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INQUIRIES

RESPECTING THE

ANATOMY OF THE EYE,

By ARTHUR JACOB, M. D.

MEMBER OF THE ROYAL COLLEGE OF SURGEONS IN IRELAND,
DEMONSTRATOR OF ANATOMY, AND LECTURER ON DISEASES OF THE EYE,
IN THE UNIVERSITY OF DUBLIN.

COMMUNICATED BY

MR. EARLE.

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Read June 3, 1823.

IN the following Memoir, I propose to discuss some of those points relating to the anatomy of the eye, which have been rendered interesting by the difference of opinion entertained respecting them; as well as to inquire into the structure and application of those parts which, from their beauty, or peculiarity of appearance, have attracted particular attention. I shall at once proceed with the subject, without further preliminary observations.

On the Passage of the Optic Nerve through the Sclerotic Coat.

The description usually given of the entrance of the optic nerve is, " that it arrives at the back of

the eye, enclosed in a strong sheath, continued from the dura mater, and firmly connected with the sclerotic: that when it approaches the globe of the eye, it becomes diminished in size, and in its passage through the sclerotic, is contracted into the form of a cone, the rounded apex of which comes in contact with a membrane perforated with small holes called the *lamina cribrosa*, which closes up on the inside the hole in the sclerotic through which the nerve passes: that through the perforations in this membrane the nervous fibres are transmitted, and within the eye form a slight projection from which the retina originates."* This notion of a *lamina cribrosa* has had its origin from Albinus†, and has arisen from examining the part after the retina had been washed away, and the optic nerve cut off on the outside close to the sclerotic; an appearance answering the description given of the *lamina cribrosa* being thus produced. This *lamina cribrosa*, however, appears to be nothing else than the extremity of the optic nerve where the firmer tubular portion is discontinued. If the sheath of the nerve be slit up through the sclerotic into the globe of the eye, the nerve does not appear to cease with a rounded apex behind the *la-*

* Halleri Elementa Physiologiæ, tom. v. lib. xvi. sect. 2.—Zinn de Oculo, cap. iii. sect. 2. Sabatier, Anatomie, tome ii. p. 70.—Cuvier, Leçons d'Anatomie Comparée, tom. ii. p. 412. Rees's Cyclopædia, article Eye.—C. Bell's Anatomy, vol. iii. p. 50.

† Moeller, Observationes circa Retinam, sect. 12, 13. in Halleri Disp. Anatom. select. tom. vii. supplem.

mina cribrosa, as has been represented; but it is obvious that they are altogether continuous, without any line of separation between them. The *lamina cribrosa*, as it is called, has the same white colour as the nerve, without any of the dark tinge of the surrounding sclerotic, and, if compared with a section of the nerve at some distance from the eye, is found to present exactly the same appearance. If the optic nerve be forcibly compressed, the medullary matter is forced through these orifices at its extremity in the bottom of the eye in vermicular coils, as the sebaceous matter is forced from the follicles in certain parts of the skin; a similar appearance is produced upon the cut extremity of any part of that portion of the nerve which is external to the cavity of the scull. After death, especially if the parts be placed for some time in water, the medullary matter of the nerve is projected in the form of a button or tuft in the bottom of the eye; an appearance arising either from the contraction of the firmer part or *neurilema* upon the medullary portion, or from the medullary matter imbibing the water, and thus becoming too large in quantity for the unyielding structure within which it is enclosed: at the same time, a similar tuft or button presents itself at the cut extremity of the nerve. This button or projection has been noticed by most anatomists in their descriptions of the organ, and is represented in a remarkable manner by Söemmering, in his enlarged outline section of the eye; but I think the explanation now given

respecting it will prove correct upon examination. In reptiles and fishes the nerve is not enclosed in a cellular or tubular cylinder as in *mammalia*, but folded in a peculiar manner, consequently in them, in place of a button or tuft presenting itself in the bottom of the eye, a stellated or crucial medullary projection has been observed, and may be well seen in the eye of the turtle, conger eel, and others: I have not myself, however, observed this appearance in those animals immediately after death. The facts just stated, if correct, are worthy of the particular attention of anatomists, as affording an excellent example of the extraordinary and important changes which animal structure undergoes when the influence of vitality no longer predominates over the operation of physical forces or chemical affinities. What I have just said respecting the expression of the medullary part of the nerve in the form of vermicular coils, strengthens the opinion that the nerve consists of a number of tubes containing this medullary matter; but a careful examination of a longitudinal section leads rather to the conclusion that it is deposited in a cellular structure, or at least that the communications between the medullary fibres are so frequent as to cause the part to assume such an appearance. Having removed the medullary part from a portion of the optic nerve of a whale by gentle pressure, and passing water through it, I filled it with mercury, and allowed it to dry; upon making a longitudinal section of it, the surface presents an irre-

gularly cellular, rather than a tubular appearance. As this subject, however, belongs rather to the inquiry respecting the structure of nerve in general, I shall not proceed further with it at present, especially as the above opinion differs somewhat from that of Reil, who has probably given more attention to this point*.

On the Termination of the Retina anteriorly, the canal of Petit, and the Ciliary Processes of the Vitreous Humour.

In descriptions of the anatomy of the eye there is no part of the subject upon which there has been so much diversity of opinion as upon the question of the termination of the retina anteriorly. Some maintain that the retina, that is both its medullary and vascular layer, terminates at that part of the vitreous humour where the ciliary processes begin to adhere†; others, that it is continued to the lens‡; others, that it is the vascular layer only which extends so far§; and others again, that the vascular

* Reil. Exercit. Anat. Fac. 1, de Structura Nervorum, p. 32.

† Zinn, de Oculo, cap. iii. sec. 4.—Winslow, Exposition Anatomique. Tete. No. 223. Söemmering, Icones Oculi Humani.—Cuvier, Leçons d'Anatomie comparée, tom. ii. p. 418.—Rees's Cyclopædia, article Eye.

‡ Monro on the Brain, Eye, and Ear, p. 94.—Lietaud Essais Anatomiques, p. 118.

§ Halleri Elementa Physiologiæ, tom. v. lib. xvi. sect. 2.—Bichat, Anat. Descript. tom. ii. p. 447.—Dictionnaire des Sciences Med. Oeil.—Cloquet, Traité d'Anat. tom. ii. p. 727.

layer is continued even over the lens*. The following appears to me to be the state of the parts. On removing the choroid, ciliary processes, and iris, we see the retina terminating with a defined dentated margin, about a quarter of an inch from the circumference of the lens: between this line of termination and the lens, the vitreous humour retains upon its surface part of the black pigment which covered the ciliary processes. If the eye be examined shortly after death, removing the black pigment from this part of the vitreous humour with a camel hair pencil, there is an appearance of, at least, the vascular layer being continued to the lens; this part not being so transparent as the rest of the hyaloid membrane, or so opaque as the retina. From such an examination I was led to conclude that the vascular layer was continued to the margin of the lens, but I adopted a contrary opinion after I had witnessed the change which took place when the part had remained twenty-four hours in water; the retina then separating with a slight force, and frequently detached by the disturbance given in making the examination. If, after removing the choroid, without disturbing the retina, the part be allowed to remain in water for some days, the medullary part of the retina begins to give way, and may be altogether detached by agitation in the water, leaving the vascular layer firmly attached at the line of termination just described.

* C. Bell's Anatomy, vol. iii. p. 53.—Sabatier, Traité d'Anatomie, tom. ii. p. 71, 1781.

With all the care I could bestow, I have, however, never succeeded in separating this layer from the vitreous humour further. If the maceration be continued for a few days longer, the vascular layer of the retina gives way, the larger vessels alone remaining attached at the original line of termination of the retina, and appearing to enter the hyaloid membrane at this part; the appearance which at first so much resembled the vascular layer proceeding towards the lens, remaining unchanged, being, in fact, part of the vitreous humour itself. The circumstance which has most strengthened the notion of the retina being continued forward to the lens is, that often on raising the choroid and ciliary processes from the vitreous humour, we find those processes covered in several places by a fine semi-transparent membrane insinuated between the folds; this is supposed to be the vascular layer of the retina, but is really the corresponding part of the hyaloid membrane which is torn up, being firmly united to this part of the choroid. If the sclerotic, choroid, iris, and retina, be removed one or two days after death, leaving the vitreous humour with the lens imbedded on its anterior part, we observe a number of *striæ* on the vitreous humour converging toward the circumference of the lens, corresponding in number, size, and form, to the ciliary processes, giving the same appearance collectively that the circle of ciliary processes, or *corpus ciliare* does on the choroid, and narrowed toward the nasal side as the *corpus ciliare* is. This

appearance has been noticed by most authors *, but some describe it as arising merely from the marks left by the ciliary processes, while others consider these *striæ* of the same nature as those productions of the choroid, and call them the ciliary processes of the vitreous humour; it is the *corona ciliaris* of Camper and Zinn. If we remove the black pigment with a camel hair pencil, we leave those productions on the vitreous humour more distinctly marked than when covered by the colouring matter, and presenting all the characters above stated; commencing behind with a well-defined margin, and terminating anteriorly by attachment to the capsule of the lens, the furrows between them capable of receiving the ciliary processes of the choroid, and the folds calculated to be lodged in the corresponding furrows of these processes. Fig. 1. Plate IX. is a very faithful representation of the vitreous humour of the human eye thus treated. If the cornea and iris be removed from a human eye within a few hours after death, a dark circle surrounding the lens between it and the anterior extremities of the ciliary processes may be observed: this is the part of the corona ciliaris of the vitreous humour to which the ciliary processes of the choroid do not extend, which appears dark on account of its perfect transparency; the converging *striæ*

* Zinn, de Oculo, cap. iv. sect. 3.—Halleri Elementa Physiol. lib. xvi. sect. 17.—Camper, de quibusdam Oculi partibus in Halleri Disp. Anat. Select. vol. iv.—Hovius de Circulari Humorum Motu in Oculis.

are evident, even on this part where the ciliary processes are not insinuated, interrupting the view if we attempt to look into the bottom of the eye by the side of the lens. It is, in my opinion, therefore, certain, that part of the vitreous humour, as that transparent body is called, enters into the formation of the posterior chamber of the aqueous humour. The demonstration of this fact is, however, attended with difficulty, because the flaccidity arising from even slight evaporation of the fluids of the eye, permits the ends of the ciliary processes which present themselves in the posterior chamber of the aqueous humour to fall towards the circumference of the lens, and appear attached there. For myself I can say, that, having made the dissection in the way just pointed out, the eye of course in water, and beneath one of those globular vessels which I formerly described*, I could see to the bottom of the eye through the space in front of the vitreous humour, between the ciliary processes and the margin of the lens; this space is, however, perhaps larger in some individuals than in others.

Each fold of the corona ciliaris of the vitreous humour seems to consist of two layers of hyaloid membrane, capable of being separated one from the other, and distended by inflation, and admitting of communication with each other round the lens. It appears to me that the canal of Petit, or canal godronné, is formed in consequence of these

* Philosophical Transactions for 1819.

folds receiving the injected air one from the other; it is, however, generally described as being formed by the membrane of the vitreous humour splitting at the circumference of the lens, one layer going before and the other behind that body, the canal existing between these two layers and the capsule of the lens. That the capsule of the lens has no share in the formation of the canal of Petit, I conclude from filling this canal with air, and allowing the part to remain for some days in water, and then with great care removing the lens included in its capsule; this I do not find, however, causes the air to escape from these cells, but leaves them presenting nearly the original appearance, and after the air has escaped I can pass a small probe all round in this canal, raising by this means the folds from the hyaloid membrane. It is difficult, however, to preserve the air in these folds for any length of time under water, because the tendency of the air to ascend causes the rupture of the membrane, by which it is allowed to escape. After the lens, included in its proper capsule, has been detached from its situation on the vitreous humour, the space it occupied presents the appearance of a circular depression, surrounded by those productions of the hyaloid membrane of which I have just spoken, the vitreous humour remaining in every respect perfect, notwithstanding this abstraction of the lens.

On the Capsule of the Chrystalline Lens.

The real nature of the capsule of the lens has not, I think, been sufficiently attended to; its thickness, strength, and elasticity, have certainly been noticed*, but have not attracted that attention which a fact so interesting, both in a physiological and pathological point of view, deserves. That its structure is cartilaginous, I should conclude, *first*, from its elasticity, which causes it to assume a peculiar appearance when the lens has been removed, not falling loose into folds as other membranes, but coiled in different directions; or if the lens be removed by opening the capsule behind, and withdrawing it through the vitreous humour, allowing the water in which the part is immersed to replace the lens, the capsule preserves in a great degree its original form, especially in the eye of the fish: *secondly*, from the density and firmness of its texture, which may be ascertained by attempting to wound it by a cataract needle, by cutting it upon a solid body, or compressing it between the teeth: *thirdly*, from its permanent transparency, which it does not lose except on the application of very strong acid or boiling water, and then only in a slight degree; maceration in water for some months, or immer-

* Zinn, de Oculo, loc. citat. Halleri Element. Physiol. lib. 16. sect. 20. Petit, Mem. de l'Acad. Roy. des Sciences, 1730. p. 444. Bichat, Anat. Descrip. tom. ii. p. 457.; and many others.

sion in spirit of strength sufficient to preserve anatomical preparations, having little or no effect upon it. If the lens be removed from the eye of a fish dressed for the table, the capsule may be raised by the point of a pin, and be still found almost perfectly transparent. This combination of density and transparency gives the capsule a peculiar sparkling appearance in water, in consequence of the reflection of light from its surface, resembling a portion of thin glass which had assumed an irregular form while soft; this sparkling I consider very characteristic of this structure. The properties just enumerated appear to me to distinguish it from every other texture but cartilage; still, however, it may be said that cartilage is not transparent, but even the cartilage of the joints is semi-transparent, and, if divided into very thin portions, is sufficiently pellucid to permit the perception of dark objects placed behind it, and we obtain it almost perfectly transparent where it gives form to the globe of the eye, as in the sclerotic of birds and fishes. If the soft consistence, almost approaching to fluidity, of the external part of the lens, be considered, the necessity of a capsule capable itself of preserving a determinate form is obvious. If the lens were enclosed in a capsule such as that which envelopes the vitreous humour, its surface could not be expected to present the necessary regular and permanent curvature; nor could we expect that if the form of the lens were changed, it could be restored without this provision of an elastic capsule;

hence this perhaps might be adduced as an argument in favour of the hypothesis that the eye is adapted to distance by a change in the form or situation of the lens. In the eye of man, and other mammalia examined by me, I do not find the capsule of uniform thickness throughout, but the anterior segment is much stronger than the posterior; this I account for from the circumstance of the anterior portion receiving no support from other parts, while the posterior is imbedded in the vitreous humour.

The lens has been considered by some as having no connexion with its capsule*, and consequently that its formation and growth is accomplished without the assistance of vessels; such a notion is so completely at variance with the known laws of the animal economy, that we are justified in rejecting it, unless supported by unquestionable proof. The only reasons which have been advanced in support of this conclusion are, the failure of attempts to inject its vessels, and the ease with which it may be separated from its capsule when that membrane is opened. These reasons are far from being satisfactory; it does not necessarily follow that parts do not contain vessels, because we cannot inject them; we frequently fail when there can be no doubt of their existence, especially where they do

* Petit, Memoires de l'Acad. Roy. des Sciences. 1730. p. 436. Halleri Elem. Phys. vol. v. lib. 16. Dict. des Sciences Med. art. Cristallin.

not carry red blood. I have not myself succeeded in injecting the vessels of the lens, but I have not repeated the trial so often as to make me despair of accomplishing it, more especially as Albinus, an anatomist whose accuracy is universally acknowledged, asserts, that after a successful injection of the capsule of the lens, he could see a vessel passing into the centre of the lens itself*. Lobé, who was his pupil, bears testimony to this†. The assertion that the lens is not connected with its capsule, I think I can show to be incorrect: it has been made from want of care in pursuing the investigation, and from a notion that a fluid exists throughout between the lens and its capsule. When the capsule is opened, its elasticity causes it to separate from the lens; especially if the eye be examined some days after death, or has been kept in water, as then the lens swells, and often even bursts the capsule and protrudes through the opening, by which the connexion is destroyed. I have however satisfied myself that the lens is connected with its capsule (and that connexion by no means slight) by the following method. I remove the cornea and iris from an eye, within a few hours after death, and place it in water, then with a pair of sharp pointed scissors I divide the capsule all round at the circumference of the lens, taking care that the division is made behind the anterior con-

* Annotationes Academicæ, lib. i. cap. 7.

† Lobé, de Oculo Hum. in Halleri Disp. Anat.

vexity, so that the lens cannot be retained by any portion of the capsule supporting it in front. I next invert the eye, holding it by the optic nerve, when I find that the lens cannot be displaced by agitation, if the eye be sufficiently fresh. In the eye of a young man about six hours dead, I found that, on pushing a cataract needle into the lens, after the anterior part of the capsule had been removed, I could raise the eye from the bottom of the vessel, and even half way out of the water, by the connexion between the lens and its capsule. It afterwards required considerable force to separate them, by passing the needle beneath the lens, and raising it from its situation. I believe those who have been in the habit of performing the operation of extraction, have occasionally encountered considerable difficulty in detaching the lens from its situation after the capsule had been freely opened, this difficulty I consider fairly referable to the natural connexion just noticed.

The fluid called *aqua Morgagni*, supposed to surround the lens and separate it from its capsule, appears to me, when it does exist, to be confined to the anterior part. I once met with it in the human eye, within five or six hours after death, and at longer periods in a few other instances, but how far the product of disease I cannot determine. In the eyesof sheep and oxen yet warm, I do not perceive the least appearance of such a fluid ; after some time, however, has elapsed, it is found in

considerable quantity, but evidently in consequence of that change which takes place after death, by which fluids are permitted to escape into situations not formerly occupied by them. Petit* found only half a grain of this fluid within the capsule of the human lens, and could not obtain sufficient for analytical experiment from eighteen eyes; he also says he found it in one eye and not in the other.

On the Membrane of the Aqueous Humour.

When we find a fluid contained in such a cavity as that in which the aqueous humour is lodged, the boundaries of which consist of parts so different in function and structure, we must conclude from analogy that this cavity is lined by a membrane capable of secreting and containing this fluid; at least the knowledge we have as yet acquired of the animal economy justifies us in drawing such a conclusion. The existence of this membrane has, however, rather been admitted from reasoning, than proved by demonstration. It must be admitted that a membrane lining the inside of the cornea has been described, and considered as the membrane of the aqueous humour, but this membrane lining the cornea appears totally different both in structure and function from a membrane capable of performing such an office; it is in fact

* Mem. de l'Acad. Roy. des Sciences, 1730. p. 445.

cartilaginous*, and of precisely the same nature as the capsule of the lens, and placed here, as I should suppose, to answer the same purpose which I have assigned to the capsule of the lens, that is, to enable the part to preserve correctly the regular degree of curvature. Its similarity in structure to the capsule of the lens does not, on comparison, admit of question; the same elasticity, the same tendency to coil when cut, the same permanent transparency after maceration or immersion in hot water, acid, or spirit, identify both structures. To the cornea it bears no resemblance; no two membranes can, perhaps, be more dissimilar. It is easily demonstrated; merely scraping the surface, without any previous preparation, raises it in shreds. It separates on immersing the cornea in any fluid, which causes that membrane to become corrugated, as boiling water, acid, or spirit; but the best way to display it is to allow the eye to remain a few days in water, and then with a pair of sharp-pointed scissors carefully cut the cornea all round at its junction with the sclerotic, taking care that the point of the scissors does not puncture the elastic membrane. As soon as the cornea is nearly divided, there is little diffi-

* Its cartilaginous nature was noticed by Des Mours, about the middle of the last century. I have not met his memoir on the subject.—See De Wenzel, Manuel de l'Oculiste, art. Tunique de l'Humeur Aqueuse: see also Ribes, Mem. de la Soc. Med. d'Emulation, tom. vi. p. 656. It has been described by Mr. Saurey in the eye of the hare.

culty in slipping the point of the scissors between it and the elastic membrane, and then dividing the rest; afterwards the cornea may be raised by a pair of forceps, so slight is the connexion, leaving the elastic membrane perfect, presenting the appearance of a cornea of peculiar transparency, and perfectly confining the aqueous humour. This membrane is not discontinued at the edge of the cornea, but passes under the sclerotic for a short distance between it and the ciliary ligament, and terminates with a defined edge. As far as my observations extend, I find this membrane existing in the eyes, not only of man and other *mammalia*, but in those of birds and fishes also: it is, perhaps, most easily displayed in the eye of the horse. A small transparent vesicle has been occasionally noticed projecting from an ulcer of the cornea; there can be no doubt but that it arises from this membrane being propelled through the ulcer by the aqueous humour confined behind it. If the explanation just given of this supposed membrane of the aqueous humour be correct, it follows that the real secreting membrane, lining the entire cavity, remains still to be demonstrated. How far this may be accomplished, at least in part, I shall attempt to show when I come to speak of the structure of the iris.

On the Foramen, Yellow Spot, or Fold of Söemmerring.

The justly celebrated anatomist, Söemmerring, some time previous to the year 1795, observed in the retina of the human eye, nearly in the axis of vision, an appearance which had escaped the attention of all preceding anatomists*. He describes it as a hole in the retina, with a yellow margin, mentioning, as accidental, a fold which occupies the situation of this hole, and tends to conceal it, and thus accounting for its remaining so long unnoticed. This appearance is so constant and remarkable, that its existence may be very rationally considered essential to correct vision, and it, therefore, becomes an interesting object of speculation. The circumstances respecting it, which it seems important to ascertain, are, whether it is actually a hole in the retina, with a yellow margin; whether, in addition to this hole, the retina is folded or puckered in at this part; or whether the appearance of a hole arises from a deficiency of the medullary layer of the retina, without any orifice in its vascular layer. Both Söemmerring himself and many others† seem to consider that the fold is

* Söemmerring. S. T. Icones oculi humani.—De corporis humani fabrica. Vol. iv. p. 204.

† Söemmerring, as above. Article Eye, Rees's Cyclopædia. D. W. Söemmerring de Oculorum Hominum Animaliumque Sect. Horizont. p. 17.

accidental, and the consequence of changes occurring after death. It is here necessary to call to mind what those changes are with respect to the retina. If the eye had become flaccid previous to dissection, the retina, on being exposed, presents an irregular surface, arising from a number of folds diverging from the optic nerve as from a centre, and evidently produced by the loss of support, from the partial evaporation of the fluid of the vitreous humour. These folds, however, never observe any regular form, or preserve precise situations, and may be obliterated by changing the position of the eye in the water. They disappear altogether after the part has remained some time in water, in consequence of the vitreous humour becoming again distended, from imbibing the fluid in which it is immersed. It, however, requires no very great care or experience to distinguish between those accidental folds and the peculiar one in question. If the examination be made from without, removing the sclerotic and choroid behind, the retina appears to be forced or drawn at this point into the vitreous humour, to the depth of about a twelfth of an inch, the entire fold being something more than an eighth in length. At first there is little or no appearance of a hole, but after the eye has remained for some time in the water, the fold begins to give way, and a small slit makes its appearance, which gradually widens, and assumes the appearance of a round hole. This hole is large in proportion to the degree to which the fold has yielded; and when

the fold totally disappears, as it sometimes does, the transparent point gives the appearance which Söemmerring represents, of a hole with a yellow margin. If, instead of making the examination in this way from the outside, we view this part through the vitreous humour, the appearance of the hole is more remarkable; but still that part of the retina is evidently projected forward, beyond the level of the rest of that membrane. In the eye of a young man, which I had an opportunity of examining under peculiarly favourable circumstances, within five hours after death, I noticed the following appearances. The cornea and iris having been cut away, and the lens removed from its situation, I placed the part in water, beneath one of the globular glasses, and held it so as to allow the strong light of a mid-day sun to fall directly upon it, when the retina to the outside of the optic nerve presented unequivocally the appearance of being drawn or folded into the form of a cross or star, with a dark speck in the centre, surrounded by a pale yellow areola. I further satisfied myself of the prominence of the fold by holding a needle opposite to it, while the light shone full upon it; a shadow being thus cast upon the retina, which deviated from a straight line when passed over the situation of the fold. To ascertain whether there is actually a hole in the retina, or merely a deficiency of nervous matter at this point, I allowed the eye to remain for some days in water, until the connexions of the parts began to give way. I then introduced a small

probe between the retina and vitreous humour, the part still remaining in water, and, bringing the blunt point of the instrument opposite the transparent spot, attempted to pass it through, but found I could not do so without using force sufficient to tear the membrane. I also removed the nervous matter by maceration and agitation in water; and, on floating the vascular layer, found that I could no longer ascertain where the spot had originally existed, there being no hole in the situation previously occupied by the transparent speck.

I have been induced to dwell more particularly on this subject, because I hope that the investigation may lead, in some degree, to the explanation of the use of so remarkable a structure. If the existence of this projecting fold in the bottom of the eye, and in the axis of vision, be admitted, it may be asked, what is the state of the image formed on so irregular a surface? Is it equally correct throughout? Is there not a small part of the retina placed nearer the lens, by being thus projected in form of a fold? If the size of the image be proportioned to the extent of the retina, or formed according to our notions of the optical mechanism of the eye, must it not have very large vessels interposed between it and the sensible part of the retina? Is correct vision the result of the first and single impression of the image on the retina, or of repeated impressions on different parts of that membrane, by changes in the situation of the image?

I throw out these questions to provoke discussion, rather than to attempt to answer them myself.

In the year 1819, I gave a description of a membrane, which forms part of the structure of the retina, separating the medullary or nervous layer from the choroid coat. This description was read before the Royal Society, and published in the Philosophical Transactions. I had not then an opportunity of illustrating that description by drawings, but have since succeeded in procuring most satisfactory and faithful representations, from specimens most carefully and successfully prepared in the human eye, as well as in that of the sheep. As these drawings represent, in a very striking manner, the characteristic delicacy and peculiar appearance of this membrane, and fully explain its relation to the retina, I have added them to the present memoir; that of the human eye (Fig. 2. Pl. X.) represents also the state of the fold of Söemmerring when first exposed, and before the transparent point had become fully developed. (Fig. 3. Pl. X.)

On the Structure of the Iris.

In considering the structure of the iris, the question which it is most important to determine respecting it is, "Whether we can detect in it any peculiarity of appearance, which, when compared with the forms and arrangement of muscular bodies

in general, justifies us in concluding, that it belongs to that class of organs?" If, on the other hand, the muscularity of this organ be admitted, (from the phenomena which accompany its action being in unison with the laws which regulate muscular action in general,) in what part of this membrane does such muscular structure reside? I believe, most persons who are in the habit of making frequent examinations of the eye, have been struck by the remarkable appearance which the front of the iris presents in the living subject. This appearance is generally considered to be produced by vascular arrangement. The arteries are described as converging toward the pupil, and, when they approach that opening, ramifying and forming a chain of inosculations, at a short distance from its margin, thus dividing the iris into a greater and lesser ring. An appearance which justifies such a description is certainly to be observed, but is, I believe, altogether independent of the arrangement of the vessels. If the iris be attentively examined in the living subject, or under water after the cornea has been removed, a number of irregularly shaped masses may be seen projecting from the middle space between the circumference and the pupil. From the convexities of these masses, a number of elevated lines, equally irregular in size and number, proceed toward the pupil, and attach themselves at the distance of about a twentieth part of an inch from its margin, and from this point of attachment a number of much smaller *striæ* converge to the

edge of the central opening. It is quite impossible for words to give an adequate idea of this appearance; I have, therefore, caused a magnified drawing to be made from an excellent specimen; which specimen, along with some other preparations, illustrating the subjects of the present communication, I have presented to the Hunterian Museum, where they may be seen. (Vide Pl. IX. Fig. 1.) If I ventured to compare the appearance which I describe with any other with which we are acquainted, I should say that it resembled strongly the *carneæ columnæ* and *cordæ tendineæ* of the heart, both in form, arrangement, and irregularity of conformation. This structure is more strongly marked in the hazel than the blue iris; and, in many cases, the fleshy projections coalesce, by which they appear less distinct; but the loops or cords which arise from them always exist, and often project so much from the plane of the iris, as to admit of having a small probe or bristle passed beneath them. That this appearance of the iris does not depend on any particular disposition of its vessels, is, I think, obvious; from the thickness of these *striæ*, or cords, being so much greater than the vessels of the iris; from their being arranged in a manner altogether different from vascular inosculation; and finally, because the iris, when successfully injected and expanded, does not present that interlacement of branches surrounding the pupil, which has so often been described from observation of it in its uninjected state. If the iris

be macerated for a week or ten days in clean water, until the blood is removed from its vessels, and the pigment from its posterior surface, its texture yields so much as to permit us to extend it to double its natural size: it should then be spread out and secured upon a piece of wax, coloured by lampblack. In this condition, it seems to consist almost entirely of vessels converging in a serpentine form from the circumference to the pupil: the peculiar structure which I have just described in front, though rendered less conspicuous, yet still preserving its original character (Fig. 2. Pl. IX.) is a representation of the back of a blue iris thus treated. These serpentine vessels have been described as radiating fibres converging from the circumference towards the centre, and the dilatation of the pupil attributed to this contraction*. That they are vessels, however, a successful injection, I think, proves, the whole of them becoming filled with the colouring matter, as may be seen (in Fig. 4. Pl. IX). To the size and direction of these vessels I wish to call particular attention, in order that their appearance may be contrasted with that of the front of the iris, which has been considered dependent on their distribution.

In order to obtain a correct view of the posterior surface of the iris, a transverse vertical section of the eye should be made at the distance of about an

* Maunoir, sur la Structure de l'Iris.

eighth of an inch behind the cornea, and the lens and portion of vitreous humour attached to it removed: the iris now appears covered by a thick layer of black pigment, marked by a number of converging lines; these lines, on close inspection, are found to be channels or hollows, as if resulting from a puckering or folding of the membrane. The pigment is secured from being detached and diffused in the aqueous humour by a fine transparent membrane which is closely attached to the margin of the pupil, from whence it is continued over the back of the iris, and anterior extremities of the ciliary processes, to the circumference of the lens, over the front of the capsule of which it is also probably extended, if it is, as may be supposed, the membrane of the aqueous humour. This delicate tissue may be turned down by the point of a needle; as it is connected to the iris by loose cellular structure only, in the interstices of which the black pigment is deposited. It is at first black, but, by gentle agitation in water, the colouring matter is removed, and the membrane remains transparent. Fig. 3. Pl. IX. is a drawing taken from a preparation, where the membrane was merely turned down without being freed from the pigment. When the membrane and pigment have been removed, the back of the iris appears free from colour, and marked by a number of delicate elevated folds, converging from the ciliary processes to within a short distance of the pupil; they are permanent and essential, and seem of the same nature as the

ciliary processes. The pupil is immediately surrounded by a well-defined distinct circle, about the twentieth part of an inch in diameter, of a denser structure than the rest of the iris; this is what has long been described as the orbicular muscle or constrictor of the pupil. If the iris be treated as I before mentioned, by maceration and extension, this appearance still preserves its integrity, and retains its original character (see Fig. 2. Pl. IX).

From the foregoing observations, I conclude that, if experiment leads to the inference that the iris is a muscular body capable of dilatation and contraction, its anatomical structure strengthens the conclusion; and that this muscular power more probably resides in this remarkable structure in front, than in the radiating fibres (as they have been called) behind. The arguments which have been advanced in favour of a dilating power in the radiating *striæ*, apply equally to this fasciculated structure of the anterior surface.

On the Membrana Pupillaris.

The *membrana pupillaris* is generally supposed to disappear about the seventh month of fœtal life. I shall endeavour to show that this occurrence does not take place until about the period of birth, as should, indeed, have been previously supposed. If the eye be examined about the fifth month, the

membrana pupillaris is found in great perfection, extended across a very large pupil; the vessels presenting that singular looped arrangement (with a small irregular transparent portion in the centre) so well depicted by Wrisberg, Blumenbach, Albinus, Söemmerring, Cloquet, and others. About the sixth month, it is equally perfect; the pupil is, however, smaller, the iris being more developed. Fig. 5. Pl. IX. is a very faithful drawing from a specimen at this period. Subsequently to this date, the vessels begin to diminish in size and number, and a larger transparent portion occupies the centre. At the approach of the eighth month, a few vessels cross the pupil, or ramify through the membrane at a short distance from the margin; without at all presenting the looped appearance of the previous period, but admitting a free communication between the vessels of the opposite sides of the iris (see Fig. 6. Pl. IX). The pupil is now still more diminished in size, and the iris has assumed its characteristic coloured appearance; notwithstanding the absence of vessels, the membrane still preserves its integrity, though perfectly transparent. The period now approaches when it is to disappear; this occurrence takes place, according to my observations, a short time previous or subsequent to birth. In every instance where I have made the examination, I have found the membrana pupillaris existing in a greater or less degree of perfection in the new-born infant; frequently perfect without the smallest breach, sometimes presenting ragged apertures in

several places, and, in other instances, nothing existing but a remnant hanging across the pupil like a cobweb. I have even succeeded in injecting a single vessel in the *membrana pupillaris* of the ninth month, from which preparation Fig. 7. Pl. IX. has been drawn. Where I have examined it, in subjects who have lived for a week or fortnight after birth, as proved by the umbilicus being healed, I have uniformly found a few shreds still remaining. Fig. 8. Pl. IX. is taken from a preparation obtained from such a subject. It is obvious, from the preceding observations, that the membrane does not disappear by a rent taking place in the centre and retraction of the vessels to the iris, as supposed by Blumenbach, but that it at first loses its vascularity, then becomes exceedingly thin and delicate, and is finally absorbed. The demonstration of what I have advanced respecting this delicate part, is attended with much difficulty, and requires great patience. The display of the *membrana pupillaris* of the seventh month is comparatively easy; but at the ninth month, or subsequently, it can only be accomplished by particular management. The eye, together with the appendages, should be carefully removed from the head; it should then be freed from all extraneous parts by the scissors under water, and a careful section made at a short distance behind the cornea; taking care to include the vitreous humour in the division, in order that the lens may remain in its proper situation. The portion to be examined should now be removed into a

shallow vessel of water, to the bottom of which a piece of wax has been secured. The operator should be provided with fine dissecting forceps, and needles in light handles; with one needle he should pin the sclerotic down to the wax, and with the other raise the lens and portion of vitreous humour attached to it from the ciliary processes, and separate the ciliary ligament from the sclerotic. He may now expect to discover the membrana pupillaris, but its perfect transparency renders it completely invisible; he may, however, ascertain its existence, by taking a minute particle of the retina and dropping it into the centre of the pupil, where it remains suspended if this membrane exist. The preparation should now be taken up in a watch glass, and placed in a weak mixture of spirit and water, and a little powdered alum, raised on the point of a needle, dropped upon it. After a day or two, it may be examined; and, if the membrane be present, it has become sufficiently opake to be visible, and may now be suspended in a bottle of very dilute spirit.

The drawings which accompany the present memoir, have been executed with great care and fidelity by Mr. John Jacob, of Waterford; they are good specimens of his success in the delineation of subjects requiring much care and dexterity.

Explanation of the Plates.

Plate IX. *Fig.* 1. A magnified view of the front of a hazel iris, which shewed the fasciculated structure particularly well. The projections and cords very prominent.

2. A blue iris after maceration and extension, shewing the vessels free from blood which have been described as radiating fibres; the orbicular ring of the pupil strongly marked.

3. Ciliary processes and back of the iris, the membrane of the aqueous humour turned down.

4. Iris of a child, injected, dried on talc, and preserved in spirit of turpentine.

5. Membrana pupillaris of the sixth month.

6. Membrana pupillaris of the eighth month.

7. Membrana pupillaris of the ninth month, with a single vessel injected; it presents several ragged apertures.

8. Membrana pupillaris ten days after birth, existing in the form of

Fig. 1.

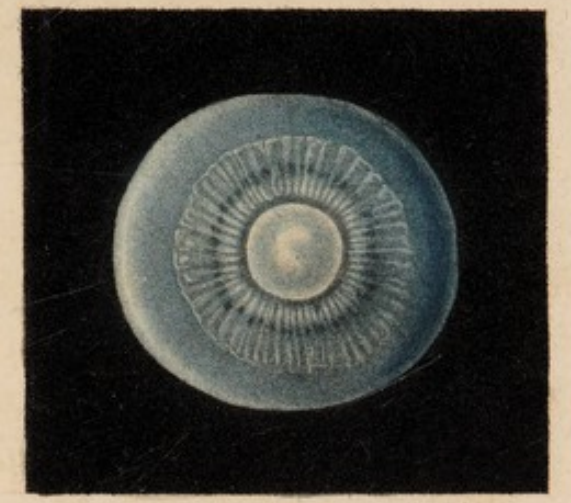


Fig. 2.

Fig. 3.

Fig. 1.

Fig. 2.

Fig. 3.

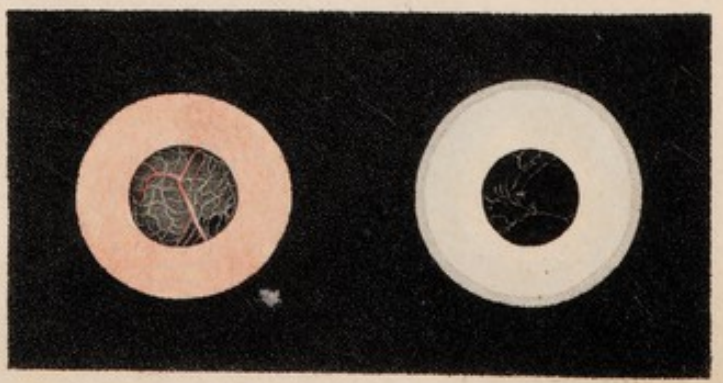
Fig. 4.

Fig. 5.

Fig. 6.

Fig. 7.

Fig. 8.



a very delicate broken tissue resembling a cobweb.

Plate X. *Fig.* 1. Shews the *corona ciliaris* surrounding the lens after the black pigment had been washed away; this is the appearance which I have described under the title of ciliary processes of the vitreous humour.

2. The membrane which covers the retina in the human eye turned down, exposing the fold of Söemmerring before it had expanded and displayed the transparent point.

3. The same membrane turned off from the retina in the eye of the sheep.

THE END.

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