is observed, due to what is termed incongruence of the retina. For instance, in strabismus convergens, the double image should be homonymous, and the distances between them commensurate with the amount of deviation from the proper visual axis; but where there is incongruence of the retina, we find these conditions reversed; and even if the images are homonymous, the distance between them bears no proportion to the want of parallelism in the optic axes. In a divergent squint also, will perhaps be found homonymous diplopia, whilst a convergent case may have crossed double images.

Gräfe distinguishes two classes of this affection. In the first, the healthy eye fixes the object with its centre. Upon closing this, however, the affected eye does not adjust its central spot upon the object, but a point of the retina lying either internal or external (according to the character of the squint) to the central spot, and with which, in a fixed gaze, it ultimately becomes identical.

In such cases, it is obvious that a line dividing the retina into a right and left half, does not fall exactly in the centre, as in the healthy eye, but is situated in a convergent squint, on the inner side of the centre; and rays of light, therefore, whether acting upon the macula lutea or on points of the retina external to it, describe an image as if thrown across that of the healthy eye; and it so happens that a crossed double image may be observed in conjunction with a convergent squint. It is otherwise when the vertical line falls on the outer side of the centre, for images will then be produced in a corresponding direction; and thus with a divergent squint will be found homonymous diplopia.

After a strabismus, convergens or divergens, has existed for some time, it frequently happens that a portion of the retina in the affected eye has lost the power of mutual vision on a line inwards or outwards according as the case may be; and, therefore, if tested with a prism, its base in the former turned inwards, in the latter outwards, no diplopia will be observed. When, however, the base of the prism is applied vertically upwards or downwards, if incongruence of the retina exists, the double images will now be crossed and differ in height; or, should they be homonymous, the distance between them will not be at all proportionate to the amount of the squint.

Before operating for strabismus, it is evidently of importance to ascertain whether or not incongruence of the retina exists, which is readily discovered by the aid of prisms,* the facility of uniting the double images directing in a great measure the course to be pursued, as, under some circumstances, an operation might not be advisable. For instance, if, on applying a prism with its base outwards, crossed diplopia should be aroused, an operation would probably subject the patient to great inconvenience, from the crossed double images produced, and which it would be difficult to suppress. It might also happen, that, in the natural endeavour to obviate the confusion in sight, by separating the images wider apart, the eye would be turned outwards, producing the still greater deformity of a divergent squint. Or the original condition might again appear by the contraction of the rectus internus in a similar natural endeavour to unite the images.

In the second class of cases of incongruence of the retina, according to Gräfe, each eye being tried separately fixes the object with the macula lutea; but the two points not being

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* Vienna opticians include prisms in the box of test-lenses which they supply to Ophthalmic Hospitals.

identical when both eyes are open together, diplopia arises. An operation might be here performed to cause the rays of light to fall upon that centric point of identity in the retina that would correspond with the macula lutea in the healthy eye.

If there is a very great difference between the double images and the deviation of the optic axes, it is very problematical indeed that any operation will enable the patient to unite the images so as to bring them accurately over each other. The object therefore should be to correct the squint only so as to restore as much as possible the parallelism of the optic axes. The personal appearance will at all events be greatly improved; and as the images are widely apart, if they happen also to be homonymous, the defect soon ceases to be a cause of annoyance. Persons who squint have always double vision; but they acquire the power of attending to the sensation produced in one eye at the time.

Should the incongruence of the retina not have been discovered until after the operation, and the diplopia be complained of by the patient, this may be corrected by the use of prismatic glasses, which, for the two eyes, may be of the strength of one-half only of a single prism, that will unite the two images in one.

In a lady suffering from paralysis of the oblique muscle of the left eye, M. Farro found diplopia disappear when the patient turned her head towards the right shoulder, and at the same time inclined the left side of the face forwards. The diplopia arose from the circumstance that, in paralysis of the superior oblique muscle, all objects looked at with both eyes appear double. The two images seem one above the other on a parallel line, for the posterior segment of the eyeball on the side affected necessarily descends. When, therefore, in the case alluded to, the head was bent over the right shoulder, the left eye was raised and the right correspondingly depressed, the two images were made to fall upon the two retinas at symmetrical points, so that objects which appeared double when viewed horizontally, were brought directly over each other by a position that enabled them to be vertically observed. As Dr. Jacobs of Dublin, who was the first to notice and explain the effects of a paralysis of the superior oblique muscle, observes, the forward movement of one side of the face is not absolutely necessary; it merely permits the rectus externus to remain inactive, and thereby diminishes the necessity for local muscular exertion.*

Amblyopia.—The early stages of that formerly very undefinable disease, amaurosis, was described as amblyopia; and when it was difficult to distinguish the seat of the disorder, whether in the transparent media or in the functional powers of vision, was quite as fertile a field of error and uncertain diagnosis as was the more advanced evil.

But, although the old classification and nomenclature of what were formerly termed amaurotic cases will have to be abandoned, it perhaps will be useful to retain, during the transition process to a more improved system of eye disease, some of the names by which well-marked distinctions in state or character were formerly known, and of course will be most familiar to the general practitioner of to-day. *Amblyopia* is one of these, and may still be employed to describe a complication with some general disorder of the nervous or vascular systems. Also *asthenopia*, or that weakness of sight which sometimes occurs without any apparent disease of the eyes,

* Dr. B. Séquard found that "when the pons varolii is diseased, there is paralysis of the trunk and limbs on the opposite side. The sixth nerve is very often affected, thus allowing the globe of the eye to be drawn inwards. Paralysis of this nerve never exists except with disease of the pons varolii. Those fibres of the facial nerve which are distributed to the *orbicularis palpebrarum* have three roots spread into the *pons varolii;* hence that muscle is often paralysed. In addition to the above positive, there is negative evidence of great value; the third pair of nerves, and hence the superior rectus, levator palpebræ, internal rectus, inferior rectus, and inferior oblique muscles, remain unimpaired. The fourth pair is not involved; so that the rolling power of the eye remains intact. Unless the disease extends to the medulla oblongata, hearing is unimpaired. Sometimes the external rectus is affected, when the patient sees double."

or symptom of constitutional disturbance affecting those organs.

Amblyopia is the nervous shortsightedness of some authors,* and is certain to be aggravated by every form of debilitating disease, over-work, bad food, bad air, sequelæ of fever, and several other causes, as spermatorrhœa, which will increase the intensity of the symptoms. The administration of alteratives, with tonics, especially blood-tonics, or any similar plan of treatment, promises therefore the most beneficial results. I may add, that when the impairment of vision is combined with a deficiency of colouring matter in the blood, the value of iron can scarcely be overrated. "The blanched lip and the pale tongue of an anæmic patient challenge us to prescribe a salt of iron, because we know that element to be wanting to restore our patient to health." Quinine with iron may be advantageously employed, and I have at times found arsenic and strychnine in combination very useful remedies.

Donders and others refer asthenopia, in most instances, to the existence of hyperpresbyopia, an affection of the refractive media, whereby the patient is unable (except for a short time) to bring divergent rays to a focus on the retina. The explanation given is, that the patient so affected is always inclined to exert all his nervous and muscular energy to effect a sufficient curvature of the lens, to cause the divergent rays proceeding from objects surrounding him to be brought to a focus on the retina; in other words, to enable the patient to see distinctly. The nervous energy of the patient soon becomes exhausted by this continued strain, and then the symptoms of asthenopia occur. The fact that those symptoms

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* "In *amblyopia*, or defective sight from affection of the retinal or nervous apparatus, although neither distant nor near objects are seen distinctly, the latter may be seen better than the former, because the eye receives a greater number of rays from a near object, so that the impression on the retina is stronger. Such a case, which may be called nervous shortsightedness, must be distinguished from true or optical shortsightedness. In nervous shortsightedness the sight will often be improved by a convex glass of low power, 30 to 40 inches focus."—Wharton Jones.

disappear on the use of appropriate glasses and remedies, serves to indicate that they are somewhat dependent upon an affection of accommodation.

Among the labouring classes, perhaps the most frequent symptom of diseased vision is that of asthenopia, and is chiefly due to over-work, especially the fatigue of nightwork by gas and candle-light. That the larger proportion of yellow rays, and great impurity of an atmosphere where numbers of work-people are crowded together for hours, have much to do with the prevalence of asthenopia, might be safely predicated, and is fully proved by the large proportion of persons employed in such trades applying at our ophthalmic hospitals for advice, as compared with those engaged in more exposed but vigorous out-of-door employment. And it is also worthy of observation, that persons employed upon work requiring concentrated light and powerful magnifiers, as engravers, watchmakers, and of the large number of those who for hours together use microscopes, few comparatively complain of asthenopia—much oftener of myopia—and, as a rule, preserve their sight to a late period of life. This is explained by the fact that they generally take care to correct the quality of the light, by the various aids of tinted glass, green paper shades, and other modern scientific appliances.*

The characteristic symptoms of asthenopia, resulting from imprudent or incautious use of the eyes under unfavourable circumstances, are of a suggestive and premonitory character; and it may be observed that the disease generally affects patients of weak and delicate frames, and young ill-fed subjects enfeebled by close attention to pursuits of a sedentary character. In the first instance, fatigue of vision is complained of after employment of the eyes on any of the accustomed pursuits, and this will be experienced even when such employment has been in moderation. The confusion of sight is sometimes accompanied with heaviness in the head, or actual

* The following Table, showing the comparative effects of occupations in the production of Eye Diseases, compiled from the books of the Royal West-

headache. If the occupation has been that of needle-work, the stitches can now no longer be seen; if of reading, the lines seem to run into each other, and complete indistinctness very soon follows. A temporary relief is obtained by looking at distant objects, or shutting the eyes, and for a moment or two the object again becomes distinct. Rest, indeed, for a day or two, is always attended with much benefit. In some cases, no great impatience of light is evinced; but in the great majority, a bright day is disagreeable. Strong artificial light is also complained of, and sometimes the intolerance of it is very marked. How much asthenopia depends upon the state of the general system is further illustrated by the benefit derived from a course of gentle alteratives, with tonics, especially such as improve the condition of the blood. A proper attention to the state of the skin excites an important influence for good on the eyes. A due amount of sleep, regularity

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minster Ophthalmic Hospital, gives only a portion of the occupations of the 6,000 cases treated during the year 1858:—

In-door occupations requiring close attention, but not necessarily in crowded rooms.		In-door occupations in crowded rooms or workshops.		Out-door occupations.	
Artists	4	Blacksmiths	71	Bricklayers	45
Carvers & Gilders	8	Bootmakers	28	Carpenters	75
Copper-plate Engravers	7	Clerks	80	Cabmen and Coachmen	71
Cutlers	6	Compositors	30	Charwomen	34
Engravers	15	Dressmakers	84	Labourers	305*
Jewellers	10	Governesses	24	Porters	57
Lithographic Printers	13	Laundresses	52	Painters	32
Opticians	4	Machinists, Engineers	94		
Musicians	10	Milliners	29		
Total	77	Total	492	Total	619
Married Women, closely and continuously employed in household duties and other occupations not particularized					634

* About one-half of whom are engaged in warehouses, and should be added to the total in the second column.

in diet, daily sponging the skin, the frequent use of the Oriental bath, flannel underclothing and garments adapted to the season, are all matters of important consideration where any predisposition exists, or unfavourable circumstances threaten an attack of asthenopia, which is so frequently the precursor of more serious disease. The eyes of children at school are often too much tried, and a disposition induced not at all favourable for the preservation of good sight. Any prolonged exertion of the eyes, especially after bodily fatigue, or during recovery from debilitating illness, is always prejudicial. It should also be kept in mind, that any strong light distresses the eyes. On the other hand, to exercise the sight by too weak or dull light also strains and fatigues the eyes, and is a source of as much, if not more, mischief. Gas, oil, or candle-light is very inferior to the mild light of day. Our own feelings tell us that work at all trying to the sight is best done by day. Students and others, therefore, who have much reading and writing, should do so by daylight. To read by day and write in the evening is a good rule: in like manner, seamstresses should do dark-coloured and fine work by daylight, and coarser work by candle-light. All artificial light should be bright without being dazzling. Sunlight must not be allowed to fall directly on the work, as the intense light may affect the retina, and cause congestion, or even inflammation. It is still worse, however, attempting to read or work by the feeble flickering light of a fire, or in bed by candle-light; and it is also very trying to the sight to read when riding, as the eyes are injuriously strained by the constant motion of the carriage. Another evil which should be guarded against is the incautious use of spectacles, commonly sold under the name of eye-preservers, but which more often intensify the sunlight, inasmuch as all blue and some green-coloured glasses increase the chemical action of light, and may add to the excitement of an already over-wrought or irritable retina. The only spectacles fitted for weak sight are those of *neutral-tinted* glass, without any admixture of blue.

DISEASES OF THE CHOROID.

Glaucoma, Irido-choroiditis, Choroiditis, Choroiditis Pigmentosa, Hyperœmia, Posterior Staphaloma, and Atrophy.

Having already shown that affections of the retina and optic nerve are sometimes characterized by a greenish reflection of the eye, and a cupped condition of the nerve, very similar to the lesion which occurs in glaucoma, I shall now enter at large into the nature of this latter disease, as one of the choroid coat of the eye, distinctly differing from the former class, as the participation of the retina, here, seems always to be secondary. An argument in favour of this view, is the very unfavourable diagnosis necessarily imposed by an undoubted glaucomatous invasion of the eye, as compared with the hopes that may be justly entertained in mere functional disturbances connected with the retina. From the fact also that the exciting cause of glaucoma is intra-ocular, either in the optic nerve or vessels of supply, or both conjoined, the changes that occur are progressive, the various tissues becoming one after the other involved; and it is perhaps to the stages not being sufficiently distinguished that we owe the very different views of its pathological character which have been entertained by different authors. In this manner it has been supposed to depend upon disease in the choroid, in the retina, or to some abnormal opacity in the vitreous humour. It was long considered by the first authorities as due to inflammation of the choroid, with effusion between it and the retina; but which Gräfe sufficiently proves was owing to the opinion being based upon appearances in far advanced cases, and which did not therefore really possess the true typical character of glaucoma.

An indistinct obscurity cognizable in the deep-seated humour of the eye, and a greenish reflection from the fundus, occurring generally in persons of mature age, prepare us to suspect the presence of glaucoma. The sluggish dilated pupil is somewhat altered in colour. A hardness and tension of the globe is also always observed—due, there can be no doubt, to an increase in the contained fluids. The sclerotic has a peculiar pale-bluish hue. The premonitory symptoms, which may appear suddenly, but more generally are spread over weeks or months, are sometimes so slight as to excite little attention, until some progress has been made by the disease. Occasional dimness of sight is complained of, and any existing presbyopia is increased. Pain in the eyeball—iridescent halos appear to surround the light of a candle—sometimes accompanied with severe headaches, are apt to occur towards evening. Accessions, at first perhaps separated by long intervals, now return more frequently, the dimness is permanent, and the case, with occasional remissions, may be said to have become chronic. Examined with the ophthalmoscope, the cupping of the optic nerve entrance is very characteristic. It is readily distinguishable by the abrupt suddenness of the depression, and by a peculiar lateral extension, from the shallow and more saucer-like form of the same kind of appearance present in functional or cerebral affections of the retina and optic nerve. The pulsation of the central vessels is also an important diagnostic appearance, as it is to some extent a measure of the inter-ocular mischief caused by the pressure of the increased fluids in the globe. Sometimes hæmorrhagic extravasations are visible, both in the retina and vitreous humour.

It is observable that the excavation of the optic nerve progresses gradually with the increasing tension of the globe. This part it would seem offers less resistance than any other where it is supported by the unyielding texture of the sclerotic coat: and an atrophied condition of the nervous fibres in this situation follows upon the excessive pressure to which they are exposed.

There is another form of glaucoma, differing remarkably from this subacute development of the disease, very generally ushered in without any distinct inflammatory stage, and presenting but few of the usual premonitory symptoms. Instead of proceeding gradually, it appears to accumulate suddenly in intensity, and so violent sometimes is the attack, that vision is lost as if by a stroke. It comes on usually at night, with intolerable headache, especially in the forehead and orbital region in general. The pupil is widely dilated, immoveable, the whole globe very hot, and the seat of unusual tension, with every appearance of an internal ophthalmia. The iris has a dull greyish or greenish hue, and presses forward; the posterior surface of the cornea being also duller, and evidently affected by the prevailing excitement. After a few hours of intense suffering, which often I have seen abate almost as suddenly as it commenced, vision in part returns, and the paroxysm seems at an end. In some cases, the blindness continues from the first, leaving an idea in the patient's mind that the calamity proceeded from a violent nervous or bilious headache. These inflammatory paroxysms recur at irregular intervals, more or less protracted, each time seriously diminishing the power of vision; the symptoms, at first transitory, become confirmed, and the disease ends in total blindness.

When the refractive media lose the small amount of turbidity incidental to the immediate paroxysm, we perceive in the ophthalmoscope certain spots in the retina, and sometimes extravasations between it and the choroid. The cupping of the optic nerve may be noticed progressively increasing; and as this proceeds, the arterial pulsation, if it does not spontaneously appear, may be easily produced by pressure made on the eyeball with the finger.

It is unnecessary to extend my remarks here to a general review of the many different opinions that have prevailed, not only as to the seat and immediate cause of glaucoma, but also as regards its pathological character. It will, perhaps, be sufficient to express my own opinion, and some of the reasons which have led me to conclude that the disease is, primarily, an inflammatory condition of the ciliary muscle; not unlike a form of rheumatism which affects more particularly the fibrous texture of hollow muscles; whilst it is considered by some as a specific inflammation of the serous membrane in connection with the particular organ invaded. It is not because anatomists fail to distinguish any corresponding structure in the tunics of the eye, that we may not infer such an existence, as symptoms evidently allied pathologically can only be explained by a reference to some organism of the character alluded to. We know the arguments that have been adduced in support of the view that the arachnoid is a true serous membrane, from the symptoms and sequelæ of meningitis, which are not the least illustrative or demonstrative of this being the probable fact. At all events, the pathological characters given by old English writers to *aquo-capsulitis*, which may be said to be, in fact, all included in the continental synonymes of "*iritis serosa* and *hydromeningitis*," are such as strongly suggest, if they do not actually impose, ideas of an inflammatory invasion of some corresponding or allied membrane to those which in other situations are well known to be obnoxious to such attacks. The ordinary conventional designations of *arthritic ophthalmia* and *rheumatic iritis*, all point in the same direction of a necessity being recognized to describe a disease of most painful excitement, and which, marked by the most prominent symptoms of ordinary inflammation, is yet aggravated by depleting treatment. The age at which glaucoma most usually appears, is also an evidence of its connection with a habit of body favourable for the development of arthritic inflammation. Ciliary neuroses are never altogether absent, and the nocturnal accessions of the paroxysms are also consistent with an explanation which would refer glaucoma to a specific inflammation, invading the fibres of the ciliary muscle of a low atonic character, and consequent upon the undue excitement it is usual to call nervous irritability, aggravated forms of which are neuroses or neuralgia, so commonly the premonitory symptoms of this serious disease. Entertaining such views, I have therefore been very much struck by the observations of Dr. Philz upon what he terms inflammation of the *tensor choroideæ*:—

"We were long in doubt," says this indefatigable observer, "whether inflammation of the *tensor choroideæ* occurred as an independent phenomenon. While some ophthalmologists thought that an inflammation confined to the tensor muscle should be admitted, others opposed this view, and rejected the admission of a *cyclitis*." . . . "Although I myself, as already mentioned, have had no opportunity of examining anatomically any recent case of inflammation of the *tensor choroideæ*, yet I believe I may justly infer its previous existence, from some of the changes in the ciliary muscle which I have seen; such as its transformation into a more or less dense reddish or whitish connective tissue, or its shrinking into a shining tendinous texture. I believe that such changes occur, isolated or in combination with an exudation process in the tensor muscle, that the exuded substances may consist sometimes in an albuminous, sometimes in a fibrinous, sometimes in a hæmorrhagic fluid, and may undergo yet further changes." . . .

"More frequently than with recent parenchymatous changes of the *tensor choroideæ*, which often pass quite unnoticed, unless disturbances in accommodation or disorders of the iris call for medical aid, have we to do with the sequelæ of this affection. These show themselves as parenchymatous disease of the middle layer of the ciliary body and the ciliary processes contemporaneously with all the appearances of glaucoma."

If I correctly understand the meaning of Dr. Philz, he appears to be (and jusly so, in my opinion) reluctant to admit of the presence of active inflammation, whilst he is at a loss to account otherwise for the evidences of *parenchymatous inflammation* of the ciliary muscle, which he and others have detected in glaucomatous eyes. The changes here alluded to, are, the transformation of the fibrinous structure into a reddish or reddish-white connective tissue, sometimes more or less atrophied, exhibiting a shining tendinous texture. There is, however, I think, very little difficulty in arriving at correct conclusions as to the pathological nature of this disorganizing condition, which, while it is not actually true *cyclitis*, is still, in its prominent symptoms, even in its first stages, a disease marked by great vascular excitement. The exudations afford sufficient evidence of this; for whilst they are not suppurative, except when a positive internal ophthalmia has invaded the orbit, they consist either of an albuminous or fibrinous deposit, and an infiltration among the fibres of the ciliary muscle.

It is interesting to note the pathological consistency which such a view establishes between the most prominent symptoms of glaucoma and the appearances and consequences of, no doubt, an allied, if it be not a premonitory, stage, occurring in the structure of the iris—that portion of the choroidal system which not only readily determines the seat of the disorganizing attack to a part more easy of access and of less serious moment, but also early excites attention, and the necessary care to remedy and provide against further mischief. I, of course, allude to that form of irido-choroiditis upon which iritis-serosa depends, and in which a fibrinous exudation upon the anterior surface of the iris is always first observed.

Were it necessary to go beyond my own observation to account for the abnormal secretion of the fluids of the eye in glaucoma, Philz' statement, in connection with what he terms *superficial parenchymatous inflammation of the iris*, would embrace, as far as it goes, my own opinion of the immediate cause of the former more extensive disease of the whole choroidal system. His views also of the implication of the ciliary muscle, primarily, corresponds so closely with the conclusions I have myself arrived at with regard to the pathological nature of the origin, seat, and the first chief cause, of glaucoma, that, as far as their special object goes of distinguishing *cyclitis* from irido-choroiditis, with which it may be confounded, I think the discussion he enters upon may be taken as containing a fair account of the general symptoms observed. I differ, however, very decidedly with him, when he proceeds to say, "that no data for diagnosis can be drawn from the subjective symptoms any more than from the appearance of a distribution of vessels in the annulus conjunctivæ, nor from the formation of numerous vessels extending from the periphery of the eyeball to the annulus, and there ending as if sharply cut off, whereby the whole circle of connection of the cornea with the sclerotica attains the appearance as if a furrow were drawn in the latter, a symptom which I regard as belonging to *cyclitis*." And I would remark here, as regards the little value Philz attaches to these very suggestive symptoms, that, on the contrary, the degree of vision, and especially the loss of the power of accommodation, are of chief importance in distinguishing between *irido-choroiditis* and the *cyclitis* in connection with acute glaucoma; and that Philz is discussing the same disease to which my present observations refer, is evident from his own words immediately following the above extract: "more frequently than with recent parenchymatous changes of the *tensor choroideæ*, which often pass quite unnoticed, unless disturbances in the iris call for medical aid, have we to do with the *sequelæ* of this affection. They show themselves as disease of the middle layer of the *corpus ciliare* and ciliary processes contemporaneously with all the appearances of glaucoma."*

I would, however, more particularly direct attention to these, as being the most characteristic symptoms of choroidal vascularity accompaning that form of cyclitis which ushers in an attack of glaucoma, and especially to those remarkable evidences of constriction so apparent around the corneal junction with the sclerotica. It is here the ciliary muscle in its broadest part is closely attached to the inner wall of the canal of Schlemm, and where it is also connected with the iris. In their

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* I gather, then, from the writings of Dr. Philz, that he regards Glaucoma (or, as he terms it, "*Choroiditis, with exudation from the anterior branches of the choroidal arteries*") as dependent upon swelling of the ciliary processes, and effusion into the aqueous and vitreous humours. To the former he ascribes the nervous pain (ciliary neuroses), the loss of power of accommodation, the dilatation of the pupil, and the anæsthesia of the cornea; to the latter, increase of intra-ocular pressure, impaired vision, pulsation in the arteria centralis retina, cupping at the entrance of the optic nerve, atrophy of the sclerotica, commencing at the circumference of the cornea, and the altered circulation in the sub-conjunctival vessels.

passage from the choroid to the iris, the anterior and posterior ciliary arteries pass through it, and the ciliary nerves ramify freely throughout its substance. Instead, therefore, of being of trivial importance, I consider appearances so significant of constriction in such a situation most important, not only for the purpose of diagnosis, but to direct and determine the treatment; especially, as the indication is confirmed by the success which has so uniformly attended section of the ciliary muscle near the junction of the cornea and sclerotica, so as to divide the common attachment of the several parts with which it is connected. Here, with Mr. Hancock, the originator of the operation, I believe is to be found the required factor for that impeded circulation to which is properly to be referred that distension of the globe in glaucoma due to the transuded fluid which escapes from the congested and overloaded vessels.

Agreeing therefore perfectly with my colleague, Mr. Hancock, in all points of practice, and the preference to be given to his simple and safe operation before the more hazardous one of iridectomy, I differ somewhat from him in the *rationale* upon which he rests the benefits derived from section of the ciliary muscle. Where I think diagnosis has been chiefly at fault is in ascribing the excess of fluid in the distended eyeball of glaucoma to increased secretion: and the advocates for the excision of a portion of the iris even advance, that the consequent diminution of the secreting surface is probably the chief source of the benefit which follows the operation. Mr. Hancock states, "that the ciliary muscle, losing its elasticity and contractility, is converted into a rigid, unyielding cord. The eye is consequently deprived of its accommodating power, and the blood-vessels—nerves, and doubtless the absorbents, from their peculiar arrangements with reference to this muscle—being compressed, the circulation through these vessels is impeded; their coats, already weakened by the exciting disease, yield, form aneurismal pouches, give way, or become varicose. The parts supplied by these vessels, nerves, &c. are deprived of their nourishment; whilst the intra-

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ocular effusion or hypersecretion takes place subsequently to, and resulting from, these morbid changes." He further observes, "regarding the fluid therefore as playing but a subordinate part in the disease, it seemed to me that the first object to be attempted was the improvement of the state of the blood-vessels by removing constriction, and so relieving the circulation through them, with the view of arresting, or of diminishing, the abnormal secreting surface." Here, it may be remarked, appears a somewhat anomalous consequence, that when the circulation is arrested and the normal supply of fluid therefore checked, the secretion should be increased. No doubt it is by a process of osmotic force that the serous portion of the blood finds its way through the congested and strangulated vessels, and that so far Mr. Hancock's own illustration stands good: "If a ligature be placed tightly round a limb, œdema or an abnormal collection of fluid takes place, with swelling and proportionate disturbance of function." The disturbance, however, in this case, cannot, as I have before stated, be properly ascribed to increased secretion.

Mr. Hancock also entertains the same opinion as myself, that the objective state of the eyeball, in what Philz calls "parenchymatous inflammation of the tensor choroideæ," observed in acute glaucoma, is really the result of disordered action in the ciliary muscle; and that the symptoms of constriction present, the evidently elongated eyeball in its anterior posterior axis, in the distinct depression around the corneal segment of the globe, corresponding to its connection with the ciliary muscle, and in the congested state of the vessels visible; that all these are undoubtedly referrible to spasmodic rigidity of the fibres of the ciliary muscle, rather than to any atrophied condition; the difference being that which exists between cause and effect. In fact, the permanent success of the operation is in a considerable degree promoted by the return to the normal state of the fibres of the ciliary muscle, when freed from the constricting band of its own tissue abnormally contracting around the circular line, where the iris, the sclerotic, and the cornea are in immediate and intimate connection with it. A state of atrophy certainly supervenes, but cannot be said to be present with acute glaucoma, where, in the great majority of cases, one operation for the division of the ciliary muscle suffices for relief. Where indeed it requires to be repeated, in overlooked or neglected cases of chronic glaucoma, the necessity may then, perhaps, be properly attributed to some progress towards an atrophied condition of the muscle.

We have further evidence that the distension of the eyeball in acute glaucoma is not the result of the vascular excitement present; for, were it a product of inflammation, there would certainly be more evidences of such change seen with the ophthalmoscope. The rapid improvement in sight after the operation for section of the ciliary muscle, itself proves that the alterations induced either in the retinal or choroidal membranes are neither effusions nor deposits; which, however, might naturally be expected to follow the aggravated symptoms of internal inflammation, so characteristic of an attack of acute glaucoma.

In view of an anomaly such as this, Gräfe might well observe: "it proves that there are inflammations of the choroid of a very different kind. Diseases occur in this tissue, which are characterised by great circulatory and textural changes; the aqueous humour at the same time is not much altered; whilst there are others of which the opacity of the aqueous humour is pathognomonic. The general appearance of the so-called iritis-serosa, or hydromeningitis, was well described by the older authors; that their account now requires alteration is only owing to the advance of anatomical knowledge. Such an inflammation may continue for a long time without the occurrence of distinct changes of texture, adhesions, &c.; at all events, the chief symptoms continue to be diffuse cloudiness, and increased amount of the aqueous humour, probably with increased pressure in the anterior chamber. I hold a similar view of glaucomatous choroiditis, that it is a disease of secretion. Serous iritis is also nosologically allied to chronic glaucoma. We not unfrequently find transitions of the former into the latter, and we find, *mutatis mutandis*, this fact also pointed out by older writers. The treatment of both affections is also analogous, with the difference that in iritis-serosa iridectomy is a last resource, recovery being often obtained by other means. In short, I consider *acute glaucoma* to be a choroiditis (or irido-choroiditis) with diffuse imbibition of the vitreous body and aqueous humour; and in which, increase of the intra-ocular pressure, compression of the retina, and the well-known series of secondary symptoms, are produced by the increased volume of the vitreous humour."

I shall now proceed to examine the relative merits of the two operations which have been proposed for the relief of the tension in glaucomatous eyes. The soft elastic packing of the humours which ordinarily provide for the sufficient extension of the membranes of the eye, becomes practically converted into a hard, unyielding body, the pressure of which gradually destroys functional integrity, and ultimately the delicate organization that surrounds it. Of the two very different operations recommended to obviate these evils, that introduced by Gräfe, iridectomy, or the excision of a portion of the iris, is not only a very delicate, but, when we consider the nature of the parts concerned, a very elaborate process. Although, therefore, strongly recommended by its advocates, and most undeniably successful in a number of cases of glaucoma, in reducing the prominent symptoms and restoring sight, still it must be confessed iridectomy has failed to obtain general approval among the profession in England. I do not, however, agree with that indiscriminate condemnation which prevails in some quarters ('Dublin Quarterly Journal of Medical Science,' 1860), although I certainly prefer the simple section of the ciliary muscle, and which, equally efficacious, is exposed to far fewer contingencies of subsequent serious complication. Besides, its ablest advocates state that iridectomy, occasionally, " is one of the most delicate and critical in its nicety of all the operations of the eye;" therefore, confirmed by considerable experience and practice, I have no hesitation in urging upon the attention of the profession the vastly superior advantages to be derived from section of the ciliary muscle, both in simplicity and safety. The only instrument required is an ordinary Wenzel's knife, which is introduced about the tenth of an inch from the outer margin of the cornea, where it joins the sclerotica. An incision obliquely backwards and downwards is then made of little more than one-eighth of an inch in extent, and dividing the various structures represented by the dotted line in Fig. 17; the ciliary muscle is cut through,

Fig. 17.

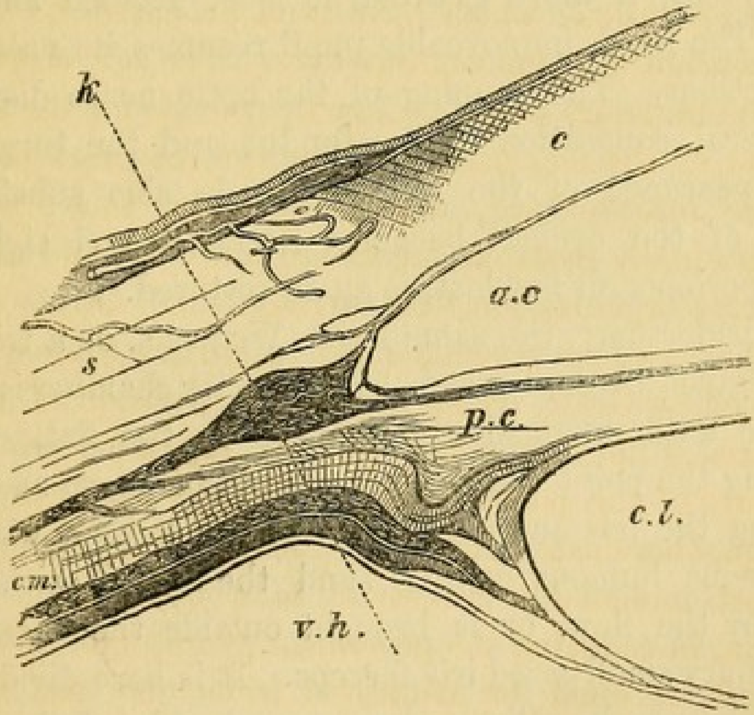

Fig. 7.—An enlarged vertical section of the Eye: *c*, the cornea; *s*, the sclerotic coat; *a*, *c*, the anterior chamber; between which and *p*, *c*, the posterior chamber, lies the iris and its pigmental coat; and to the left, near *c*, *m*, the ciliary muscle and ligament; *c*, *l*, the crystalline lens; *v*, *h*, the vitreous humour. The dotted line *k* indicates the direction of the knife, and the structures divided, in section of the ciliary muscle.

and, what I think most important of all, the triangular canal of Schlemm. It is not necessary to the success of the operation that either the aqueous or vitreous humours should be invaded, although sometimes an escape of fluid by the side of the knife indicates this to have been the case. The essential object is to divide the immediate cause of the most threatening symptoms, which is the band of constricting tissue; for I think there can be no question that to the purely mechanical obstruction thus occasioned in the blood vessels the evil of undue tension is to be attributed; at all events, when performed in cases where the pain has previouly been very great, the relief afforded by the operation is immediate, and the patients always express themselves as fully sensible of the benefit they have received.

In more advanced cases, also, of chronic glaucoma, the improvement, if more gradual, is most decided and gratifying. The fixed, immoveable pupil resumes its natural size and functions. The cupping of the optic nerve disappears, the general congestion of the fundus and the turgid varicose appearance of the retinal vessels also subside; the tension of the eyeball becomes normal; and sight, previously perhaps all but lost, is again restored.

For iridectomy, the same knife, Wenzel's, or a triangular lancet-shaped blade, is used. The anterior chamber is entered with the knife inclined at an angle on the flat, carefully advancing the point towards the opposite side, so as to avoid wounding the iris and the lens. As the knife is withdrawn the aqueous humour escapes, and the iris is either prolapsed by the flow, or is brought outside the chamber by the ordinary small-sized iris forceps. It is here divided from its pupillary to its ciliary edge, on each side of the forceps, with small scissors, and the detached portion, being then torn from its ciliary attachment, is carefully cut away from the rest of the iris, so as not to leave any shreds within the angle of the first incision. A section equal to one-sixth of its circumference is generally sufficient. The operation requires care; in the first place, the incision should be an ample one, directed *superiorly* and *internally*, beyond the margin of the cornea, and nearly to the level of the iris, so that the ciliary ligament is included in the section. If there are no adhesions of the iris, it generally prolapses immediately, and there is no difficulty in seizing it. Much care is necessary to avoid injury to the lens with the forceps. The segment of the iris should be rather large, as small and incomplete excision of the iris is often followed by a closed pupil. It is to be remarked that the segment of the iris should be complete, up to its ciliary margin. If blood escape into the anterior chamber during the operation, it should be removed, by inserting a fine scoop within the lips of the incision, and at the same time make slight pressure on the globe. The cornea must not be pressed upon. The operation is best performed when the patient lies on his back, the surgeon standing at his head. The after treatment, in this as well as in section of the ciliary muscle, consists in seclusion from light, opium to relieve pain and secure rest, with a light wet pad or bandage applied to the eye.

As the knife enters the anterior chamber a little behind the apparent junction of the sclerotica and cornea, and therefore cuts across the line of constriction previously indicated, it seems much more natural and philosophic to attribute the benefit which follows iridectomy to the first incision made, whereby the band of tissue at the primary seat of the mischief is effectually divided.

M. Schwigger believes that division of the anterior tendinous insertion of the tensor choroideæ is most instrumental in effecting the cure; while others are of opinion that the effect is to be compared to that of an ample incision into inflamed tissue, or an abscess, when the inflammation generally subsides immediately after the operation. Gräfe himself considers that the removal of the tension is the chief cause of the curative effect; and it is certainly true, that, in certain morbid conditions, the intra-ocular pressure is so considerable, that the aqueous humour often spirts out with great force when the section of the cornea is made.*

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* Iridectomy has also been recommended as a preparatory operation for linear extraction of cataract.

Mackenzie long since recommended paracentesis corneæ and paracentesis sclerotica to relieve the advanced stages of glaucoma, by taking off the pressure (as he explicitly enough states at page 899, *Diseases of the Eye*) of the accumulated fluid on the retina:—" The puncture should be made with a broad iris-knife, at the usual place of entering the needle in the operation of couching. The instrument, pushed towards the centre of the vitreous humour, is to be turned a little on its axis, and held for a minute or two in the same position, so that the fluid may escape. A transient amelioration of vision, as well as relief from pain, is sometimes the result of the operation, or even of that of puncturing the cornea, and evacuating the aqueous humour." It is only justice also to mention that very nearly the same operation was recommended by Mr. Middlemore, in his treatise on *Diseases of the Eye*, published in 1835. Mackenzie likewise makes the interesting observation (and which, in the first place, probably led him to his conclusions upon the value of diminishing by a special operation the pressure of the accumulated fluid in the eye), that extraction of the lens was an effectual means of arresting the progress of glaucoma.

I do not think it requisite to institute a comparison even, between the relative merits of iridectomy, and the operation for section of the ciliary muscle. Facts speak for themselves. It is only necessary to know, for a correct opinion to be formed, that the alleged constriction at the junction of the sclerotic and the cornea, involving all the parts surrounding the canal of Schlemm, and to divide the textural cause of which is the professed object of the operation, has never been denied; whilst constantly accumulated instances of success incontestibly prove the soundness of the principles, upon which I rest my advocacy for its general adoption in cases of glaucoma. In fact, the simplicity and safety of section of the ciliary muscle, compared with that of iridectomy, is of itself a point of no small importance. This operation has now been performed in upwards of three hundred cases, at the Royal Westminster

Ophthalmic Hospital, by myself and colleagues, and no greater misadventure has ensued than that of a slight *prolapsus iridis*, and this in no more than three or four per cent. of the whole number. Whereas, in iridectomy, serious hæmorrhages, suppurative inflammation, atrophy of the eyeball, and ultimate extirpation, have frequently resulted, even under the care of the most practised operators. It is, indeed, confessed that liability to these casualties constitutes a most serious drawback to its general adoption; and should therefore limit it, in my opinion, to cases where complications authorize a departure from the simpler and equally efficacious operation.

It may be always, indeed, safely prognosed that section of the ciliary muscle will be followed by greatly improved vision. Sight even has been restored in apparently hopeless cases, where the glaucoma had existed for a longer or shorter time, and the signs of congestion on the external membranes had disappeared. The operation is therefore always indicated in chronic glaucoma, when ophthalmoscopic inspection shows that the papilla and its vessels are not in a very advanced state of atrophy. The failures have generally occurred in long-standing cases of glaucoma, where attention has not been sufficiently directed to a proper examination of the condition, in this respect, of the entrance of the optic nerve and its central vessels.*

Acute Glaucoma.—J. B——, aged 52, had subacute glaucoma of the left eye, for which I operated on the 17th August, 1860, with success. This case has been reported in full at page 383 of 'The Lancet,' Oct. 20th, 1860 (Case 12). This patient returned to the hospital,

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* *Murray and Heath's Binocular Ophthalmoscope.*—In my observations on the binocular ophthalmoscope (see page 19), I stated that all the instruments I had hitherto had an opportunity of examining, and making trial of, were in many respects not only very imperfect in construction, but most troublesome in use; so much so that I still had a decided preference for the monocular. In the first place, unless the distance between the pupils of the observer correspond precisely with that between the points of emergence of the rays, Dr. Teulon's (Nachet's) instrument is almost useless. Secondly, a slight differ-

January, 1861, suffering from all the symptoms of acute glaucoma in the right eye. For certain reasons, I decided to perform iridectomy on this eye; but violent inflammatory action followed and completely destroyed the sight. I saw the man August 6th, 1862, and am able to say that the improvement in the left eye has been permanent, and has enabled him to follow his usual employment since October, 1860.

Subacute Glaucoma.—E. E——, aged 54, admitted August, 1861. With the exception of occasional attacks, apparently of an arthritic nature, has habitually enjoyed good health. About three years ago, without any apparent cause, the sight of the left eye began to fail, whilst at the same time he complained of circumorbital headache, accompanied

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ence in the width, sufficient to prevent perfect combination of the two portions of the light pencil, produces double vision and complete confusion. And, thirdly, a somewhat greater difference, by excluding one eye from the visual act, reduces the instrument to a monocular ophthalmoscope of small utility, one half the light being lost to the observer. There are other objections of less importance than those stated, and all of which have been most successfully overcome by Messrs. Murray and Heath, of Piccadilly; and I may say, they have succeeded in producing a binocular instrument of great value and practical utility. As now perfected by these opticians, the ophthalmoscope is as follows:—Two prisms (A B) are placed immediately behind the fixed perforated mirror (not shown in the diagram), so as to divide the light pencil, and reflect it right and left.

The reflected portions are then received, and again reflected by two

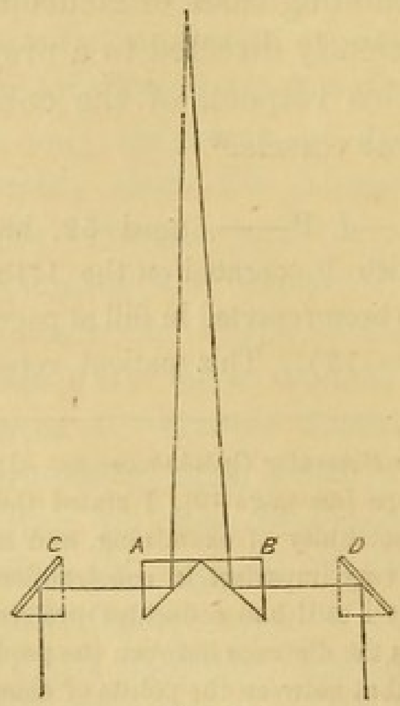

Fig. 18.

by the appearance of stars falling before his eyes. Subsequently, on using the eye alone, he found that objects seemed so much reduced in size "that men were dwarfed to the size of sparrows;" and at length vision was wholly lost. In this condition he became a patient of the late Mr. Guthrie, by whom he was treated for some time without benefit. The right eye became similarly involved, a like train of symptoms preceding the nearly complete extinction of sight.

At present the right eye has perception of large objects, though he cannot distinguish the largest of Jager's test-types. Vision is entirely lost in the left eye, light and darkness being alike undistinguishable. The epithelial corneal layer rough; pupil widely dilated, of a greenish hue, remains perfectly fixed when the strongest light is thrown upon it from the ophthalmoscope; there is considerable ciliary and sub-conjunctival injection. The anterior chamber is much reduced, so that the iris seems to press on the cornea. The eyeball tense.

Ophthalmoscopic appearances.—Left eye: Media tolerably clear; optic papilla markedly cupped; whilst pulsation of its central vessels is clearly and beautifully seen. Right eye: Media more obscure: the morbid appearances are pretty much as in the left, though perhaps less marked.

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mirrors (C D), so arranged that by turning a screw they can be set at any required distance apart, from two to three inches; while, in order to facilitate adjustment, the plate upon which they slide is finely graduated. Another screw increases or diminishes their inclination, and consequently the direction in which pencils proceed from them. As shown in the diagram, they are parallel to the reflecting faces of the prisms, and at right angles to each other, so as to give parallel pencils. By increasing their inclination, they give divergent, by diminishing it, convergent pencils. Among other advantages of this arrangement, is the application of ocular lenses placed immediately behind the mirror (C D), as in the ordinary ophthalmoscope, either to amplify the indirect image, or, in myopia, to obtain the divergence necessary for direct examination. It is obvious that the inclination of the mirrors (C and D) affects only the direction of the pencils reflected from them, and does not at all alter the character of convergence or divergence given to each pencil by the refractive apparatus of the eye from which it issues.

"Messrs. Murray and Heath's instrument, on account of its adjusting properties, not only admits of being passed from hand to hand, and modified, by turning a screw, to suit any observer, but it has the much greater advantage of affording complete rest to the muscular and accommodation apparatus. By altering the inclination of the mirrors, the precise direction may be given to the pencils of light that enables the eye to receive them without effort, and to

Aug. 1861.—I performed section of the ciliary muscle on either eye. The patient left the hospital a month afterwards, at which time he could walk about with safety but could not read.

April 2nd, 1862.—Came to the hospital to-day. With his right eye he can read No. 20 of the test-types at a distance of three feet.

Ophthalmoscopic appearances.—Right eye: The vessels of the retina are large and tortuous. Left eye: the vessels are small; there is still slight cupping of the optic papilla.

Acute Glaucoma.—S. R——, aged 67, admitted Oct. 2nd, 1861, with acute glaucoma. This case was so well marked that it scarcely needs a particular description. The pain was most acute, and sight entirely lost. There were cupping and pulsation of the arteries of the retina, and all the other well-recognised symptoms of acute glaucoma.

I divided the ciliary muscle on the 3rd of October. The operation gave immediate relief; and although the patient was unfortunately attacked with erysipelas, she recovered the sight of the eyes, and left the hospital on the 24th October, cured.

Glaucoma.—R. R——, aged 43, a valet, admitted July 24th, 1861. Has been a light dragoon, and served in India. Always had good sight as a young man, but in going out to India he became blind when the moon was shining; although he could see well in the day-time, he became totally blind at night. This lasted for about a week,

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study the images they form without fatigue. There is a superficial appearance of complexity about the screws, the use of which should be mastered by preliminary practice with a candle flame as an object; and the instrument is only perfectly adjusted when the observer looks through it, almost without being conscious of its presence. If a little pains be taken in the first instance, the beginner will find no difficulty, except a liability to set the mirrors much too near or much too far apart, in either case totally excluding one eye from participation in the visual act, and using in fact a monocular ophthalmoscope, with perfect definition, but no relief. After once seeing the relief that may be obtained, the way in which the retinal vessels appear to stand out from the nerve entrance, this mistake would be impossible.

"In order to obtain the direct image, with sufficient illumination, the patient must sit under a jointed gas-burner, so that the flame can be brought well forward, and a little below the level of the vertex. The variable inclinations of the mirror, besides fulfilling the purposes mentioned above, allows the observer to experiment upon his own acccommodation and powers of visual direction in a highly interesting manner, although space forbids me to enter into details on this part of the subject.

"Messrs Murray and Heath have now substituted prisms for the lateral

In 1851 he injured the right eye, and this was followed by severe inflammation. The sight of the eye has been gradually getting worse, now very limited, and he is continually troubled with flashes of fire in the eye, and orbital pain. Globe very hard.

Ophthalmoscopic appearances.—Right eye: In the axis of vision, and near the yellow spot, is a purplish patch as of congestion. The fundus presents a whitish irregular appearance throughout. Numerous black patches, somewhat rounded in shape (and these in either eye), are mostly arranged on the outer side of the optic entrance. Optic papilla pale, and cupped; vessels of retina very small and irregular. The left eye presents similar appearances, except that the black patches are less, and the whitish (like millet seeds) more numerous; these are seen to surround and encroach on the optic nerve entrance, which has therefore an ill-defined margin.

July 26th.—I performed section of the ciliary muscle on each eye. About three drops of fluid escaped from the left eye, and about six from the right. The patient states that the pain was very slight during the operation.

28th.—Says he can see rather more clearly with the left than he did before the operation.

31st.—Before the operation, he could barely see No. 12; now with his left eye he can see No. 12 at arm's length, and can read No. 4, or even No. 2, by straining the eye. With the right eye, before the operation, could not read No. 20; now he can read No. 16. He says the spider-like muscæ have disappeared.

Aug. 4th.—With the right eye he can now read Nos. 8 and 10, and with the left eye No. 2.

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mirrors, as shown by the dotted lines in Fig. 18. It is obvious that prisms would produce the same general effects, and be susceptible of the same changes of position as mirrors."

It is in my power to endorse Mr. Carter's statement,* that, "With the assistance of this binocular ophthalmoscope, not only is the cupped optic nerve immediately recognised, as an unmistakable cup or cavity, but even small effusions of blood, lymph, or serum, present aspects that are conclusive with regard to their relations to the general field. The vessels of the retina, too, appear to stand out from, and to be distinctly on a plane anterior to, those of the choroid, which again, in young light eyes, with good illumination, may be recognised at different depths in the chorio-capillaris."

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* 'Lancet,' March 7th, 1863.

10th.—He can just read No. 2 with his right eye; with his left he can read No. 2 at twelve inches.

Subacute Glaucoma.—Eliza L——, aged 63, admitted into the hospital Dec. 10th, 1862. Two years ago, the left eye first attracted her attention, the sight being very dim. The right eye soon after became affected in a similar manner. Had applied to two other institutions, and her eyes were examined with the ophthalmoscope. Obtained no relief; her sight was indeed dimmer. With the right eye can barely read No. 16 type-tests; with the left can only see the black colour of No. 20. Eyeballs very hard to the touch.

Examined with the ophthalmoscope, distinct cupping could be observed in both eyes, a marginal line around the optic discs well defined, and great tortuosity of the vessels. Pulsation clearly seen when the eyeball is compressed. Irregular striation, commencing in both lens from circumference, but not involving the direct axis of vision. I divided the ciliary muscle in both eyes.

18th.—She complains of great pain around orbits and in the eyes. Apply Ext. Belladonna. No improvement in the sight.

20th.—With the right can count fingers. Symptoms of erysipelas present. Pil. Hyd. c. Rheo. o. n. and Mist. Ammoniæ c. Cinchon. t. d.

23rd.—The right eye much better; can see my features clearly. The left nearly dark.

24th.—The left eye improving; can clearly perceive objects.

30th.—Can read easily, with both eyes, No. 12 type-tests; progressing most favourably.

Subacute Glaucoma, double iridectomy, and section of the ciliary muscle.—D. B——, aged 45, of Great Grimsby, admitted Dec. 10th, 1862. Five years ago caught a cold whilst at work, A severe attack of low fever ensued, followed by rheumatism. The right eye became inflamed, with violent pain around the orbit, the inflammation continuing for about seven weeks, during which time he was unable to see; after the symptoms subsided, could see well. The left eye then became similarly affected, but did not recover quite so well as the right; still he was able to see to work. Two years ago he came up to the hospital, and was then admitted. His sight had been gradually failing for some weeks, the field of vision becoming more and more contracted. The circumocular pains were at times most severe, and the globes very tense—stony hard to the touch. Cupping of the optic nerves and pulsation of the arteries were distinctly perceptible. At the time he could distinguish persons, but not features. The light always appeared to him of a very gloomy character; he could not read any of the type-tests. I performed iridectomy on both eyes, which was followed by immediate improvement in sight, as he could read in a week after names on the shops across the street. On his return home, however, his sight once more began to fail; and since, for about eighteen months, had been unable to distinguish anything beyond light from darkness. Complained of a number of bright lights like half-moons continually dancing, as he expressed it, before his eyes, with occasional pain in the eyeballs; his health had otherwise been good.

Dec. 12th.—I performed section of the ciliary muscle in both eyes. A slight increase of pain followed the operation, which was relieved by opium in full doses at bed-time.

18th.—Can see somewhat better with his back to the window; is able to see me with his left eye, but cannot distinguish features.

24th.—Can see better this morning, and count fingers when the hand is held up.

On the 30th, was discharged, his sight improving.

Of this interesting case it may be observed, that iridectomy failed to secure more than temporary relief; I therefore, on the last occasion, resorted to section of the ciliary muscle, and by that means hope to effect a permanent good. Indeed, it is only a few days ago (April 23, 1863) that I received a communication from the worthy vicar of North Somercotes, written at the request of the patient, who states—"He can see a little better, but still imperfectly. He has continued taking medicine according to your prescription, and would like to know whether any change is necessary. . . . I never saw him looking better in health." In a few other instances where I have tried section of the ciliary muscle after iridectomy, the patients have also derived more or less benefit from the operation. In several cases I have performed iridectomy on one eye, and section of the ciliary muscle on the other. The results, although variable, have been, in the greater number of cases, in favour of the latter.

It may further assist the memory in the diagnosis of glaucoma, if I here introduce a few observations made by Dr. Mackenzie upon the subject, in a contribution to the Ophthalmic Hospital Reports:—

"1st. That the sea-green appearance behind the pupil, whence the name arose, does not depend, as was once generally supposed, on any thickened or discoloured condition of the vitreous humour, but on a diplochromatic state of the crystalline, by which it absorbs the extreme prismatic rays, and reflects the middle ones.

"2nd. That the vitreous fluid in glaucoma is superseded by an unhealthy secretion, which over-distends the eye, makes it feel hard, causes severe pain by pressing on the ciliary nerves, and obliterates the sensibility of the retina; a state of matters which I found to be susceptible of relief by paracentesis of the eye, through either the sclerotica or the cornea.

"3rd. That, in advanced cases, the optic nerve behind the eye shows itself, on dissection, in a state of atrophy, deprived more or less of its proper nervous substance, and flattened.

"Ophthalmoscopic investigations have added new facts to our knowledge of glaucoma. One of these is the pulsation of the arteries of the retina; and another, the concave or excavated state of the papilla of the optic nerve.

"These phenomena can scarcely be discerned in the advanced stages of glaucoma, owing to the diplochromatic and muddy state of the crystalline. To see them, then, the student should be directed to examine a case in which the dioptric media have as yet lost but little of their normal colour and transparency.

"To discern the pulsatory movement of the vessels, requires a sharp and experienced eye, and the observer will find it of service, while directing his attention to this point, to have the patient's head supported, and the diseased eye steadied by the fingers of an assistant."*

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* In the dilated pupil of glaucoma, and other diseases, when the pupil does not contract under the stimulus of light, I strongly recommend a trial of the

Irido-choroiditis.

The pathology of *irido-choroiditis* is much more definite and exact than can be said of glaucoma. Its primary seat and symptoms are prominent and decided from the commencement. It is slower and more gradual in its approaches, frequently commencing with ordinary iritis, its attacks are therefore not marked by the paroxysmal violence which characterizes acute glaucoma; nor does it subside with that degree of impunity to the parts affected, which is so remarkable a feature in the more fortunate cases of the latter disease.

It may justly be concluded, from its intimate relationship with the choroid coat of the eye, that the iritis which often ushers in an attack of irido-choroiditis, commences originally with congestion of that membrane; a condition easily distinguished in the ophthalmoscope from hyperæmia of the retina, by the deeper hue of the fundus, and the varicose appearance of the vessels, especially the veins. The specific inflammation itself assumes a variety of aspects, which seem to depend upon the situation, or the nature, of the inflammatory products. Gräfe, however, proposes to divide the cases into two classes, which amount to two different diseases, for whilst he defines one as invading the iris primarily, in the other he makes the *iritis* a secondary symptom of an inflammation, or other abnormal condition of the choroid. I believe it to be sufficient to describe the differences observed as constituting stages of the same disease. At all events the distinction most to be depended upon, retinal separation, ensues as a consequence of the inflammation extending from the

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"Calabar Bean," an agent introduced into practice by Dr. Argyll Robertson, of Edinburgh. A drop of the fluid extract applied to the eye, causes contraction of the pupil in from fifteen to thirty minutes. It is likewise found most useful in staying the disagreeable confusion of vision which remains while the pupil is dilated after using atropine for the purposes of ophthalmoscopic investigations.

iris to the choroid coat generally, serum being effused upon its inner surface, and so upheaving and detaching the retina; and that this does not occur in cases of the first class of Gräfe, is simply from the subsidence of the symptoms, or the limitation of the vascular excitement, by proper remedies having been adopted in its early stage. And, therefore, describing the two classes of *irido-choroiditis* as one disease cannot be strictly correct; for, when the primary cause of the retinal separation must be the definite disease, the latter being only a symptom, whatever effect it may have upon the choroid, in producing inflammation, this certainly will not be *irido-choroiditis* in a specific sense; and to call it so in any other, would give rise to uncertainty and confusion, if not in forming our own diagnosis, in conveying the idea of a diagnosis to others.

The best method of examining the state of the pupil, in irido-choroiditis, is by oblique illumination. When mydriatics fail in producing any reaction, a zone of fibrinous exudation will be seen to connect the edge and posterior surface of the iris with the capsule. It is this complication, no doubt, which originates that form of lenticular opacity observed in some cases, and which has disappeared with the reabsorption of the fibrinous exudation. And here I cannot help observing that whilst Gräfe expressly lays it down *that improvement of vision is always due to remission in the choroidal complication, and not to any reabsorption of the pupillary exudation*, still he seems to have overlooked this *a priori* argument against a classification of *irido-choroiditis* with recognised cases wherein the iritis was subsequent and secondary.

The haziness of the vitreous humour occasionally observed in irido-choroiditis is due to the inflammatory products having transuded into its structure, and is therefore less frequently present as a symptom than in inflammation of the retina, or else appears at a much later stage in the disease. Opportunities of examining the vitreous sometimes occur in those cases where the media in the direct line of the axis of vision remains transparent; a very limited field certainly for observation is afforded. There is more as the disease progresses towards a cure, or when, unfortunately, the inflammatory symptoms end in atrophy of the choroid.

The globe of the eye in irido-choroiditis becomes softer as the extent of the choroid implicated becomes larger, although it is an observation well founded, that inflammation of this membrane will often be present without any external indication beyond the objective symptoms of ordinary iritis. The ophthalmoscope, however, in favourable cases for examination, betrays considerable changes in progress on the fundus of the eye. Amidst the very evident congestion will be observed a number of little patches or spots of less intensity of hue, surrounded by a hazy *penumbra*, at first appearing at some distance from the optic nerve entrance, and then becoming merged into each other, until a considerable portion of the fundus is involved. These are considered to be the first indications of atrophy, which, when more advanced, shows the choroid pale and attenuated, so that the sclerotica is visible through these points, and the circumscribed limits of which are described by a well-defined black line, marking, under the altered circumstances, I presume, the normal limits of pigmental deposit.

The extension of the inflammation from the iris in irido-choroiditis is a well-determined principle, and this pathological connection of what I have shown to be a continuous structure is still further illustrated by the singular aptness to relapses, where synechia or adhesion of the iris to the lenticular capsule has remained after an attack. Gräfe also lays it down as a rule, that partial closure of the pupil is the point from which further complications proceed, especially *chronic choroiditis*, with progressive *amblyopia*, and ultimately atrophy of the globe. It is in this stage, or form rather, that irido-choroiditis is apt to be confounded with the acute stage of glaucoma, a prominent symptom being a severe neuralgic affection of the fifth pair of nerves. This kind of attack often gives way to ordinary antiphlogistic treatment and mydriatics;

the pain ceases, vision becomes comparatively good, and the patient seems cured. Often, however, after a return to his usual avocation, and without any discernible cause, a similar train of symptoms again set in, and are relieved, but with a progressive degree of posterior synechia. In this manner, successive inflammations occur, each time more painful and obstinate, until complete closure of the pupil ensues, and the posterior surface of the iris is permanently attached to the capsule of the lens. The progress of the disease is then marked by intolerable pain, the eyeball presents the dull red hue of venous congestion, and becomes softer than normal, the consequence of an altered secretion of the vitreous humour. Such unsatisfactory cases usually end in chronic choroiditis and atrophy.

Seeing how much depends therefore upon adhesions of the iris, as the source of the frequently recurring relapses of inflammation, a careful examination should always be made by oblique illumination of its abnormal connections, especially posteriorly with the capsule. If not extensive, or of recent formation, mydriatics will be almost sufficient to re-establish its natural condition; and if this does not result after a fair trial, immediate recourse should be had to operative measures.

When irido-choroiditis has made some considerable advance, we find the ciliary processes congested: the iris becoming adherent to the capsule of the lens, and, with it, yielding to the intra-ocular pressure, is pushed forwards towards the cornea, the anterior chamber being diminished in size. Serum finally takes the place of the vitreous humour; the cornea becomes obscure on its posterior surface, and its sensibility is diminished. The sclerotic also assumes a dull leaden hue, and frequently becomes staphylomatous; vision is then limited to the merest perception of light, or is altogether lost.

Even after complete closure of the pupil, and some progress towards the more serious softening of the globe, since the introduction of Desmarres method of tearing the iris, or iridectomy, it has been found that unlooked-for success has followed an operation.

Desmarres way of performing iridectomy appears to present a somewhat simpler mode of operating, and a greater command over the eye in selecting the point of entrance. The patient being placed on a high and narrow couch, and accordingly as it is in the left eye or the right, the operator stands on the corresponding side, or in the most convenient way, if the object is to penetrate the upper part of the cornea. Two assistants are required; one raises the upper lid with an elevator, and holds the patient's head; the other takes the lower lid, and with well-pointed forceps seizes the conjunctiva near the cornea, in a spot opposite to that at which the knife is made to enter, so as to prevent any motion in the eyeball. A Beer's knife is then inserted precisely at the junction of the sclerotic and cornea, it is then pressed forward into the anterior chamber in a direction parallel to the plane of the iris, and makes an incision about a quarter of an inch in extent. The knife is then withdrawn, the assistants at the same time slightly loosening the elevator to avoid as far as possible the escape of the aqueous humour.

The surgeon now, with the hand that held the knife, inserts the curved, or canula-forceps, into the eye, with the concavity towards him, and passes it forward behind the cornea as near as possible to the adhesions; the blades of the instrument are allowed to open, and the iris immediately protrudes between them. The membrane is then lacerated by a slight effort; and when it has given way, the prolapsed part is cut away by one of the assistants with curved scissors. The after treatment is of the ordinary simple character. Even when not perfectly successful, that is, where retinal complication and atrophy have progressed very far, the operation is valuable, as it checks the morbid symptoms, and prevents the extension of the disease, which is always imminent, to the other eye. It is found also to have a lesser advantage, but still one of some importance, it preserves the shape of the eyeball.

The remarks of Gräfe upon this point are instructive: "That an atrophied globe could be refilled would appear enigmatical, if, according to former ideas, we were to consider it as a positive disease of nutrition; but, as we have often urged, it is in such cases simply a symptom of choroidal stasis. The choroid is the secreting organ of the vitreous body, and if its circulation stagnates, the reproduction of the vitreous body will necessarily fail, and its volume will diminish. In chronic choroiditis, instead of the normal, an abnormal fluid will be given out for the purpose of nourishing the vitreous body, so that the latter will vary chemically and in quantity from its healthy condition. It is evident that when atrophy has proceeded a certain extent, the eye cannot resume its original form. But a certain degree from choroidal stasis is curable, as is well known to all attentive observers, and as present observations abundantly prove. Besides, we know that, in actual iritis for example, the globe is often softer than in the healthy eye, and that this symptom retrogades as the inflammation subsides. It is evident that the diminished resistance is owing to imperfect secretion of the fluid of the vitreous body; for in the volume of the aqueous humour there is no change capable of affording the required explanation."

As the choroidal complication subsides, the vitreous humour continues to clear, and it is ultimately found that vision is not wholly lost; this is proved partly by ophthalmoscopic examination, and partly by testing the sight.

In the earlier stages of this disease, I may add, section of the ciliary muscle has been attended with very great success, as the following cases serve to illustrate:

Elizabeth A——, aged 30, a widow, a pale, delicate-looking woman, was admitted an in-patient of the Royal Westminster Ophthalmic Hospital, April, 1862. The history of the case given by herself, was as follows:—"The second week in January of the present year, I felt some pain in my eyes. My mother examined them, and thought she saw a speck on the right eye; but as the pain was not very great, no further notice was taken. A few days after, however, the room and everything in it appeared to be in a fog; there was considerable redness, and I could distinguish nothing clearly, my right eye being the worst. I applied for advice to a medical man, and the remedies partially relieved the pain; but my sight got worse, so that I could scarcely distinguish objects. The pain afterwards increased, and the light was most intolerable. I was frequently advised to come to the hospital, but my expected confinement, and the illness and death of my husband prevented me."

In the following March, the pain in her eyes was very great, and general weakness after confinement compelled her to keep her bed the whole month. Early in April, feeling somewhat stronger and able to move, her mother brought her in a cab to the hospital. She was then in a state of great prostration: had been obliged to wean her baby, who, being very weakly, died a few days after. The orbital pain was excessive, and the photophobia so great, that the eyelids could scarcely be forced asunder. A momentary glance showed a highly vascular conjunctiva; but it was quite impossible to ascertain the state of the iris. Pulse very low, and her face pallid in the extreme, As she refused to leave her two other little children and come into the hospital, I placed her under treatment, as an out-patient, for a short time, without the slightest benefit. However, on the 20th, she was admitted, and I performed section of the ciliary muscle on both eyes. Before night, all pain ceased, and in a few days she was able to leave her bed and find her way anywhere about the wards. On the 26th, she was able to read No. 12 test-types, and could bear a more careful examination of the eyes. Synechia existed in the right eye, and the pupil was immoveable. In the left, a few irregular patches of deposit could be seen in the pupil. To take a mixture of iodide of potassium and iron. May 10th, her sight and general health had so much improved, she was discharged from the hospital. In August, I received a very pleasing letter of thanks, written in a neat hand, thanking me for what I had done, and congratulating herself on the existence of an invaluable institution, that, as she says, had "restored my sight and me to my family."

In this case, there can be no doubt that perfect restoration of sight in the right eye, as well as in the left, might have been effected, had circumstances favoured an earlier resort to the operation. Section of the ciliary muscle was followed by an immediate cessation of all the more urgent symptoms, and which threatened destruction to sight in both eyes. The adhesions, due to the primary iritis in the right eye, may probably be overcome by iridectomy; but having regained good sight in the left, she prefers depending upon a course of medical treatment for further relief.

Irido-choroiditis, with keratitis.—James Phillips, aged 22, at the age of four years had variola, and has had only partial vision of the left eye since. Face presents the characteristic expression of congenital syphilis; such as depressed nasal bone, notched peggy teeth, especially the upper incisors. Four years ago, was attacked with inflammation in the same eye, with supra-orbital pain extending backward to the occiput. The sight of this eye was so nearly lost, that he was only able to distinguish light from darkness. This state continued for four days, when the painful symptoms subsided, and his sight began gradually to improve; but not enough to enable him to see objects with the eye so well as before the attack of variola. Very profuse lacrymation, and crescents of turgid vessels encroach on the cornea above and below, with a pink zone of finely injected vessels surrounding its margin. The vessels of the sclerotic are purple and varicose, especially in the upper half of the globe. The cornea is slightly hazy. At work, he derives no benefit from the small amount of sight in this eye.

The right eye was quite well up to about six weeks ago, when he first began to feel pain over the forehead, which, extending backwards, reached to the occiput. In two days, sight was so much diminished, that he could only distinguish light from dark, and the pain gradually became worse. He was ordered a mixture of potassii iodidi. pil. hyd. o. n. and a blister. Under this treatment, sight improved for a time, and he could clearly discern objects; he continued for a week in that state, when it became worse again, and he lost all perception, save a distinction between day and night. The cornea hazy, semi-transparent, pupil contracted, a congested vascular crescent encroaching over its lower and upper margins. A bright pink zone also immediately surrounds the cornea. The vessels of the sclerotica numerous and gorged; tension of the globe nearly normal. A constant flow of scalding tears. He has not so much pain in it now; but cannot bear light. Tongue clean, appetite good, bowels regular.

May 6th.—I performed section of the ciliary muscle on the right eye. A light pad was applied, and tinct. opii m. xxv. given at bed-time.

14th.—Profuse lacrymation came on suddenly in both eyes. To return to mist. potassii iodidi co. pil. hyd. cum opio. o. n. Full diet, with porter.

15th.—Cornea clearing gradually; and the congestion of conjunctiva disappearing. Repeat mixture with pil. hyd. quininæ et ferri.

16th.—Cornea of right eye still clearing, some parts rapidly. There is now only slight opacity in the centre.

17th.—He was suddenly seized with pain in the left eye to-day, and therefore most anxious to have it operated upon.

18th.—In the left eye the symptoms continue unabated; suffers at night with pains extending from the fore to the back part of head. Intense photophobia and profuse lacrymation. There is a vascular crescent encroaching upon the cornea, one-eighth of an inch. The large sclerotic vessels varicose, and of a deep purple colour. A broad pink zone surrounds the corneal circumference opposite to the external canthus; this zone has a purple tinge. The vessels of the conjunctiva large, tortuous, and bright red; the tension of eyeball abnormal; and the globe tender to the touch. Tongue feverish, pulse 100. I could no longer refuse his wish to have this eye operated upon, and at once divided the ciliary muscle.

May 21st.—All photophobia has disappeared from the right eye, and is subsiding in the left. The congestion in the latter and all urgent symptoms relieved. My reason for not operating earlier on this eye, was chiefly in consequence of its previously diseased state; it had been useless to him for two or three years.

May 24th.—No photophobia or pain in right eye; remains of leucoma opposite pupil. Left is much better; he was discharged on the 27th, and able to resume his employment.

Keratitis, with irido-choroiditis.—Elizabeth K——, aged 48, admitted July, 1862, states that five years ago she found her eye getting very weak, and her sight gradually becoming worse. She applied immediately to a public institution, and was under treatment for six months without obtaining relief. She was then for some weeks a patient at two general hospitals.

In July last, she became a patient of the Royal Westminster Ophthalmic Hospital. The eye then presented all the appearances of long standing *keratitis*. There was also a well-marked constriction around the cornea, together with photophobia, great pain, irregular pupils, and other symptoms indicative of irido-choroiditis. I performed section of the ciliary muscle, with immediate relief to all the symptoms. Three days after she commenced with the iodide of potassium mixture. No bad symptom supervened; her sight gradually improved as the opacity of the cornea disappeared. The sclerotic congestion also rapidly cleared away. The pupil rather small and contracted; nevertheless, in ten days after the operation she was able to see and read a note received from a relative, previously having been unable to do more than distinguish the form of the largest test-types.

Irido-choroiditis.—C. M——, a labouring man, admitted April 16th, 1862. The account given by the patient was as follows:—Two years and three months ago he lost the sight of the right eye. Fifteen months since the left eye became affected, first with numerous dazzling sparks, which, after a short time, were replaced by black spots, and a cloud floating before the eye; then a dense fog, which during the last few weeks has gradually become darker; when he came to the hospital, he could only perceive large bodies before him. The loss of vision has been accompanied by a good deal of pain of a lancinating character.

The ophthalmoscope disclosed a considerable number of large turgid vessels, with some few pupillary adhesions; iris bulging forward. The pupil of the right eye nearly occluded by adhesions, and the capsule of lens apparently implicated.

I divided the ciliary muscle in both eyes. No unfavourable symptom supervened, and on the 26th he could read No. 14 test-types with the left eye There was much less prominence of globe, and the vessels were nearly normal; all pain had subsided.

The man continued to improve, and in a few days from last date left the hospital.

Irido-choroiditis: Iridectomy.—Eliza R——, aged 32,a servant. Had previously enjoyed good health, with the exception of some amount of rheumatic pain in the limbs. December, 1860, first observed dimness of sight coming on, with pain and intolerance of light. She had to leave her place in consequence. Her sight becoming much worse, she was admitted into the hospital. Upon examination, I found she could not read the largest type-test with the right eye; and with the left only No. 18. There were symptoms of cyclitis; the characteristic zone around the cornea; pupil small and immoveable, bulging iris, and apparently opacity of the capsule of the lens. Complains of great pain in the eyeball, with intolerance of light.

June 26th, 1861.—I performed iridectomy in the right eye, the anterior chamber becoming filled with blood during the operation. At 9 p.m., complaining of pain, t. opii. m. xxv. was given, and subsequently hyd. chlor. grs. ij. pulv. opii. gr. $\frac{1}{2}$.

27th.—This morning complains of slight pain only; the blood in the anterior chamber diminishing.

28th.—Clot rapidly disappearing. No pain. Ordered mist. potassii iodidi ter. die.

July 1st.—I performed iridectomy in the left eye; considerable pain followed the operation.

3rd.—Symptoms of iritis appeared; to take hyd. chlor. gr. ij. opii. gr. i. at bed-time, and mist. quinine ter. die.

5th.—Less pain and congestion.

8th.—On the bandage being removed, the new pupil was observed to have a linear shape; only a narrow slit from its pupillary edge of the iris to the periphery. Sight, however, remained to some extent, as she could distinguish large objects when in motion. About one half of the cornea opaque. The calomel and opium to be kept up at night, and to take mist. potass. biniodide ter. die.

10th.—The sight of right eye improved; in a fortnight from this date, she was made an out-patient.

Three months afterwards, finding the sight of the left eye very dim, she returned to the hospital, and I removed an opaque lens, and at the same time enlarged the pupil. When discharged, had made a tolerable recovery.

Chronic Kereo-iritis, and subsequent irido-cyclitis.—Jane E. W——, aged 21, admitted May 16, 1862. Had then been suffering from recurring attacks of ophthalmia upwards of twelve months. Complexion florid, teeth peggy, two upper central incisors deeply notched. Evidences of glandular abscesses about neck; catamenia irregular; sometimes amounting to menorrhagia, at others nearly or altogether wanting. She first suffered with the right eye about twelve months ago, and was under treatment nine months; then the left began, with considerable pain, and a pricking sensation in the globe and over the brow. The sight of this eye gradually getting darker, and at present can only discern white from black ; cannot see the outline of her own hand. There is considerable sclerotic injection, a constriction around the cornea, and then a zone of bright pinkish vessels giving to the cornea a very prominent appearance; the central portion of which is quite opaque, apparently a thickening of the whole corneal substance ; the photophobia is too great to enable me to ascertain by oblique illumination the condition of the iris in either eye. One vessel, much larger than the rest, is seen running to supply an old ulcer near the temporal margin of the cornea. There is profuse lacrymation when the lids are separated or on any attempt made by the patient to expose the eyes to light. A good deal of injection throughout the whole conjunctivæ, not granular. I at once decided upon section of the ciliary muscle in both eyes. Cold pads were applied, and she was placed in bed. On the 20th, the pain had greatly subsided; and on the 23rd, could clearly discern her own fingers. As there is still a good deal of photophobia, belladonna was freely applied.

June 3rd.—Pain has ceased ; she can now submit to any examination ; the corneæ clearing rapidly; can see No. 16 type-test with ease, and on the 8th, had recovered so far, that she was able to leave the hospital and attend as an out-patient. I kept her under observation until she was quite able to resume her occupation. April, 1863, had been no relapse; but there was some irregularity in both pupils, with posterior synechia in left.

Choroiditis.

The appearances of choroiditis in the ophthalmoscope are, usually, such as indicate a pre-existing subacute stage of disease, such as general congestion, hæmorrhagic spots, opacities, and pigmental deposits. In serous exudation between the retina and choroid, a turbid opacity is communicated to the vitreous humour, indicative of some progress towards dissolution of the latter in consequence. Other indications of exuded products of inflammation are opaque appearances, the result of adhesions between the choroid and the retina, in which the pigment membrane of the one and *stratum bacillosum* of the other have become changed in texture. We find, however, choroiditis more frequently associated with iritis—the choroid and iris being so intimately connected with each other—than with retinitis.

An increased orange, or tawny-yellow redness of the fundus is a prominent symptom, and distinguishes its seat from the corresponding allied condition of the optic papilla and retina, which are always proportionately implicated in hyperæmia of the choroid. This condition of the eye, so long as the foramen centrale, *macula lutea*, remains unaffected, is however compatible with a fair amount of vision; and it is not unusual for a slight attack of choroiditis to run its course without much disturbance to vision, and certainly none in the external appearance of the eye.

Spots of a yellowish colour are first observed surrounding the optic nerve entrance, and in a very short time, becoming as it were more definitely clear, by comparison with the chorio-capillaries which are seen distributed over it in a regular net-work. As the disease progresses in choroiditis, the vessels become more distinct; but being then of a bright orange colour, the ramifications of the retinal vessels are more distinctly seen. When the latter vessels become implicated in the advancing atrophy, the spots or spaces appear perfectly white; what remains of the choroidal coat being transparent, allowing the inner surface of the sclerotic to reflect the light through it. Small masses of detached pigment, in the form of grey or deep black spots, distributed over the fundus, heighten the effect by contrast. In the early stage they are few in number, but increase with the disease; and as evidence that these belong to the choroid, the vessels of the retina can be seen passing over or amongst them. The appearances these pigment deposits assume, is generally that of masses of epithelium stripped off from the white spaces in the choroid coat.

Choroiditis.—J. C——, aged 38, shoemaker, admitted August 16th. Sight dim for the last three years; left eye particularly so. At present can read large print; suffers from bilious headaches and heaviness over the brow, for which he has often been under the care of a medical man; "never had very good health;" smokes a good deal; eyes rather heavy and full, with great desire to sleep. Two days ago, found the sight of the left eye nearly gone.

Ophthalmoscopic appearances.—Choroid congested, of a brick-red colour; vessels of retina varicose; entrance of optic nerve in the left eye obscured by the chorio-capillary congestion, which extends to foramen centrale; lens and vitreous transparent. To be cupped on nape of neck, and take three grains blue-pill, with two of extract of hyoscyamus, every night; aperient draught every morning. The medicine was continued for a week, with mustard plaster every night to the nape of neck, which had the effect of removing much of the congestion. To take two pills of hydrarg. with galbanum every night, and a mixture of rhubarb in infusion of calumba twice a day. This was continued up to the 10th of September; at which time he had nearly recovered vision, and was able to resume work.

Recurrent Choroiditis.—E. B——, aged 29, domestic servant, admitted Sept. 6th. This patient was of a bilio-nervous temperament; both pupils were rather contracted; slight ptosis, and quivering of left superior palpebræ. Her sight had been affected for six or seven years; recurrent attacks of inflammation; the quivering of the eyelid began only a month since, with occasional shooting pains through the temples; feels a great weight in the eyes, with giddiness. Catamenia small in quantity and irregular, appetite bad, pulse 70.

Ophthalmoscopic appearances. — Considerable congestion of the choroid; chorio-capillary net-work extending over the papilla of the optic nerve, leaving not the smallest point uncovered; vitreous slightly hazy. To take two pil. hydrarg. cum galbanum every night, and two tablespoonfuls of the mist.. ferri aperien. three times a day. Counter-irritation to the nape of the neck.

Oct. 1st.—Having steadily persevered with her remedies, the more urgent symptoms had subsided; vision much improved; discharged with a recommendation to continue her medicines for a short time.

Chronic Choroiditis, with Hydrophthalmia.—"A healthy-looking journeyman, aged 68, had, for several months, decreasing sight in the left eye. The conjunctiva showed an increase in the number and size of its vessels, the sclerotica blue on its deeper surface. The iris of this eye was greyish, whilst that of the healthy eye appeared blue. The lens perfectly transparent. By directing the patient to look upwards and downwards, an irregular dark cloud appeared from below, and again disappeared. The pupil was more dilated, and the optic axis had a somewhat divergent direction from the healthy eye. Three weeks after this investigation, the patient observed a number of star-like bodies, and the sight had become much more disturbed. With the ophthalmoscope, the retina below and towards the outer side appeared raised from the choroid, the effusion giving to it the appearance of an elevation; causing the eye to move up and down, produced a wavy motion. The optic nerve entrance was bluish grey; the vessels of the retina numerous, and ramified freely over a varicose and congested condition of the choroid coat."

The treatment consisted in leeching, and small doses of mercury, followed by a combination of purgatives with diuretics, and at a later period tonics; but, although the patient was considerably improved, the sight remained imperfect. It is interesting to know that, notwithstanding the unlimited separation of the retina from serous exudation between it and the choroid, the patient had some perception of light from the commencement.*

I have lately had under my care a case of chronic choroiditis with hydrophthalmia, accompanied with a good deal of pain, of an often recurring character, and considerable hardness of the eyeball. The patient, a poor man, had been under treatment elsewhere for some time without obtaining relief, and therefore gladly submitted to my proposal to try the effect of an operation. For this purpose, I admitted him into the hospital, and performed section of the ciliary muscle, which was followed by immediate mitigation of symptoms. At the end of the month, the eye assumed a normal appearance, and was quite free from pain; indeed, could not be distinguished from its fellow, the sound eye.

Hyperæmia of the Choroid.

In *hyperæmia* of the choroid, the normal appearance of the fundus is much altered by the dilated condition of the ves-

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* Bildiche Darstellung Der Krankheiten Des Menschlichen Auges. Von Dr. Theodor Ruete.

sels; the membrane is of a deeper red than usual. Of course, the effect varies with the complexion of the individual, and will be more apparent in fair subjects. It is a correct observation, however, that the condition of the optic papilla and the chorio-capillary circulation will always afford a good indication of the extent of hyperæmia. In some instances, the vessels of the retina are congested in corresponding proportion to those of the choroid. Congestions of the vessels of the choroid are more diffuse than those in the retina, and of a dark venous red colour, which, when the inflammatory attack has not been quickly relieved, may pass into choroiditis pigmentosa, or posterior staphyloma.

When the choroid becomes more congested, complications of a graver character may be anticipated; but it is fair to infer that the introduction of the ophthalmoscope, and the ready opportunities of relief among the poor in incipient eye disease afforded by ophthalmic institutions, will for the future, in a great measure, prevent the recurrence of those cases of disorganization in the choroid and retina which are too frequently recognized as the results of past and irremediable mischief. Morbid changes sometimes involve considerable portions of the choroid, and, when early observed, are evinced by more or less of congestion around certain spots, which are recognised by a hazy obscurity that hangs over and particularly marks their situation. These soon run into each other, forming large patches, and in this way sometimes involve the greater part of the fundus. As the integrity of the membrane is subverted, the pigmental cells are destroyed, and yellowish-white points of uncovered sclerotica may be observed, bordered with a fringe of intense blackness, as if due to collections of the dislodged pigment. At a later period, these spots are converted into perfectly white spaces, where the vessels of the choroid have become obliterated by the advance of atrophy. This condition may be mistaken for anæmia, from which however it may be distinguished by the perfectly white spaces interspersed amidst a general pallor of the fundus.

Hyperœmia of the Choroid.—David S——, aged 17, consulted me August 13, 1861. A pale delicate-looking lad, whose health had been much injured by an attack of measles, four years ago. About Eastertime in the present year the first symptom of failing sight was noticed, which was accompanied by headache, and a feeling of giddiness on stooping. On suddenly raising the head, numerous black spots appeared floating before him ; and when the eyes are turned towards the candle, four or five are seen as if surrounded by circles of fire. Has also a throbbing pain in the right eye. Upon the application of a drop of atropine to dilate the pupils, he complained of being able to see "a glimmer of light only." The cornea rather prominent. Tongue loaded, and bowels irregular.

Ophthalmoscopic examination. — Hyperæmia of choroid ; a great amount of chorio-capillary injection over the periphery of the optic disc. Humours perfectly clear ; fundus of a deep red colour; vessels of the retina slightly congested. There are several deeply injected patches about the neighbourhood of the optic nerve, giving to the fundus, at these particular spots, quite a purplish hue. I may here remark that this purplish colour about the fundus I have often noticed in connection with, or in suspected cases of, masturbation ; in this instance I had strong reasons for believing the patient to be addicted to the debilitating vice. I prescribed Pil. Hyd. c. cretæ et Rhei. o. n. and a compound iron mixture three times a day. Open air exercise, cold baths, and early rising. On the 28th he caught cold, and had an attack of conjunctivitis in both eyes. As this subsided, sight gradually improved. On the 18th of September, he was so much better, that reading produced no fatigue, the spots had vanished, and he left London for the country. These appearances are imperfectly represented in plate 4, figure 13.

Choroiditis Pigmentosa.

Choroiditis Pigmentosa is very readily detected with the ophthalmoscope. It commences at the ora serrata, and by a slow process gradually involves the whole of the fundus to the optic nerve entrance. Its most prominent appearances are those of atrophy about, or near, the optic nerve ; and the black specks and flocs of every shape which are observed floating in the vitreous humour, or more systematically arranged in lines along the course of the retinal vessels; formerly very apt to be confounded with the truly subjective symptom described under the term *muscæ volitantes*. Some of the cases are so remarkable in appearance, as to suggest the idea that the pigment must have been all detached from the choroid coat, and carried into the vitreous body.* It is clearly distinguishable by this circumstance from *retinitis pigmentosa*, which it somewhat resembles in the pathognomonic source of its most striking characteristic pigmental complication. I have, however, frequently seen choroiditis pigmentosa associated with *retinitis pigmentosa*, at an advanced stage of which the liquefaction of the vitreous humour seems greatly to facilitate the movements of the contained films of detached pigment, decolourized by maceration.

But although complete pigmental denudation of the choroid is the threatened consequence of long-continued inflammatory action, cases of the kind are far less numerous than another disease of the choroid, the first symptoms of which are those of hyperæmia, followed by inflammation of that membrane: I refer to *sclerotico-choroiditis posterior*, or *posterior staphyloma*. This latter, when congenital, is said to arise from intra-uterine inflammation; future observation, however, may perhaps determine it to be one, *sui generis*, due to some abnormal condition, or weakness of the sclerotica, and its choroidal complications but the objective symptoms accompanying the development of the disease.

Choroiditis Pigmentosa.—Thomas R——, aged 26, engineer, applied to hospital Nov. 28th, 1860. General health good; always myopic, but never had any pain in the eyes, or other defect. His appearance is ruddy and healthy. Pupils natural, colour dark green. Sight only sufficient to enable him to read largest test-types.

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* The total disappearance of the choroid is denied by Dr. E. Jäger, who has found the continuity of the membrane complete in twenty-three instances in which he has examined the eyes after death. Thus, in these cases, it appears that the white spots are caused by the light reflected from the sclerotic through the choroid deprived of pigment.

Ophthalmoscopic appearances.—The fundus covered by a very large quantity of detached and fixed masses of pigment; here and there exposed patches of the sclerotic; optic nerve only made out by tracing to their source the vessels of retina, which, as they proceed from its centre, appear to be cut out and detached. I certainly never saw so large an amount of pigment, free and fixed, in any eyes as in this patient's; and yet with sight enough remaining to enable him to go about without much difficulty. The case is represented in plate 4, fig. 14. He commenced a tonic plan of treatment, chiefly iron and quinine, and kept it up for about six months At the end of this period, he thought his vision good enough, especially when assisted by No. 12 convex glasses, to seek our-door employment; and has since contrived to earn a decent living by hawking books about the streets.

Choroiditis Pigmentosa, with Posterior Staphyloma.—Mrs. M. A. W——, aged 44, needlewoman. Left eye has been weak from her childhood, and myopic. Three years ago, her sight was suddenly lost; she applied at a hospital, where she remained six weeks under treatment, the basis of which appears to have been counter irritation. She left the hospital, without having received any benefit, and was told her case was incurable. She could then barely distinguish objects with the left eye; and found, to her great disquietude, that the sight of the right eye was fast becoming impaired.

At the end of the year 1860, she came to the Royal Westminster Ophthalmic Hospital, I examined her eyes with the ophthalmoscope early in January, and the appearances of the left are tolerably well represented in plate 3, fig. 11.

The globe of the left eye is softer than its fellow, and a staphyloma posterior occupies nearly one third of the fundus. Maceration of the pigment extensive; an old hemorrhagic deposit completely covers the *macula lutea.* A few greyish-looking flocculi in the vitreous, and very slight lenticular web-like opacity.

In the right eye a staphyloma exists, but much smaller in comparison with the left; and it struck me at the time, as a very remarkable circumstance, that any amount of useful vision could exist. She complained of a large black spot occupying the centre of everything looked at. When reading, objects appear at times blotted out. Has suffered slightly from rheumatism, and had once a very severe attack of sciatica. At times, is troubled with suppression of urine, which is of a dark colour, and deposits lithic acid. Could not see to read, and obliged to give up her needlework.

Sept. 26th.—I divided the ciliary muscle ; all went on favourably, and on October 6th she was discharged, considerably improved.

The patient is still under observation, and when I last saw her she could read with the right eye the whole printed page of the hospital letter, and with the left the largest size letters. Her general health considerably improved by the tonic course of treatment.

Choroiditis Pigmentosa, Posterior Staphyloma, and Myopia.— W. M——, aged 39, admitted December 21st, 1860. Has had good health, but noticed, some five or six years ago, dimness of sight, always increasing towards evening. Frequently saw flashes of light, with rings and half-rings of coloured light before his eyes ; no particular pain. Attributed the disturbance in vision to straining his eyes whilst rowing on the Thames at night, which he was accustomed to do for exercise and amusement. As a printer's warehouseman, had also to work a great deal by gas-light. The dimness had greatly increased during the last ten months, when he began also to notice before his eyes a persistent object, which looked in a strong light like a bent hair with a little black speck in the centre. Muscæ then appeared for the first time, and have been constant since. Is liable to frequent fits of giddiness and faintness. Reads No. 12 test-types with difficulty.

The ophthalmoscope reveals posterior staphyloma in its early stage, with a considerable amount of the pigment coat detached ; some floating, much fixed and impinging on the irregularly-shaped periphery of the optic nerve. A large white space near the lower edge of nerve has the appearance as if the choroid had been dissected off at this spot. The vessels of retina are small and obscured by the masses of pigment.

The patient was put under a tonic plan of treatment, and this kept up for some months, without much benefit. I therefore proposed to operate, which he refused to submit to.

Sclero-choroiditis Posterior. Posterior Staphyloma.

Posterior Staphyloma is the frequent accompaniment, if it be not the cause in many cases, of myopia. A conical projection at the back part of the eyeball on the outer side of the optic nerve lengthens the anterior posterior diameter of the eye, so that the parallel rays from distant objects focus somewhere in front of the retina. The eye sometimes projects forwards, and is then restricted in its outward movement. It is commonly observed, that when the axis of vision in the two eyes converge, the sclerotica of a more than ordinary bluish colour, and concave glasses are required, the case will almost always prove one of posterior staphyloma. The disease, however, can only be properly diagnosed with the ophthalmoscope. A prominent characteristic is a spot on the outer side of the optic nerve entrance, of a crescentic form, and of a bright white colour, from the obliteration of the pigmental epithelium of the choroid. Its outer margin, when not defined by a dark grey or black line of collected pigment, is obscure; where it touches the optic nerve entrance, its edge appears to project; but it really forms a depression below the surrounding parts. As the disease progresses, the spot extends principally outwards, and a little downwards; but the horns of the crescent may be prolonged, until they meet. It is not unusual, in the more advanced stage, to observe a second somewhat similar patch of brilliant white, making its appearance on the inner side of the optic disc, and gradually advancing until it is surrounded by a distinct but irregular ring of altered structure.

As a rule, myopia is nearly always present, and measures, by its degrees, the progressive stages of the disease, until at length strong concave glasses are required; and even these fail when the retina becomes involved. Muscæ are much complained of, and sometimes flashes of bright light, or stars of falling fire, appear in the field of vision. Intolerance of light often adds to the distress of the patient.

Post-mortem examination of eyes affected with posterior staphyloma, prove that the sclerotic behind the crescentic patches of the white atrophied choroid has become attenuated and unequal to the pressure of the contained fluids. It, consequently, is pushed backwards around the optic nerve entrance, betraying a pathognomonic characteristic appearance, materially differing from the cupping of the disc in glaucoma. The *macula lutea*, in fact, appears to be the central point of deepest effect in the depression of the posterior staphyloma. The condition of the vitreous humour is little changed in the earlier stages of the disease; but it ultimately becomes turbid, cloudy, and more fluid. Capillary apoplexy of the retina is frequently observed as a complication arising from circumstances of situation, or constriction. Slight opacities in the vitreous are sometimes usefully indicative of the nature of the progress made in the disease. When this occurs suddenly, it may be inferred that the retina, yielding to the protruded choroid and sclerotic, has admitted of fluid being effused and collected between them. Detachment must also often take place; and when the sac, as is frequently the case, becomes ruptured, the escape of the fluid into the vitreous loads it with flocs, producing muscæ volitantes; and, as in inflammatory exudation, greatly interfering with the proper examination of the fundus.*

Posterior Staphyloma, with Myopia.—A. R——, aged 27, was admitted a patient under my care into the Royal Ophthalmic Hospital June 12th, 1861. After a protracted confinement, found her sight becoming dim, and could only see objects very near. Can make out the largest letters of the test-types, but quite unable to read. Examined with the ophthalmoscope, the optic discs present the characteristic crescentic appearances of advanced *posterior staphyloma.* White patches of denuded choroid could be seen to the outside of the nerve, and the vessels were small and constricted. As she had been some time under treatment before presenting herself here, I advised section of the ciliary muscle, which was submitted to the next day, June 13th.

She left the hospital June 24th, able to tell the time on a distant church clock, which she could not see at all before the operation; can

* Virchow holds, in the usually accepted sense, there is no such thing as inflammatory exudation; but "that the exudation we meet with in all cases is essentially composed of that material which is generated by the altered condition of the inflamed part, and of the transuded fluid which escapes from the vessels."

also read No. 8 test-types at eight inches. The cure has, so far, been permanent.

Posterior Staphyloma, with Myopia.—G. S. aged 28, a labourer, admitted 4th July 1861, under my care Ten years ago he was thrown from a horse, and fell upon his head. Ever since, the sight of the right eye has been dim. For the last twelve months, vision in his left has been failing also. He is free from pain in the eyes, except after prolonged reading, when he feels a slight aching in the right eye; this is softer to the touch, and more full and prominent than the left. The cornea is prominent, and there is the appearance of a constriction at its junction with the sclerotic. The latter is thin and bluish. With the right eye can barely read No. 2 of the test-types; and his nose nearly touches the paper in the endeavour. He, however, reads No. 20 at six inches. With the left he is able to read No. 2 at six inches. He complains of diplopia, and at times has a slight convergent squint. With the ophthalmoscope the choroidal vessels are readily distinguished from those of the retina, which are small and irregular. The optic papilla is white, and there is a well-marked crescent on the inner side of disc. In the axis of vision, at the macula lutea, is a reddish oval patch. In the centre of this is a spot of pigment, and near its outer margin is an irregular whitish patch, the exposed sclerotic coat.

July 5th.—I divided the ciliary muscle of the right eye. A few drops of fluid escaped, and the iris protruded slightly through the incision. This accident arose from the patient making a sudden start as the point of the knife penetrated the globe.

10th.—Has gone on well, having felt no pain since the operation. He can now read No. 20 at nine inches, and No. 2 at two inches; and says that objects appear much clearer. The prolapsis iridis has nearly disappeared.

Aug. 2nd.—With the eye operated upon he can now read No. 20 at nine, and No. 2 at three-and-a-half inches.

April 3rd, 1862.—He was discharged, greatly improved; and expressed himself grateful for the relief he had obtained.

Posterior Staphyloma.—A. W——, aged 27, a laundress, was admitted 15th Sept. 1861. She had had very good health, and her sight was perfectly good until a year ago, when it began to fail. Within the last two months had become very dim. The catamenia regular, but profuse; feels very weak and low; bowels irregular.

When she attempts to read, her eyes pain her, and are easily fatigued. She can read No. 8 of the test-card at five inches, but with difficulty.

Ophthalmoscopic examination.—The fundus of the eye exhibits a white patchy appearance, the optic papilla small, and surrounded by a crescent of darker hue than is usually observed in such cases. The retinal vessels very irregular and turgid.

Sept. 6th.—Section of the ciliary muscle in both eyes.

10th.—Has had no pain; can see much better, and tells the time by a watch.

Oct. 23rd.—Steadily improving. She can now read No. 8 at eleven inches, No. 6 at nine inches, No. 4 and No. 2 at eight inches, and No. 1 at six inches.

Atrophy of the Choroid.

Atrophy of the Choroid has been termed by some writers ectatic choroiditis, the prominent symptoms of which are considerable augmentation of the vitreous humour, with atrophy of the membrane, commencing in the epithelial layer, and proceeding so destructively that at length it involves all the intervening structures, the external elastic tissue alone remaining, one surface of which becomes adherent to the sclerotic, and the other to the retina; the latter sharing in the atrophy at a point where staphyloma commences. Such changes not only produce atrophy of the choroid, but also destruction of the elements of the retina.

Atrophy of the choroid is sometimes the threatened result of anæmia of this vascular membrane, following a past inflammation or subacute form of disease, brought about by debility, such as often succeeds fever, and also over-lactation. This is particularly the case in young mothers, where one pregnancy quickly follows another, and when suckling is persisted in for too long a period; an error always committed at the expense of the mother's health. In such a case the vascular and nervous systems are both deprived of their due supply of blood, and without which it is impossible to maintain the functions of mind and body in health and vigour. It is in this way vision is gradually deteriorated, and may become quite lost. The anæmic look of such patients points out at once the cause and suggest the remedies; as weaning the child, a nutritious and more generous diet, combined with some preparation of iron. It will be found of great advantage in cases of the kind to combine quinine and iron, either in pills or mixture.

Loss of colour in the choroid, and the vessels of the retina seeming to be cut out from the pale ground beneath them, is a senile change, and must not be confounded with the disease last spoken of—a condition, be it remembered, nearly always relieved by use of suitable spectacles and rest. It is perhaps still less possible to confound atrophy, with congenital deficiency of the choroidal epithelium in those persons generally recognised as albinos. The iris, as well as the choroid, in the latter class, is even destitute of its pigmental coat; and with the ophthalmoscope we look through the ciliary processes, as we might through the spokes in a wheel. Atrophy of the choroid is seen, however, in the albino as well as in other persons; and I have at the present time a case under treatment, deriving much benefit from iron, in the form of a pill composed of half a grain of sulphate of iron, one grain of quinine, one of the extract of henbane, and one of aloetic pill, taken three times a day after meals.

Atrophy of Choroid, with Incipient Cataract.—J. M——, a porter, aged 42, applied for advice on the 20th of June. The history he gave of the disease was, that about Christmas he first noticed a dimness of sight in the left eye; shortly afterwards he was attacked with rheumatism, and became an inmate of a general hospital. He was soon cured of the latter disease; but his sight gradually decreasing, he applied at the Royal Westminster Ophthalmic Hospital.

There being no outward signs of disease, an examination was made with the ophthalmoscope. In the left eye the whole fundus was of a very pale pink colour, and many white spaces; the vessels of the retina obscured by a greyish web. In the right eye the lens was seen to have many divisional markings, but so faint as not to be noticeable without the aid of the convex lens; fundus of a pale colour, and all the vessels, so far as they could be made out, were small. The general health of the patient was considerably impaired; I therefore thought it desirable to prescribe a tonic plan of treatment, which was followed by the best results. The sight of the left eye was much improved at the end of three weeks; but the opacity of the lens in the right had not diminished. In this case, the incipient cataractous disease had been overlooked.

Anæmia of Choroid.—H. J. aged 52, a waiter, applied July 11th. complaining of asthenopia. He stated that about Christmas last his sight began to fail, and is now so imperfect he cannot follow his occupation, chiefly nightwork at a tavern. "Advised to apply, about a month ago, to a *female oculist*, who told him the optic nerve was diseased, and nothing could be done to stop its progress. She afterwards said a cataract was forming, and put a *drop* into his eye, which made it much worse." This patient, a thin pale man, a widower, with several children to support, and means of subsistence very precarious, had a distressed and anxious aspect, with a weak pulse. No objective sign of the diseased condition, except a dull and sluggish state of irides.

Ophthalmoscopic examination.—Choroid coat in an anæmic condition; fundus generally of a faint pink colour, remarkably small and pale, exposing a white papilla optica; dioptric media perfectly clear and free from disease. Assuring him that he might soon expect to be cured, I prescribed the compound iron mixture to be taken twice a day, and a good nourishing diet. His general health improved rapidly; for I need scarcely add, that the anæmic condition was due to overwork, anxiety, and insufficient food.

Colloid Disease.—Besides atrophy, another change in the structure of the choroid has attracted some attention since Donders and Müller published their observations in 1856. Colloid disease, as it is called, is supposed to appear at a late period of life, which in some degree may be accounted for, as in its earliest stages the aid of the microscope is required to make out the changes taking place. At a certain period we are able to see, with the ophthalmoscope, sufficient indications of the mischief progressing, by observing patches of a rough, irregular condition of the epithelium of the choroid, which is found to be due to the presence of numerous small transparent pearl-like bodies, scattered in clusters, or strewed singly over the inner surface of the membrane. They are closely attached to the elastic lamina, so much so, indeed, as to be considered by some observers continuous with it. According to Donders, however, their seat is in the pigment cells, and are transformations of the nuclei of these cells. Undoubtedly they are found, after death, behind the pigment epithelium, and surrounded by the atrophied remains of the hexagonal cells; but their character and situation suggest rather that they are specific deposits of an earthy cretaceous nature, analogous to corresponding appearances occurring in other parts of the system, and accompanying disease of the small arteries and capillaries.

In the earlier stages of colloid disease, the fine granular excrescences have a glistening translucent appearance, strongly suggestive of a cartilagenous character, which is quite consistent with their evident proneness to become ossific, which is proved by the strong effervescence excited when brought into contact with acids. Other changes in the fundus, observed to accompany colloid degeneration, is the obliteration of the larger vessels, from the accumulating masses of earthy matter completely filling up the interstices in their finely reticulated distribution over the fundus. In the ophthalmoscope these incrustations, first lining the epithelium of the choroid, are seen to conceal the vessels behind them, those of the retina being plainly distinguishable in front as they pass over them. Ultimately, however, these vessels become implicated, and the little earthy incrustations follow the course of their delicate ramifications.

Melanotic growths, cancer, and tubercular diseases of the choroid and retina, although rarely met with, are more easily detected with the binocular ophthalmoscope. The small masses are seen to be projections with bright pinkish vessels interspersed throughout, and differing considerably from the metallic reflection imparted to the fundus by fibrinous clots, deposits of lymph, or detached retina.

SPECIMENS OF JÄGERS TEST-TYPES.

No. 1.—Brilliant.

The place of our retreat was in a little neighbourhood, consisting of farmers, who tilled their own grounds, and were equal strangers to opulene and poverty. As they had almost all the conveniences of life, within themselves, they seldom visited towns or cities in search of superfluities. Remote from the polite, they still retained the primeval simplicity of manners; and frugal by habit, they scarce knew that temperance was

No. 2.—Pearl.

virtue. They wrought with cheerfulness on days of labour: but observed festivals as intervals of idleness and pleasure. They kept up the Christmas carol, sent true-love knots on Valentine morning, eat pancakes on Shrove-tide, shewed their wit on the first of April, and religiously cracked nuts on Michaelmas eve.

No. 3.—Nonpareil.

Being apprised of our approach, the whole neighbourhood came out to meet their minister, dressed in their fine clothes, and preceded by a pipe and tabor; a feast also was provided for our reception, at which we sat cheerfully down; and what the conversation wanted in wit,

No. 6.—Bourgeois.

was made up in laughter. Our little habitation was situated at the foot of a sloping hill, sheltered with a beautiful underwood behind, and prattling river before; on one side a meadow, on the other a green. My farm con-

No. 8—Small Pica.

sisted of about twenty acres of excellent land, having given a hundred pounds for my predecessor's good will. Nothing could exceed the neatness of my little enclosures; the elms

No. 10—Pica.

and hedge-rows appearing with inexpressible beauty. My house consisted of but one story, and was covered with thatch, which gave it an air of snugness; the

No. 12.—Great Primer.

walls on the inside were nicely white-washed, and my daughters undertook to adorn them with pictures of their

No. 14.—Double Pica.

own designing. Though the same room served us for parlour and kitchen, that

No. 16.—2-line Great Primer.

only made it the

No. 18.—Canon.

w a r m e r.

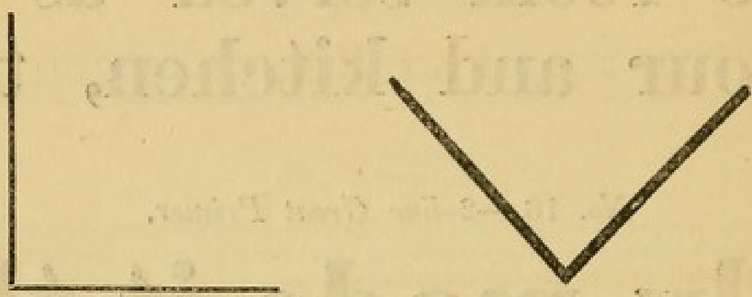
No. 19.—4-line Roman.

Besides,

No. 20.—8-line Roman.

as it

IN ASTIGMATISM, HORIZONTAL AND VERTICAL LINES CANNOT BE SEEN WITH EQUAL CLEARNESS AT ONE AND THE SAME TIME; IN CONSEQUENCE OF THIS THE SQUARES OF A DRAUGHT BOARD APPEAR ELONGATED IN ONE DIRECTION, AS GREY LINES; OR THE UPRIGHT AND HORIZONTAL BARS OF THE WINDOW FRAME ARE NOT SEEN WITH EQUAL CLEARNESS:—



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III. IF THERE BE NO DIFFERENCE IN THE DISTANCE AT WHICH THE VERTICAL AND HORIZONTAL LINES ARE SEEN WITH THE GREATEST DISTINCTNESS AND BEST DEFINITION.—AND, LASTLY,

IV. WHETHER OR NOT THE OBSERVER CAN SATISFY HIMSELF THAT HE HAS THE POWER OF ADJUSTING THE EYE, SO AS TO BE ABLE TO SEE LINES WITH PERFECT DISTINCTNESS AND DEFINITION AT ANY OTHER THAN ONE DISTANCE.

NOTE ALSO IF THERE BE ANY DIFFERENCE IN THE SIGHT OF THE TWO EYES.

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