Anatomy. — *"Concerning an Isolated Muscle of the Ciliary Body of the Pigeon's Eye, Situated near the Eye-split"*. By J. H. ZALMANN. (Communicated by Prof. J. BOEKE).

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When making a sagittal section of the pigeon's eye we soon reach, after the cornea and the iris, the eyesplit situated in the basis of the iris and in the basement membrane of the corpus ciliare.

In the ciliary body peripheral to this eyesplit we are then particularly struck with a stout muscular fascicle which, in virtue of its firm structure, projects into the spaces of Fontana and is distinguished from the other ciliary muscles by its peculiar form.

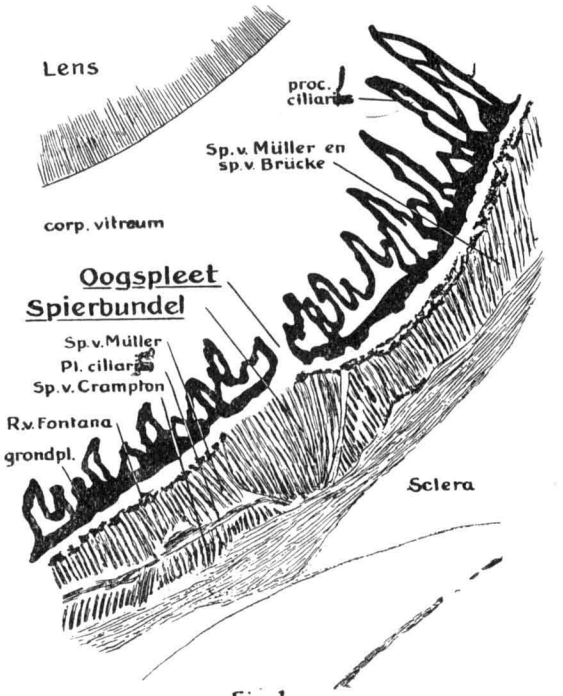

Fig. 1.

Sp. v. Müller = Muscle of Müller.
Sp. v. Brücke = „ „ Brücke.
Oogspleet = Eyesplit.
Spierbundel = Muscular fascicle
Sp. v. Crampton = Muscle of Crampton.
R. v. Fontana = Spaces of Fontana.
grondplaat = basement membrane.

For convenience' sake we will term the plane through the beak and the middle of the two pupils: the horizontal plane. The two halves of the bulbus oculi separated by this horizontal plane we will term the lower (nearest to the jaw) and the upper half (nearest to the cranial plane). In the same way the frontal plane through the middle of the two pupils, divides the bulbus into a nasal and a cerebral half.

Now, when we make horizontal sections in the inferior nasal quadrant, we come obliquely upon the above-mentioned eyesplit and muscular fascicle. When making a radial section at an angle of $\pm$ 45° to the horizontal plane, we pass along the muscular fascicle in its whole length, and are thus in a position to determine its anatomic relations.

Besides the method of fixation, embedding in celloidin and the making of sections, there is another, viz. preparing the uvea under the binocular microscope.

To this end the posterior, median, half of the bulbus of a fresh, enucleated eye, was removed.

Along with the anterior stratum of the retina the retinal cell-layer of the processus ciliares was pulled off, in which process also the Zonula of Zinn and the corpus vitrium were removed without injuring the basement membrane of the corpus ciliare. Also the lens, held firmly in its capsule, could now be detached from the processus ciliaris without any harm to the latter.

Now, when we subsequently take up the exposed periphery of the iris and make some cuts in the iris, we can tauten the lig. pectinatum by laying back interiorly — towards the median plane — the sectors formed. With a sharp knife the fibers of this ligament are split close to the basement membrane; then the basement membrane of the corp. cil. is to be laid back still further, the spaces of Fontana are completely open and the medial side of the ciliary muscles is laid bare.

When examining the nasal-inferior quadrant of the urea, before treating it in the manner just described, we observe that the processus ciliares diverge from their radial course at the spot where we should look for the eye-split. They bend round in the direction of the nasal tangent. They make an impression as if they run over an arched sublayer.

Now, when opening in this quadrant the spaces of Fontana, we notice some details, just peripheral to the spot where the processus ciliares bent their course.

At the place of insertion of MÜLLER's muscle into the interior

lamella of the cornea, this muscle is separated from the spaces of Fontana by a pigmented fascia-layer. About halfway this nasal-inferior quadrant this pigmentation is interrupted, and is sharply demarcated from the rest by a pigmented curved line.

When the basement membrane is stretched opposite to this region, a break will be seen in the connecting line between basement membrane and musc. ciliares, formed by the insertion of the tensor chorioideae. The basement membrane bridges the non-pigmented part of the ciliary muscles. (See Fig. 2).

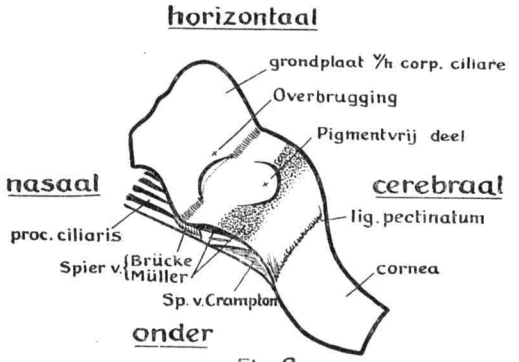

Fig. 2.

Horizontal

grondpl. etc. = basement membr. of the corp ciliare
Overbrugging = Bridging
Pigmentvrij deel = Non-pigmented part.
nasaal = nasal
cerebraal = cerebral
Spier van = Muscle of
onder = Inferior

As is shown in a reconstruction of the sections the form of a non-pigmented spot of the corpus ciliare corresponds with the form of the muscular fascicle. Moreover, the peculair bridging effected by the basement membrane seems to be related to the modified insertion of the M. tensor chorioideae. In Fig. 1 the absence of pigment on the muscular fascicle is also noticeable.

Between the horizontal plane and the part of the corp. ciliare that displays the details alluded to, the ciliary muscles present a regular structure.

From the sclera arise two muscles: CRAMPTON's muscle towards the interior lamella of the cornea and BRÜCKE's muscle as a peripheral part of the tensor chorioideae to the basement membrane of the corp. ciliare. The other part of the tensor chorioideae, MÜLLER's muscle, extends between the inner cornea-lamella and the basement

membrane of the corp. ciliare. The insertion of this muscle into the basement membrane lies slightly more towards the cornea than the insertion of BRÜCKE's muscle. The two parts of the tensor chorioideae are separated from CRAMPTON's muscle by the plexus ciliaris.

When the eyesplit in the basement membrane has been cut into, a muscular fascicle develops in the spaces of Fontana close against MÜLLER's muscle. We now turn away from the horizontal plane and first come upon the place of insertion. The muscular fibers terminate in a tendon, which bends round the compartment of CRAMPTON's muscle, first in conjunction with MÜLLER's muscle and afterwards by itself, and subsequently reaches the inner-lamella of the cornea where the lig. pectinatum takes its origin.

In further sections we see MÜLLER's muscle grow thinner and its tendon elongate in relation to the thinning out of the muscular tissue, ultimately disappearing entirely. The new muscular fascicle has now in part replaced MÜLLER's muscle and partly juts out into the spaces of Fontana.

Hereafter the structure of CRAMPTON's muscle is intensified.

BRÜCKE's muscle shrinks and reduces its place of origin on the sclera, thus making room for the new muscular fascicle. Just where MÜLLER's muscle decreases in size and disappears, this new muscular fascicle imparts twice running a considerable part of its muscular fibers to the basement membrane, which fibers conseqnently perform the function of tensor chorioideae.

The rest, by far the majority of the muscular fibers, have their origin on the sclera, between that of the muscle of BRÜCKE and that of CRAMPTON.

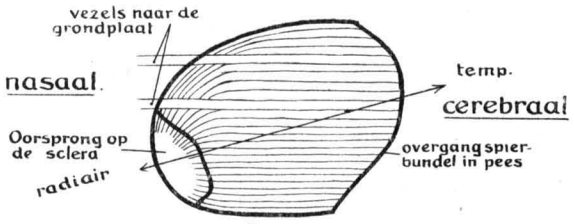

Fig 3.

Vezels naar de grondplaat = fibers towards the basement membrane.
Nasaal = nasal.
Oorsprong op de sclera = origin of the sclera.
Radiair = radial.
Cerebraal = cerebral.
Overgang spierbundel in pees = transition of muscular fascicle into tendon.

Origin and insertion end approximately in the same radial section, from which it appears that the insertion is much longer than the place of origin. The muscular fascicle is somewhat fan-shaped, diverging from origin to insertion. The muscular fibers remotest from the horizontal plane do not run quite radially, but divert slightly in the direction of the horizontal plane. The course of the muscular fibers nearest to the horizontal plane is initially diverting from the radial direction towards the perpendicular of the horizontal plane. Thereafter they curve in temporal direction, parallel to the remoted muscular fibers. In fig. 1 we also observe a curvature of the muscular fibers and likewise the fan-shape of the muscular fascicle.

Now let us consider the course of the muscular fascicle in a radial plane, vertical to the sclera. The most lateral fibers, — closest to the sclera — proceed linearly from the origin to the insertion. The fibers which help in walling off the spaces of Fontana run in a curve, viz. from the origin first perpendicularly to the sclera, then curving round in the direction of the insertion.

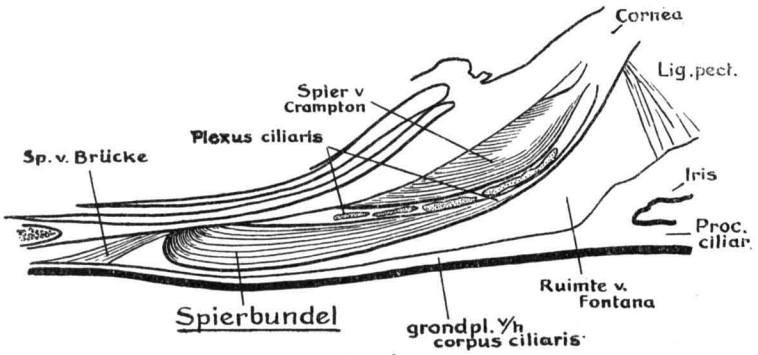

Fig.4.

Spier = muscle.
Spierbundel = muscular fascicle.
Grondvl. v/h = basement membrane of the
Ruimte v = spaces of

Among these curving fibers there are a few which run along a straight line from the place of insertion to the basement membrane. They extricate themselves from the other fibers at the place where the latter change their course, and sometimes in succession where MÜLLER's muscle ceases to exist and the muscular fascicle takes its origin on the sclera.

In fig. 5 the points in the normal corpus ciliare have been marked which in a number of succeeding radial sections have been connected by lines. We here give an explanation of the signs used:

------ the most peripherally located origin of CRAMPTON's muscle.
XXXX insertion and transition into tendon of MÜLLER's muscle.
-·-·-·- Origin and insertion of BRÜCKE's muscle.
——— Boundaries of the muscular fascicle described, with hatched place of origin.

Now let us consider again the structure of the corpus ciliare in sections farther removed from the horizontal plane.

Directly when the origin of the muscular fascicle is left uncut, the available space on the sclera is at once encroached upon by BRÜCKE's muscle. Its origin again pushes on in the direction of the cornea right against that of CRAMPTON's muscle and its muscular fibers push off like a wedge between the sclera and the rest of the muscular fascicle that has been cut into.

Likewise MÜLLER's muscle takes up its old position again. Now, farther and farther away from the horizontal plane the two parts

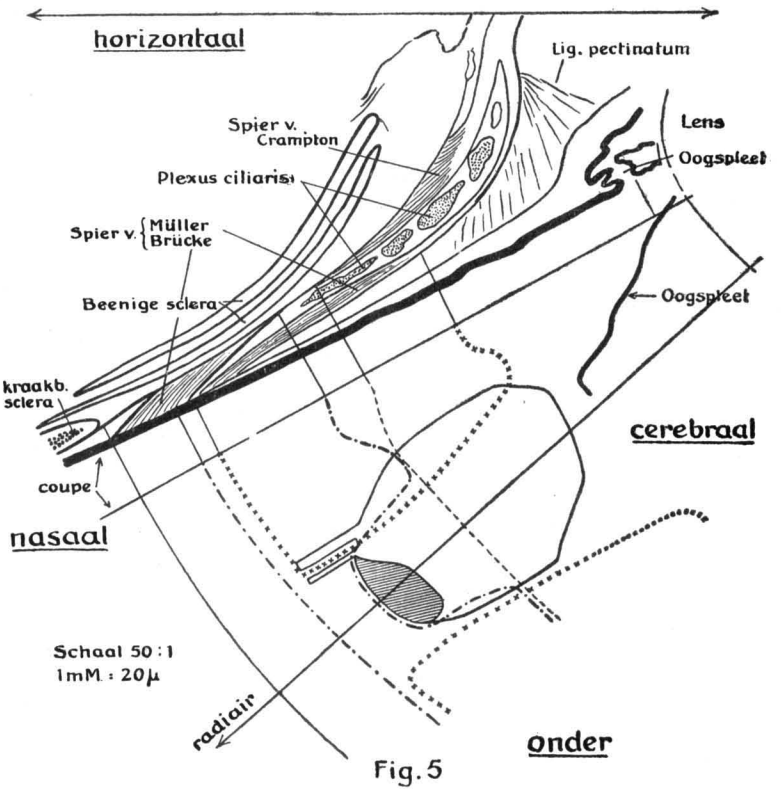

Fig. 5

horizontaal = horizontal
spier van = muscle of
Beenige = osseous
kraakbeenig = cartilaginous
coupe = section
nasaal = nasal
schaal = scale
oogspleet = eyesplit
cerebraal = cerebral
ondèr = inferior.

of the tensor chorioideae present an alternation in their strongest development. BRÜCKE's muscle and MÜLLER's muscle in turn disappear completely. When BRÜCKE's muscle loses ground CRAMPTON's muscle avails itself of the free space on the sclera to fasten its fibers more backwards.

When summarizing the above we see that in the pigeon's eye there exists near the eyesplit in the nasal-inferior quadrant a muscular fascicle, situated medially to the plexus ciliarus, running from the sclera to the inner lamella-medial part of the cornea. This origin and insertion exclude the muscle from the known types of ciliary muscles of the bird's eye. At that spot CRAMPTON's muscle is strongly developed, BRÜCKE's muscle is only slightly developed, while MÜLLER's muscle has completely disappeared.

In the preparation of the uvea the absence of this muscle accounts as well for the absence of the pigment as for the absence of the bridging by the basement membrane.

The innervation also is furnished by the plexus ciliaris. D. TRETJAKOFF (1906) describes the M. protractor lentis in the salamander's eye. This muscle, like our muscular fascicle lies near the eyesplit in the inferior half of the corpus ciliare. This musc. protactor lentis is not related to the M. tensor chorioideae. TRETJAKOFF's[1]) muscle extends downward from its origin and bends temporally towards the corneo scleral border.

The difference from the discussed muscular fascicle in the pigeon's eye, lies in the fact that contrary to the M. protr. lentis this fascicle extends upwards to bend round temporally afterwards, anyhow as far as those of its fibers are concerned that are nearest to the horizontal plane; also in this that some fibers act like the tensor chorioideae. For the rest there are many points of similarity. Among the eye-split-rests in the deep-sea fishes also a muscle, the M. retractor lentis may be discerned.

This muscular fascicle does not occur in the fowl. NUSSBAUM (1897 [2]) does not mention this pecularity in the corpus ciliare for the simple reason that he describes the eyesplit in the fowl.

Method of fixation and treatment was as follows. Fixation by means of perfusion of the bloodvessels of the head upwards from the truncus arteriosus cordis and subsequently through submersion into the fixative employed. The fixatives were of low concentration

[1]) D. TRETJAKOFF 1906 „Der Musc. protract. lentis im Urodelenauge". Anatom. Anzeiger. B. 28.

[2]) M. NUSSBAUM 1897 „Die pars ciliaris des Vogelauges. B. 57, p. 346.

in order to prevent as much as possible dislocation of the retina, viz. formalin 5%, glacial acetic vinegar $1^1/_2$—$^3/_4$ %.

Subsequently the head was deprived of skin, beak, lower-jaw and occiput, frozen on the freezing-microtome and cut through parallel to the horizontal plane as far as the middle of the two pupils. It was then thawed, dehydrated in alcohol, decalcified and embedded in celloidin or parts of it in paraffin. The sections measured 10—30 μ in thickness.

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