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THE FUNCTION OF THE PECTEN

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ANY adventurer into the realms of comparative ophthalmology can hardly fail to have had his attention attracted by the curious appearance of the *fundus oculi* of the bird. In the first place the entire absence of any obvious retinal blood-vessels is remarkable, and in the second place the optic disc itself presents several points of difference from the mammalian type. The most arresting feature of the ophthalmological picture is the pecten. This appears as a deep black mass, of a velvety texture and very beautifully convoluted. It projects from the optic disc (which is linear, not circular), and extends forwards into the vitreous in the lower part of the eye, its anterior end being free. This pecten is found substantially the same in all classes of birds, though it is subject to a great many variations as regards shape, size and number of folds. In its simplest form, without any convolutions at all, it is found in the apteryx, the fundus of which in this respect resembles that of many of the lizards. The function and morphological meaning of this structure have been inquired into from time to time but with very divergent results, so that the present paper is perhaps justified if only as a consideration of the various possibilities.

The pecten of the domestic hen (*Gallus domesticus*), which furnished most of the material for this paper, presents eighteen folds, and measures on an average 8 mm. at its base and 5 mm. at its broadest part. The folds are united together along the free edge by a band of slightly denser tissue known as the *bridge*. The base of the pecten is attached along the whole length of the

Fig. 1.

Longitudinal section of pecten of *Gallus domesticus*.

linear optic disc, that is to say, along a line corresponding to the nerve head proper and the *cauda* or tailed out lower portion of nerve. Fig. 1 shows a somewhat diagrammatic section through the nerve and pecten longitudinally. The pecten is densely pigmented and extremely vascular. Its vessels of supply reach it along its attached border. There are one or sometimes two small arteries which reach it by running through the fibres of the optic nerve, the main one in the upper part of the nerve, the second

near its middle. This last may be represented by more than one vessel. These may anastomose with other small vessels of the nerve itself and of its sheath. The main artery runs down the base of the pecten and gives a branch of supply to each of its folds. A vein comes from each fold and joins the main vein which runs down the base, occasionally communicating by small collaterals with the two veins running down, one on each side of the *cauda* (inside the sclerotic). Just above the lower end of the *cauda* these two veins join a large vein which is running upwards between the retina and the sclerotic along the old line of the fissure. This

Fig. 2.

Transverse section of pecten through *ab* in Fig. 1.

vein receives large choroidal veins from the lower part of the eye and also the main vein of the pecten. It leaves the eye by passing through a foramen in the cartilaginous sclerotic at the lower end of the *cauda*. Fig. 2 shows a transverse section through the pecten and *cauda* at the level of the line *ab* in Fig. 1.

In considering the function of the pecten the chief possibilities for consideration are as follow :

It may be connected with the mechanism of accommodation.

It may be nutritive in function.

It may regulate the intraocular tension.

It may modify in some way the operation of the eye as an optical instrument and affect the formation of images on the retina.

It may be a sense organ.

An attempt will be made to settle some of these points by an inquiry into:

1. The minute structure of the pecten tissue.
2. Its situation and optical properties.
3. The intraocular nutrition of pectinate and non-pectinate eyes.
4. The development of the pecten.

In the first place the minute structure of the pecten in the adult bird must be examined since it is necessary to discover whether it possesses muscle cells, nerves, secreting cells or other tissues, the presence or absence of which would go far in deciding its capabilities. There exist several descriptions of the histology of it, one of the earliest being that of Mihalkovics (1873). He wrote refuting the earlier idea that it was a portion of the choroid coat which had passed through the foetal fissure and proliferated inside the eye. He showed that it was not continuous with the choroid and that it did not structurally resemble choroidal tissue except in its extreme vascularity. He described it as a capillary network, each capillary having an endothelial lining and being surrounded by a structureless hyaline coat. Leuckart (1876) and Kessler (1877) returned to the earlier view that it was an accessory part of the choroid, while this was again denied by Denissenko (1881) Gegenbauer (1898) and Rabl (1898). Denissenko described the capillaries as possessing an adventitia and a surrounding hyaline membrane, while those of the choroid do not. This adventitial coat forms a thin cylinder around the vessel, the minute space between the cylinder of adventitia and the vessel wall being crossed by fine strands. Outside this cylinder is a homogeneous pigment-containing layer, which was described by Kessler and Mihalkovics as the adventitia, but which Denissenko considers as a supporting connective tissue framework for the whole capillary net.

In 1905 Bernd suggested that the pecten was an ectodermal structure and in 1908 Franz published a paper that put forward the view that it was of the nature of a glial network highly vascularized by capillaries and having along the free edge of the *bridge* certain small projections with cilium-like extremities which he took to be sensory hairs. He also described certain bulbous cells with filaments which joined the general glial network. He thought that he could demonstrate a continuity of nerve fibrils between the pecten and the nerve fibre layer of the retina along the line of attachment of the pecten to the optic nerve. He failed to find true connective tissue in the pecten and says the blood-vessels have no adventitia, though he describes three layers in much the same way as Denissenko, but under different names.

Casey Wood, in 1917, stated that he was unable to find any sensory hairs or other evidence of the nervous nature of the pecten and considered it as nothing more than a capillary network.

The following description is from sections 2μ thick of the pecten and adjacent retina of a perfectly fresh hen's eye fixed in Bouin's fluid. It differs in some respects from the earlier descriptions, chiefly those of Franz and Denissenko. Firstly, I have been unable to confirm Franz's findings of sensory hairs and end bulbs in the specimens I have examined, and secondly, Denissenko's description of the blood-vessels as lying within cylinders of adventitia and separated from them by a space seems to me not to have been founded on fresh well-fixed specimens. I have seen somewhat similar appearances in some of my earlier

Fig. 3.

Portion of pecten (high power).

material, which had been killed some hours before fixation in 10 per cent. formol, but I do not think such specimens give an accurate idea of the minute structure, as disintegration begins very rapidly in these delicate tissues.

Fig. 3 shows a high-power drawing of a small portion of the adult pecten. It is composed mainly of capillaries. Four of these and a portion of two others are shown cut in the section. They are very small and their wall is composed of a single layer of cells. These are presumably endothelial cells, but they are not typical. The nuclei are very large, oval with a darkly staining nucleolus and prominent chromatin. The cytoplasm, instead of being thinned out almost into a film as generally in capillaries, appears swollen into a structureless clear homogeneous mass in which the nuclei are embedded at intervals, no individual cell boundaries being seen. Outside this homogeneous cytoplasm and not anywhere separated from it is a perfectly clear hyaline and highly refractile limiting membrane, which completely invests every

capillary. This is difficult to represent in a drawing. It does not stain and stands out sharply in the sections as a perfectly clear thin shining line. There is no true adventitia. The capillaries contain nucleated oval red blood cells. The individual capillaries are often in direct contact with each other and also with the hyaloid membrane of the vitreous. In places, however, one finds between them other cells, rather more epithelial in type, and having a round and darkly staining nucleus and possessing no hyaline limiting membrane. The cytoplasm of these cells is crowded with pigment granules, which are in thick sections so numerous as entirely to mask everything else. In thin sections one can easily see the individual granules lying in the cytoplasm, the nucleus being in the centre. These pigment granules are all

Fig. 4.

Portion of choroid (high power).

spherical and of very varying sizes: a single cell may contain as many as 60 or 100 granules, some very large, others only just perceptible. Sometimes several of these pigment cells lie in direct contact, sometimes one only between two capillaries. They tend to be stellate in outline, filling the spaces between the rounded capillaries. The pigment granules very readily come out of the cells, and in thick or imperfectly fixed sections the whole slide may be peppered with them. The pigment-containing cells I look on as the remains of the primitive or epithelial pecten, the development of which from the inner layer of the optic cup I have already described in this journal. They are more numerous along the bridge of the pecten than in the folded part, but they are everywhere sufficiently numerous to give the entire pecten a deep black colour.

Fig. 4 shows a high-power drawing of a portion of the *choroid* from the same eye as Fig. 3 for comparison. It can be seen that

there is very little similarity. The choroidal vessels are mostly larger. Their walls are lined with flattened endothelium and are sometimes more than one cell thick, indeed, definite venules and arterioles can be made out among the larger vessels. There is a definite adventitia. There is no trace of the curious swollen appearance of the cytoplasm seen in the endothelium of the pecten capillaries and no hyaline limiting membrane. The individual capillaries are not often in contact, being all embedded in a fine areolar tissue network, in which are also the pigment cells. The pigment granules are individually very much smaller, but are present in the cell in very much larger numbers so that even in thin sections no definite structure can be made out.

From a consideration of the structure alone then we arrive at certain facts with a definite bearing on the function of the pecten. These are as follow :

The pectinal tissue consists of capillaries with specialized walls containing no unstripped muscle and no nerve fibres. Between the capillaries are epithelial pigment-containing cells, the remains of the primitive epithelial pecten. There are no structures suggestive of end organs or sensory hairs.

Take first the various theories which have connected the pecten with the mechanism of accommodation. It has been thought that the pecten might by alteration in shape or volume push forward the lens and so render the eye adapted for near vision. If the pecten exercised a direct propulsive action on the lens one would expect them to be at least in contact, which is not the case, while if the forward movement of the lens was brought about by an increase in tension in the posterior part of the eye one would expect to find some contractile mechanism in the pecten whereby its size could be actively altered. Instead one finds entire absence of any sort of vaso-motor mechanism and it is hard to see how the organ can alter in size or shape, except passively in response to changes in the general blood pressure. Indeed, it was pointed out by Beauregarde in 1875 that the pecten possessed no intrinsic power of movement. He examined the pecten ophthalmoscopically in the living bird, and described three movements of it which he classified as apparent (due to movements of the whole head), transmitted (communicated to the pecten by the contractions of pyramidalis and quadratus during movement of the nictitating membrane) and thirdly, pulsations due to the circulation in the pecten vessels. He showed by direct stimulation of the pecten and section of the muscles that it possessed no intrinsic power of movement. He supposed that it might be of use in unocular fixation to suppress the images seen in common by both eyes. The observations concerning the movements of the pecten were confirmed by Abelsdorff in 1910.

Although the turgidity of the pecten possibly varies with the general blood pressure it can be easily shown that neither the turgidity of the pecten nor the general blood pressure exercises any influence over the refraction of the eye. The following experiments were performed:

Experiment 1. A retinoscopy was performed on a live hen and its refraction found to be $+1.5D$ sph. It was then killed by cutting off its head and the blood was allowed to drain out of the head. The refraction of the eye was again estimated and was found not to have altered. To this it might be objected that although draining out the blood undoubtedly produced a fall to zero in the general blood pressure yet this might have been compensated for by a reflex constriction (at the moment of death) of the main vessels of supply to the pecten outside the eye so that the blood in the pecten vessels at the time could not drain away and its volume consequently remained unaltered. To obviate this difficulty a second experiment was done.

Experiment 2. A retinoscopy was done on another hen ($+2.5D$ sph.). It was then caused to inhale amyl nitrite until a very marked increase in the respiration rate occurred. The refraction was again estimated and showed no change. This experiment is not open to the same objection as the preceding one since amyl nitrite produces a fall in the blood pressure by a direct paralysing effect on the unstriated muscle of the walls of arterioles and not by a selective nervous action. The retinal arteries in man can be seen to dilate during its administration.

I think, therefore, that one can say that the pecten exerts no influence over the refraction of the eye.

With regard to a possible sensory function Franz suggested that the pecten might act as a detector of the slight hydrodynamic changes in pressure in the vitreous coincident with changes in the accommodation, and that the sensations of pressure change so received might serve to apprise the bird of the amount of accommodative effort expended, and thus lead to the judgment of the relative distances of objects looked at. Histologically the only ground for such a theory is the presence of epithelial cells derived from neural ectoderm. This does not of necessity imply a neural function, since this becomes lost in other structures developed from the neural tube, e.g. the posterior layers of the iris.

The possibility of a nutritive function for the pecten must be considered while its histology is being dealt with. The great vascularity and the peculiar specialization of the walls of its blood-vessels and the fact that these are often in direct contact with the hyaloid membrane of the vitreous seem to show that there may be some selective interchange between the fluid in the vessels and the

fluid in the meshes of the vitreous. It is possible that this swollen type of endothelium signifies that the vessel wall is exercising a special selective action on the fluid passing out of the vessel. One sees, perhaps a comparable thing in the wall of a capillary in a renal glomerulus, the endothelium of which is syncytial in type, with no boundaries between the individual cells. Denissenko considered that the fluid would have some difficulty in passing through the hyaline membrane which surrounds each capillary and he, therefore, supposed that the pectinal lymphatic spaces (which he thought to be between the capillary wall and this hyaline

Fig. 5.

Diagram showing optical effect of pecten. T=temporal side. N=nasal side.
P=optic nerve and area of pecten shadow. C=centre of posterior pole.

membrane) communicated at the base of the pecten with the lymphatics of the retina and that an interchange took place in this way only. This difficulty of the hyaline membrane, however, becomes more apparent than real when we remember that these structureless layers offer in reality very little true resistance to the passage of fluid, though they may occasionally exhibit the physical properties of semipermeable membranes. It is allowed, for example, that Descemet's membrane permits of the passage of certain diffusible drugs and toxins into the anterior chamber. It is quite probable that under normal conditions there is a fluid interchange through the hyaloid membrane between the retina and pecten. In some of my specimens the fibrillation of the vitreous appears to form definite radiating channels from the apex and sides of the pecten to all parts of the retina.

The situation and optical properties of the pecten must now be considered. Beauregarde has suggested that it might be of use in unocular fixation to suppress the images seen in common by both eyes. In the first place one must consider the position of the pecten. This appears to be fairly constant in a wide range of classes of birds. The domestic hen is no exception to the general rule that the line of attachment of the pecten (i.e. the optic disc) runs from a point rather below the equator of the fundus and slightly to the temporal side of the mid-point of the posterior pole of the eye. From this situation the line of attachment runs downwards and to the nasal side, making an angle of between 60 and 70 degrees with the equator. From this line the pecten projects in a plane passing approximately through the centre of the lens. It thus lies very nearly in the plane of one of the secondary optic axes. As can be seen in the diagram in Fig. 5, practically all the rays of light in the eye which approach the pecten at all are passing in a plane parallel to or slightly diverging from it, and so they almost all strike its free border and very few fall on its sides. Hence, it will intercept very few rays and its shadow will fall along its own base or very slightly to one or other side, whatever the position of the source of light. The base of the pecten corresponds to the blind spot, so that the result of the presence of a pecten is merely a slight enlargement of the physiologically blind area found in all eyes at the entrance of the optic nerve. Furthermore, the pecten is always situated below the equator, hence the blind spot is always in the upper part of the field of vision, this being very little used in birds, which either seek their food on the ground or swoop on their prey from above.

The outline of the pecten seen from the side is variable, but always conforms to one of two types, (a) symmetrical and (b) larger in its lower part. Figs. 6 and 7 show examples (after Casey Wood) of these two types, the kestrel and the tawny owl being symmetrical and the cuckoo and the burrowing owl asymmetrical. Hence even in birds with very large pectens the increase of the physiologically blind area will be towards the upper or relatively unimportant part of the field of vision.

The macular arrangements of birds are variable and fall into six classes, according to Casey Wood, i.e.

1. The amacular type.
2. The nasal monomacular type.
3. The temporal monomacular type, chiefly in owls.
4. The bimacular type.
5. The infula-macular type, having one macula and a band-like central area of acute vision.
6. The infula-bimacular type, having two maculae joined by a band.

In all cases, except a few of those with infula-bimacular fundi, the maculae are above the upper end of the pecten and so arranged that in no position of the eye would the shadow of the pecten fall

Fig. 6.

Symmetrical pectens. *a.* Kestrel. *b.* Tawny Owl (after Casey Wood).

Fig. 7.

Asymmetrical pectens. *a.* Cuckoo. *b.* Burrowing Owl (after Casey Wood).

on either macula or the intervening retina. In some birds (e.g. flamingo) with a nasal and a temporal macula connected by a band, which also runs beyond the maculae, it will be found that

the temporal macula is lower than the nasal and that the temporal end of the band is considerably below the upper end of the pecten. Even in these cases, however, it can be seen by a consideration of Fig. 5 that the pecten will not interfere with the function of the band, since this latter is only used for rays of light coming from the upper and nasal side of the eye and it is these rays that either escape the pecten altogether or give rise to a slight shadow along its base only. These temporal maculae and bands are used to perceive objects in the nasal side of the field, i.e. in front of the bird, and it is these objects which are in some cases within the field of both eyes at once. The nasal macula is used for uniocular vision and this is always situated above the upper end of the pecten and to its nasal side, so that although rays of light from the upper temporal side throw a slight shadow on the nasal side of the base of the pecten this shadow will be below the nasal macula and will not interfere with it. Hence we may conclude that the pecten plays no part in the suppression of retinal images, but that on the contrary it is most excellently arranged so as to interfere as little as possible with the full function of any part of the retina. The dense pigmentation of the pecten serves, no doubt, to prevent any blurring of images by internal reflection.

The third point for consideration is concerned with the intra-ocular tension and the nutrition of the eye. It is, I think, obvious from what has already been said that the pecten, being non-contractile, cannot of itself produce an alteration in the intraocular tension, but that it serves to modify this seems likely. It is quite possible that, being in essence a large thin-walled venous reservoir, it allows of rapid displacement of blood from the eye and so cuts short any incipient rise of tension in the posterior chamber. A distinct parallel can be drawn between the intraocular circulation in the bird and the intracranial. In both one has a comparatively rigid box (cartilaginous sclerotic and bony skull) with small vascular foramina, semi-fluid contents and vessels devoid of vasomotor nerves. The analogy becomes more apparent also in view of the small size of the pecten arteries compared with the large area of the capillary network which they feed and the large size of the issuing pecten vein: this has its parallel in the small size of the cerebral arteries, the large area of venous sinuses and the large venous foramina in the base of the skull. The hydrodynamic possibilities of such a system have been studied in the skull by Cushing, Trotter and others, and they point out that the system serves very well to maintain a constant tension within the skull. The total volume of blood entering by the arteries in a given time must always (since the skull is a rigid closed box) equal the total outflow from the veins in that time, the difference of calibre in the

two sets of vessels only causing a difference in the rate of flow in the two sets and a rapid fall of blood pressure during the transit. Any increase of tension inside the skull will be met by compression of the veins and increased rate of venous outflow, so that for slight degrees of compression, short of causing reduction of the calibre of the veins below that of the arteries the intracranial tension remains normal, i.e. similar to the general venous blood pressure. A similar state of affairs probably holds good in the eye of the bird and any rôle played by the pecten in maintaining a constant intraocular tension is a passive one, depending on the circulatory condition of the eye as a hydrodynamic system.

With regard to the part played by the pecten in the nutrition of the retina, we have already shown that it possesses a structure suggestive of the power of selective secretion. If we consider the arrangement of the retinal blood supply in various classes of vertebrates we find that it is practically only in the lower mammals (e.g. *Echidna*) that there is no trace of intraocular vascularization apart from the choroid. Most of these animals are not remarkable for their acuity of vision or the high degree of development of their eyes or visual centres, the sense of smell being in them usually more important and elaborated. Of the remaining animals which show greater specialization in the direction of sight we can recognize two main types, those which possess a more or less complete system of retinal arteries and veins (similar to man and including most mammals and some amphibia, e.g. the horned toad) and those which possess some form of pecten and no retinal vessels proper (birds, lizards and some other Sauropsidans). Of these two classes the pectinate animals usually possess the greater visual acuity and the larger and more specialized eyes, often with most complex macular arrangements. Of the non-pectinate type man and the Anthropoids may be considered to have reached the greatest degree of development, very few of the other mammals possessing a true macula. The fact that a well developed pecten is never found in the same eye as an arteria centralis retinae in itself suggests that there may be some reciprocity of function between them. An attempt was made in this connection to show that both systems produced the same relative amount of blood supply, by estimating the ratio between the human retina and its vascular supply on the one hand and between the bird's retina and the pectinal vessels on the other. This is, of course, impossible to do directly and I was compelled to adopt a very rough method: by measurement and computation of serial sections of the hen's pecten the length of its vessels was ascertained approximately and a ratio was made between this and the total retinal area. The area of a full section of the retina of a six months' human foetus (injected with Indian ink) was calculated and the

length of the vessels therein ascertained as accurately as possible. The whole calculation is so rough that I have given neither an account of its working nor its formulae in this paper, but it is of interest to note that the two ratios separately obtained were 2.3 and 2.06 respectively, thus seeming to show that if the pecten vessels were unravelled and spread out a very fair imitation of a centralis retinae system would be obtained. It seems extremely probable that the visual acuity of an animal with a vascular retina can never equal that of a bird, since the presence of blood-vessels in front of the percipient layer interferes to an appreciable extent with the clearness of the image perceived. From this point of view then the pecten may be looked on as a modification of the intraocular vascular arrangements, having special reference in phylogeny to increase in the efficiency of the eye as an optical system without interfering with its metabolism by robbing it of any of its blood supply. This is in accord with the large size of the embryonic Sauropsidan eye, the importance of the visual centres and the various indications in reactions and mode of life which point to the tendency to specialization in the direction of the sense of sight rather than any other sense in these animals.

We have so far reached the conclusions that the pecten has a nutritive function, producing lymph for the metabolic needs of the retina, that it acts passively as a damper to combat any sudden changes in the intraocular tension and that it is so constructed as not to interfere with the development of a high degree of visual acuity. These conclusions are further supported by a consideration of the comparative development of the posterior pole of the eye, by means of which it can be shown that the pecten is the homologue of the arteria centralis retinae system.

I do not propose to go deeply into the matter of development as I have already dealt with it fully in this journal. The following points, however, deserve mention:

The development of both the pecten and the arteria centralis retinae is intimately connected with the choroidal fissure. If one takes two embryonic eyes, one of a mammal and one of a bird, both at the stage when the choroidal fissure is just beginning to close, one gets the conditions represented diagrammatically in Fig. 8, *a.* and *b.* In both there is a blood-vessel (V) which runs from the posterior end of the fissure across the cavity of the optic cup to anastomose with vessels of the encircling mesoderm at the pupillary margin. In the mammalian eye (*a*) the lower portion of the optic cup is as large as the upper and the hyaloid vessel runs practically across the middle of the cavity and reaches the posterior pole of the lens. Here it breaks up to form the vascular capsule of the lens, some branches passing out of the extreme pupillary end of the cleft to anastomose with vessels outside the

cup. In the avian eye (*b*) on the other hand, the lower portion of the eye is very much smaller at this stage than the upper, the optic stalk being implanted quite low down on the posterior aspect, so that the hyaloid vessel entering at the top of the fissure only traverses the extreme lower part of the cavity of the cup and leaves again through the pupillary end of the cleft without having reached the lens at all.

As the eye in both cases increases in size there is a slightly more exuberant growth of the inner layer of the optic cup than of the outer at the posterior pole. This overgrowth of the inner layer leads to the formation of a slight heaping up and eversion of the inner layer along the upper part of the cleft. When the

Fig. 8.

Diagram of hyaloid vessel. *a*. Embryonic mammal. *b* and *c*. Embryonic bird.

nerve fibres appear in the differentiating retina they make for this upper part of the cleft in order to reach the optic stalk, and in so doing cut off some of the cells of this ridge and leave them stranded on the vitreous surface of the nerve fibre layer. In mammals this only occurs at the extreme upper end of the fissure and the little mass of sequestered inner layer cells remains as a cone-shaped plug on the disc. Fig. 9 shows this plug (*p*) in a pig embryo. In birds, however, the increased rate of growth of the retinal areas bounding the upper end of the fissure is much more marked, since it is growth here which will eventually lead to the lower part of the eye equalling the upper in size. The area in which this growth occurs is marked *x* in Fig. 8 *b* and *c*. This growth of the upper end of the fissure leads to the displacement downwards of the original point of entry of the hyaloid vessel, which

appears to be more firmly attached at the pupillary end of its course, so that this vessel, not being held up by connection with the posterior pole of the lens, still only traverses the extreme

Fig. 9.

Optic disc of pig embryo. P=epithelial cells on disc.

Fig. 10.

Developing pecten of chick. P=pecten.

lower part of the eye (Fig. 8 c). The process of sequestration of cells of the inner layer of the optic cup on the vitreous surface of the retina by the outward passing nerve fibres takes place in the bird over a much greater length of the fissure, and so leads to the

formation of a linear ridge and not a cone as in mammals. (See Fig. 10 of developing pecten for comparison with pig embryo in Fig. 9.) In both mammals and birds this mass of cells (in the one case a cone, in the other a ridge) becomes vascularized by a branch of the hyaloid vessel. In mammals the vessels in the mass of cells on the disc branch and spread over the whole surface of the retina in the nerve fibre layer as the *arteria centralis retinae* and its branches, while in birds they are confined to the ridge of cells, which increases in size and grows out into the vitreous as the *pecten*. Fig. 11 is a sketch of two models showing the early stages of the pecten ridge (a), and the vascularized cone of cells on the mammalian (human) disc (b). Thus we see that the *arteria centralis*

Fig. 11.

Models of posterior pole of eye. *a*. Bird. *b*. Human (Diagrammatic).

retinae and the pecten both represent the vascularization, by a proximal branching of the hyaloid vessel, of a mass of inner layer cells cut off from the rest of the retina by outgrowing nerve fibres.

Conclusions

1. The main function of the pecten is the nutrition of the retina by means of fluid interchange through the vitreous network.
2. Morphologically the pecten corresponds with the retinal vessels of mammals.
3. The pecten exercises a beneficial effect on the eye by neutralizing passively any sudden changes in the intraocular tension.

4. Its peculiar form and arrangement are but one of the expressions of the high degree of specialization of the avian eye in the direction of increased efficiency as an optical instrument.

BIBLIOGRAPHY

- Leuckart, R.—Graefe-Saemisch Handbuch der Gesamten Augenheilk., p. 145, Cap. 7. Vol. II., 1876.
 Mihalkovics.—Untersuchungen über den Kamm des Vogelauges. *Arch. f. mikros., Anat.*, Bd. 9, 1873.
 Denissenko.—Über den Bau und die Function des Kammes. *Arch. f. mikros., Anat.*, Bd. 19, 1881.
 Gegenbauer, C.—Vergleichende Anat. der Wirbelthiere, Leipzig, 1898.
 Rabl.—Über den Bau und Entwicklung der Linse. *Zeitsch. f. wiss. Zool.*, Vol. LXIII, 1898.
 Bernd.—Inaugural Dissertation. Bonn, 1905.
 Franz.—Der Facher im Auge der Vogel. *Biol. Zentralbl.*, Vol. XXVIII, 1908.
 Casey Wood.—The Fundus Oculi of Birds. Chicago, 1917.
 Mann.—*Brit. Jl. of Ophthal.*, April, 1922.
 Beauregarde.—Comptes rend. et mem. Soc. de Biol., Paris, pp. 132-136, 1875.
 Abelsdorff.—*Arch. f. vergleich. Ophthal.*, Heft. 3, No. 3, pp. 290-292, 1910.

A CASE OF RECURRENT DETACHMENT OF THE RETINA

BY

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IN the January issue of this journal, Sir William Lister deals exhaustively with holes in the retina and their relation to detachment, either of the sudden type or as a result of the presence of a new growth.

Towards the end of his most interesting communication he remarks: "Personally, I have seen no case in which there was a hole improve spontaneously or after treatment, and it is my opinion that with our present available methods such cases of detachment are practically hopeless." In order to supplement his own experience, he asks for further data with regard to the aetiology of holes in the retina, improvement in the clinical methods of detecting whether the retina is being pushed in by fluid from without or dragged in by adherent and contracting vitreous, and lastly for reports of the practical experience of surgeons in the treatment of these cases, classified according to their cause.

It is in reply to the third request that I venture to report a case of what I have entitled "Recurrent Detachment of the Retina," a case in which within five months three consecutive detachments were observed with apparent recovery.