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Anatomy. — *"The origin of the fibres of the corpus callosum and the psalterium."* By Dr. C. T. VAN VALKENBURG. (Communicated by Prof. L. BOLK).

(Communicated in the meeting of March 25, 1911).

Embryology, histology and pathological anatomy have not yet succeeded in fixing beyond all doubt the origin and the ending of the callosal fibres in the cortex cerebri. The communications on this subject show somewhat different results.

The earlier interpretation of the c. callosum as a typical commissure between the hemispheres has been rendered improbable, at least for man, by the anatomical researches which showed asymmetrical secondary degeneration in both hemispheres after callosal lesions.

In well-stained preparations it is possible to point out degenerated callosum fibres through some of the deepest cortex layers; sometimes such elements are isolated by the degeneration of the surrounding fibres and may be traced in the same way. But neither experimental nor pathological preparations enabled me to conclude with sufficient certainty which of the cortex layers might give origin to or receive callosal radiations.

The great difficulty in every case is the absence of myeline sheaths in the last ramifications, viz. in the axones near their origin, the usual methods depending upon the demonstration of myeline alterations (WEIGERT, MARCHI). By means of the GOLGI-method CAJAL [1]) showed the probability that in the smaller mammals (newborn rat, rabbit) pyramidal cells of different size may send their neurones between the constituents of the corpus callosum, whereas from other cortex cells axis-cylinders may originate which give collaterals into the same system. KÖLLIKER [2]), who confirmed these opinions, found in the mouse axones arising from polymorphic cortex cells, bifurcate in the area of the callosum fibres: one of the branches remains in the same hemisphere (associative fibres after KÖLLIKER), the other passes into the collateral one.

The impossibility of tracing in a histological preparation the whole traject of any longer nerve fibre compelled me to have recourse to experiments.

It is well known that the regressive (even temporary) alterations in the nerve cells after cutting their axones, depend upon many factors. The distance of the lesion from the cell and the presence of

1) CAJAL: Textura del sist. nervioso. Tomo II. Parte 2. Pag. 145 seqq.

2) KÖLLIKER: Handbuch der Gewebelehre. Band II. S. 664 flgg.

collaterals in the course of the axon between the cell and the lesion are probably the principal of these. It is therefore even possible that after a certain interval scarcely any cell degeneration would be found as a result of the cutting of callosal fibres.

I experimented upon cats and rabbits. I divided the whole corpus callosum, or parts of it, in a sagittal direction, either in the middle line, without injuring the hemispheres, or close to the sagittal medial plane through the dorsal cortex on one side. In the latter case I examined the uninjured hemisphere principally for cell alterations, the other was stained after WEIGERT-PAL and VAN GIESON.

I will communicate in this paper the results of two callosum operations: one on a cat, whose caudal callosum-half was divided, and one on a rabbit, where the same operation was performed in the frontal half.

Cat 3. Operation: March 22nd 1909.

In a small-sized, full-grown cat a sagittal section was made through less than the posterior half of the corpus callosum, including the splenium. The medial wall of the left hemisphere was slightly injured. During the first few hours after the operation, the cat showed a tendency to turn to the left in walking. The next day the animal was listless, it did not move with the natural agility, while the left pupil and eye slit were larger than the right. At the end of a week the cat did not show any morbid symptom; it was killed 4 months later.

The post-mortem examination showed the following data:

The length of the corpus callosum is 12 mm.; it was divided sagittally in its posterior part from the caudal end till the transversal plane of the caudal border of the medial part of the fissura cruciata (7 mm.). The fibres of the psalterium in this region had been equally cut; the thalamencephalon and the mesencephalon were uninjured. 1$^1/_2$ mm. behind the frontal end of the lesion a superficial malacia of the dorsomedial cortex of the left hemisphere began, which extended 8 mm. in a caudal direction, i.e. 2$^1/_2$ mm. behind the transversal plane through the posterior border of the splenium; the underlying white substance of the gyr. splenalis was for a small part, and then only superficially, softened.

It may be stated that in undoubted connection with the described cortical lesion, which in its caudal part was localised in the frontal third of the area striata — as pointed out by BRODMANN CAMPBELL e.o. —

[1]) MURATOFF: Secund. Degenerat n. Durchschneidung des Balkens N. Ztrbl. 1893
LO MONACO È BALDI: Sulle degener. conseg. al taglio longitud. del corp. call Arch. d. farmac. speriment. Nov. 1904.

the corpus geniculatum externum of the same side had lost almost all its cells in the frontal third only [1]), whereas in the corpus quadrigeminum anticum a slight loss of nerve fibres in the superficial layer was visible.

The ventriculus lateralis has been drawn in a dorsal direction by the degeneration of the callosum fibres and the softening in the gyr. splenialis.

The tapetum, which in the human brain consists, at least, partially, of callosal fibres, shows but few degenerated fibres. The great majority of commissural fibres remain dorsally to the occipital strata and spread into the dorsal (mesial and lateral) cortex; a few pass the sagittal strata in a more or less oblique direction and may run for a certain distance in the area of the tapetum. This latter is almost exclusively formed by the fasc. subcallosus (MURATOFF), substance grise subependymaire (DÉJÉRINE).

For cell alterations the right hemisphere was used, the cortex of which had not been injured at all. The paraffine blocks were cut in sections of 10 μ and stained with toluidin blue.

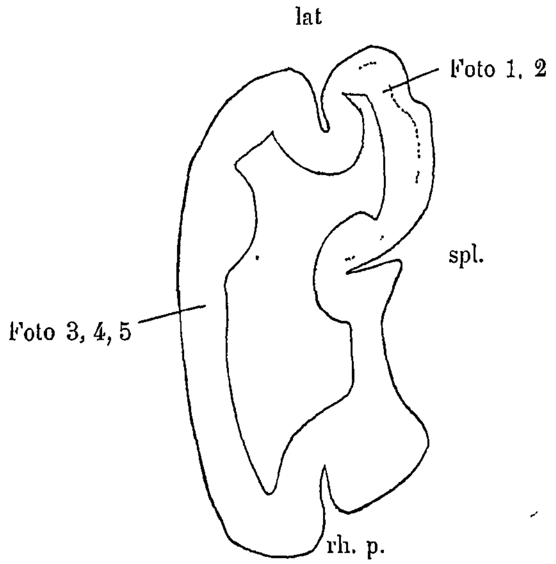

Fig. 1a.

Figure 1 represents a section through the cortex of the gyr. splenialis of a normal cat; the exact situation is to be seen on diagram 1a. The photo shows a typical lamination of the so-called visuo-sensory zone (area striata), characterised by the absence of the lamina

1) I do not insist in this paper on this statement, which is doubtlessly of importance for our knowledge of visual localization, and which agrees, in principle, with some of VON MONAKOW's fundamental observations.

granularis externa and the complication of the lamina granularis interna (BRODMANN), which latter is doubled by the line of VICQ D'AZIR (in WEIGERT-preparations); between the two sub-divisions of the inner granular layer the isolated polygonal cells (stellate) cells are found. The fifth layer (lamina ganglionaris) contains well-developed pyramidal cells, lamina VI consists of cells of a multiform type.

Figure 2 is a photogram of a section in the homologous level in the brain of the operated cat, taken from the gyr splenialis. The lamina zonalis and pyramidalis (I and III) do not show any marked loss of cells. Nevertheless in these, and probably in the granules of the inner granular layer, several elements are more or less abnormal.

Compared with the normal, too many glia cells are to be found between and around the nerve cells. The latter moreover show for the greater part an abnormal situation of the nucleus; the toluidine staining is frequently not of the Nissltype, but several cells are coloured rather diffusely darkblue. The impression made by the deeper part of the supragranular pyramidal cells is that of a recovery from a functional alteration.

The number of stellate cells within the IV (inner granular) layer has not decreased; many of them are not coloured with the same distinctness as in normal preparations; satellite-glia elements, up to 6 or 8, are often situated immediately on their surface.

The lamina ganglionaris (V) shows the most marked alteration. In normal preparations of this region, well-developed large pyramidal cells are present in this layer, not in very great number it is true, and not in a quite continuous row; particularly in the gyr. entolateralis the series shows small gaps. On the contrary these large, well-stained cells are for a good deal lacking in most of the homologous sections of the operated cat. Nevertheless a reservation must be made for few subgranular pyramidal cells, which are seemingly wholly unaltered. The preparations of the left hemisphere, taken from the most caudal part of the area striata present in exactly the same way the above-described lack of deep pyramidal cells. These sections being stained after VAN GIESON show, moreover, a marked loss of fine nerve fibres up to, and including, the inner granular layer, which is not to be found in WEIGERT preparations. The fact that the left area striata was primarily injured in its frontal third renders it difficult to give an unequivocal interpretation to the degeneration of the sheathless fibres.

In the multiform cell layer it is impossible to demonstrate a veritable lack of nerve-elements. On the other hand, secondary alterations are very evident; many cells show anomalous form and colouring; the position of the cell-nucleus — though in these smaller elements not easily to be judged — is very often excentric. Glia cells in the different stadia of activity and inaction [1]) are present in great number, particularly surrounding the nervous elements, in contrast to their behaviour in the fourth (and third) layer, where they are mostly scattered *between* the nerve cells.

Figure 3 represents a section through the cortex of the gyr. ectolateralis of a normal cat on the spot marked in diagram 1*a*. The lamination is otherwise than in the area striata. Six layers are to be easily recognised. Lamina II and III are larger than in the layer between lam. zonalis and lam. granularis interna in the visuo-sensory zone. In the deepest part of lamina III a row of larger pyramidal cells is visible immediately above the inner granular layer. In the fifth layer the pyramidal cells are of a somewhat smaller size than those in the area striata, but more numerous. The lamina multiformis (VI) is well developed, and contains fusiform and angular cells [2]).

The homologous sections of the right hemisphere of the operated cat present in the 3rd, 4th, and 6th layers about the alterations as mentioned before in the gyr-splenalis. The principal anomalies are shown by the lamina ganglionaris (V). Photogram 4 represents this layer (normal) more highly magnified; it is easy to identify in this figure several of the cells of fig. 3. The infragranular pyramidal cells are visible in an almost diagonal line from left to right.

In an almost similar way these elements are situated in figure 5, taken from a corresponding section through the operated brain. It is evident that the cells mentioned in the latter have decreased in number; the few that are visible are of a well-known, abnormal type with regard to their dark blue colour, the absence of a distinct nucleus and the nodosity of their surfaces. The supragranular pyramidal cells on the same photo form a pregnant contrast to the infragranular ones, as they have on the whole quite a normal appearance. The non-pyramidal infragranular cells in the fifth layer are doubtlessly less numerous than they should be; histological alterations cannot be demonstrated with sufficient certainty. The nerve cells of the lamina multiformis VI lie apparently closer together than in the normal preparations; their protoplasm has mostly been stained

1) See: E. DE VRIES: Exper. Untersuch. ü. die Rolle der Neurol. etc. Arbeiten aus v. MONAKOW's Institut 1909.

2) More frontally, in the transverse level of the splen. corp. callosi, many of the infragranular pyramidal cells in the gyr. ectolat. are of an uncommonly large size.

too homogeneous. A loss of cells does not seem to have taken place here.

Rabbit N°. 11. 26th. Oct. 1909.

Sagittal division of the frontal third of the corpus callosum. The animal, after awakening from the narcose, showed no other abnormality than a very insufficient, and often totally absent, eye-lid reflex on sudden light.

It was killed on November 9th. 1909. Besides the intended lesion the right thalamus opticus in its dorsal part is slightly injured. The left half of the cerebrum is quite uninjured, and stained with toluidine blue after paraffine imbedding; the right one was examined by MARCHI's method. The latter does not furnish any important data on the subject dealt with. The blackened granules of the degenerated myeline sheaths are very fine, and not to be traced with sufficient certainty beyond the deepest cortex layers.

The cortex of the rodentia shows several features very different from those of carnivorous animals. Through the whole neopallium at least the half of all the nerve cells are of a vesicular character, even in the regions where the lamination is quite clear. These more or less round cells have a large, bright nucleus, with a deeply stained nucleolus, and very little protoplasm. They fill out almost completely the 2nd.[1]), 4th., and 6th. layers. The so-called gigantopyramidal cells of BRODMANN's area 4 (motor zone) are not confined to the fifth layer, but intermingle with the more superficial layers; a distinct lamina granularis interna cannot be spoken of, as has been pointed out by BRODMANN. The right corner of fig. 6 shows the condition described; the photo is taken from a transverse section in the most frontal level where the corpus callosum fibres pass from right to left (see diagram 6a). Immediately on the lateral border of the most distal point of the gigantopyramidal zone a cortex field appears, which shows the six typical layers in a very characteristic way. The difference mentioned between the constituents of the 2nd., 4th., and broad 6th. layers on the one side, and those of the 3rd. and 5th. on the other, is obvious.

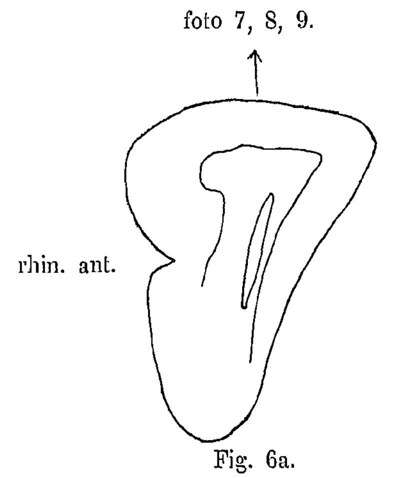

Fig. 6a.

A part of the same section is represented in figure 7 more highly magnified. The photogram has been cut immediately beneath lamina V.

1) Where it is present.

Apart from the difference of all the layers from those in figure 8 (the corresponding section of the brain operated upon) which is due to a somewhat horizontally inclined plane of cutting, it is clear that in both preparations laminae I to IV do not show any considerable divergences. The nerve cells of the third layer are well shaped, their dendrites can often be easily traced to the periphery. The so-called granular cells of the 4th. layer are of the common, above-described character; I was not able to detect in either of these laminae an unusual number or position of glia-elements.

The infra-granular pyramidal cells of the 5th layer in fig. 8, on the contrary, appear to have undergone important alterations. Their number is decidedly smaller than in fig. 7. The elements themselves have, for the greater part, lost their ordinary shapes and seem to be absolutely structureless clumps of protoplasm. The confirmation of the pathological value of this anatomical finding is given by the comparison with the well-shaped nerve cells of the 3rd layer. Gliaproliferation does not seem to be present; nor do the preparations permit exactly of demonstrating changes in the intracellular position of nuclei. Except in three or four of the infragranular pyramidal cells, the normally visible peripheral dendrite has not been coloured.

The question whether these changes are of a temporary nature or not cannot be decided; in any case, according to my experience gained in other experiments, the first alternative is for a number of the injured cells the most probable. In lamina VI, which is almost entirely represented in fig. 8, I could not state changes with sufficient certainty.

The above-mentioned peculiarity of the so-called motor area (zone 4 BRODMANN) with regard to its lamination, makes a conclusion on cell-changes, and especially on a loss of cells in this region difficult. Practically it is impossible to discern the "giganto-pyramides" of the rabbit from the other cells of the same size and shape, which are scattered among them. Up till now I have not succeeded in keeping rabbits alive long enough after the section of the bulbar pyramid, which would cause the more or less complete degeneration of the "giganto-pyramid" cells. The sagittal division of the corpus callosum having possibly brought to degeneration other elements in the same area would, by a comparison with the results obtained from the first-mentioned operation, permit an exact indication of the cells connected with callosal fibres exclusively. Hitherto I have not been able to draw any conclusion beyond the statement that the pyramidal cells *in toto* have apparently decreased in number.

Fig. 1.

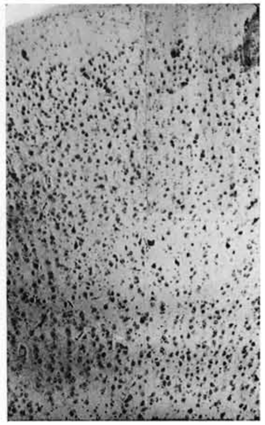

Fig. 3.

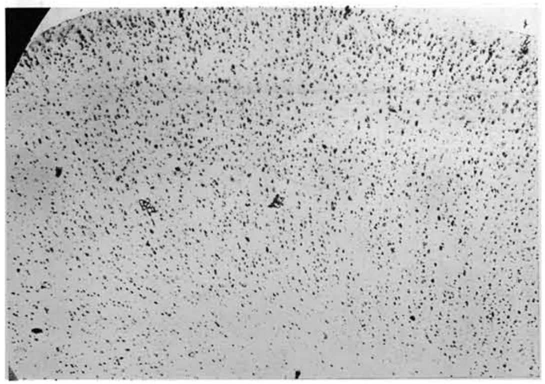

Fig. 2.

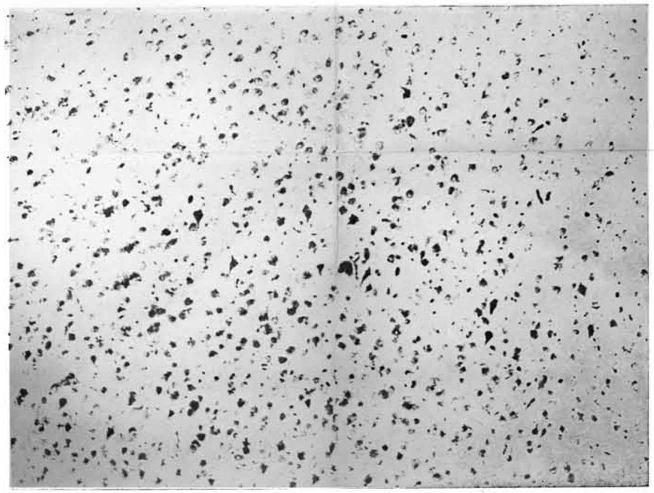

Fig. 4.

Rabbit 16. Nov. 16th, 1909.

It seems *a priori* probable that the extirpation of a part of the neocortex will cause in the opposite hemisphere changes of the same nature as are brought about by section of the corpus callosum. In order to verify this presumption the frontal quarter of the lateral wall of the right hemisphere was extirpated, including the region, slight faradic stimulation of which caused movements on the crossed side (facialis and jaw; the fore-leg reacted only slightly). The region thus roughly defined was well extirpated (i.e. the knife was inserted a little more distally). After the narcose the left eye-slit was 1.5 mm. larger than the right one; the left fore-foot did not react on an unusual position being given to it (dorsum manus on the ground), while the right fore-foot did so immediately.

By the next day these symptoms had disappeared. The animal was quite normal and died of enteritis in the night between 10th and 11th December, having thus lived 24 days. The anterior half of the left hemisphere was treated by Nissl's method, when it appeared that the injury was confined to the region described above.

Owing to the circumstance of the animal having been dead for some hours and having suffered from an infectious disease, some caution must be exercised in judging of the colouring results, and only such as are independent of the more specified reaction of the cells on the colouring matter should be accepted. A few seemingly misformed, badly coloured, or almost colourless cells should not be regarded. Even taking this into account, however, there is nevertheless a distinct alteration visible in the fifth layer, which with regard to the nature of the remaining cells does not appear to differ from the conditions in the case of the previous rabbit.

There are, however, more cells which are well coloured[1]), and moreover the coloured ones are not confined to the immediate proximity of lamina IV, but also occur, though in less number, on the boundary of the 6th layer.

As was stated above in the case of Cat N°. 3, the operator's knife had come in contact not only with the callosum, but also with the underlying *psalterium*-fibres. The cell changes which would probably be the result of this lesion must be sought for in the ammon's horn.

There the well-known, large pyramidal cells are indeed altered partly in a characteristic way. While a great number of them (on the left side of the arrow in fig. 10) are quite normal in form and structure, as

1) A study of the whole series is needed to judge of this.

2*

can be seen in fig. 11 (the same preparation more highly magnified) the cells to the right of the arrow exhibit abnormalities clearly shown by fig. 12. Normal Ammon's pyramid-cells both of cat and rabbit (in the case of the former they are of larger size) colour well with toluidine blue; the type is polygonal, with slightly rounded corners. The nucleus is large, and tinted very slightly or not at all with blue; the nucleolus is darkblue [1]).

If these be compared with the cells of the right half of the Ammon's horn of fig. 10, as they are represented highly magnified in fig. 12, hardly a single cell will be seen with a nucleus visible; the protoplasm of the cells is homogeneous and dark in colour. Almost all the cells have heavy coarse neurones; a few have the characteristic appearance of injured ganglion cells. It is remarkable that affected and unaffected cells do not occur together in the same sagittal region, or only in a slight degree; the two regions may practically be divided by a line. The boundaries are so clear as to be immediately noticeable, even in VAN GIESON preparations. I shall not quote as an example of this the left Ammon's horn of cat N°. 3, as the objection might be put forward that the hemisphere of this side had been primarily injured. But in the case of a rabbit, where the most caudal part of the callosum together with the underlying fibres [2]), the psalterium, had been touched, the same thing is very apparent in VAN GIESON preparations. The exact division between affected and unaffected cells I hope to give later.

The other elements of the cornu Ammonis — the fascia dentata cells — were found to be unaltered, as were also the ammon-pyramids in a more ventral position in cat 3. The rabbit above-mentioned showed, in connection with the abnormal relative position of the Ammon's formation in rodentia as compared to carnivora — the distribution of the cells somewhat otherwise; in principle this makes no difference.

In judging the results of experiments like the above, one ought, in my opinion, to take up the position already given by VON GUDDEN. A cell, which degenerates after cutting of an axis-cylinder, gives origin to that axis-cylinder. The wider interpretation given to the degenerating cells, viz. that they might also be the elements to which the cut axis-cylinder leads, is in certain circumstances certainly correct, but only in the case of newborn operated animals, perhaps also in the case of some long-existing lesions, or in a few exceptional cases

[1]) I disregard here the histological differences of the pyramidal cells distinguished by GOLGI, CAJAL, KÖLLIKER etc., which belong to the Ammon's horn.

[2]) Fornix normal on both sides.

Fig. 5.

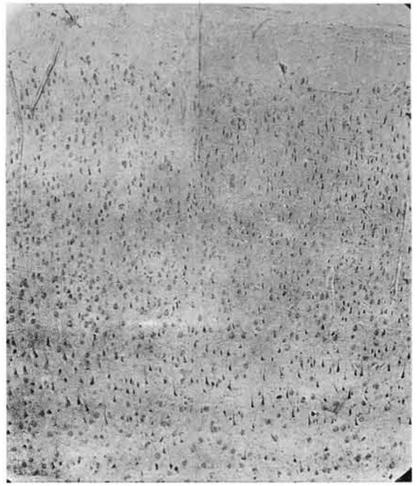

Fig. 7.

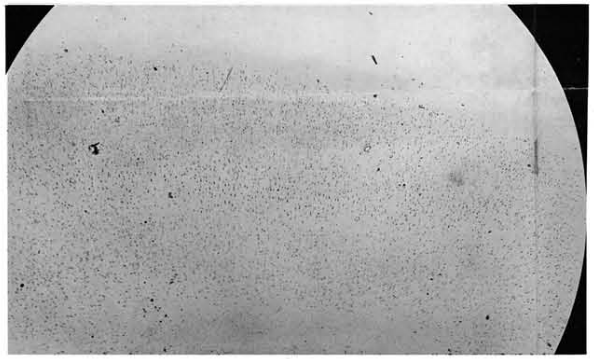

Fig. 6.

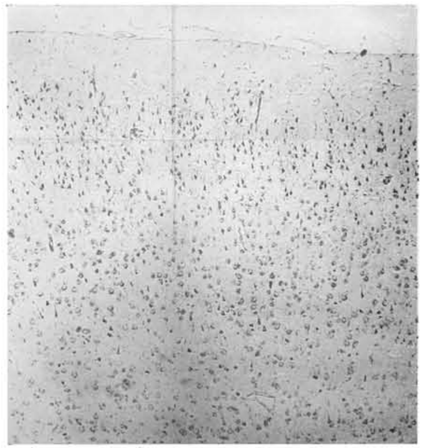

Fig. 8.

not yet to be explained more fully (cells of the nucl. ventralis acustici which degenerate after lesion of the peripheral octavus).

The method which I used in operating on full-grown animals is preferable, in so far as it, in general, leaves no room for doubt, at least about the connection between the cut fibres and the degenerating cells.

Where, moreover, the cortex cerebri, examined in series of sections, uniformly lacks cells which are present in unoperated animals, these cells must be regarded as elements of origin of cut fibres of the corpus callosum.

A second maxim in estimating the cell degeneration after cutting of the axis-cylinder is that a total even temporary "disappearance" of the cells of origin is not to be expected, when important collaterals arise between the place of the lesion and the cell of origin of the axis-cylinder. It may thus be assumed that no other cellulifugal fibres are connected with the degenerated cortex nerve cells outside the corpus callosum. The nerve cells in the cortex cerebri which cannot be made visible are confined to the subgranular pyramidal layer (lamina V BRODMANN). The only lesion which might influence the cells of the hemispheres examined by NISSL's method is, in the operation performed, exclusively the cutting of the callosum, in which the injury to the cortex might have to be included, which latter, however, could only influence by means of the callosum-elements of the side examined. The last is the case only in the operation of rabbit 16, in which animal but a part of the cortex was removed. From the above, therefore, we may deduce without doubt that the said sub-granular pyramidal cells give origin to the callosal fibres.

The examination showed, moreover, that alterations of a less serious nature occur in various layers, viz. changes in the cell-bodies themselves, — where a judgment on degeneration or approaching recovery could not be pronounced with certainty; — and further a loss of intercellular molecular matter and a massing of active glia-elements.

Experiments performed in other parts of the nervous system prove that cutting the axis-cylinders has likewise an influence on the cells of origin, when important collaterals are given off by the axis-cylinder between the place of the lesion and the mother-cell. The changes which are then met with in the cell body are of a temporary nature and disappear wholly or partially after some time [1]). This period of

[1]) It is known that the giganto-pyramids of region 4 (motor zone) disappear when the pyramid tract is previously cut. This suggests strongly that callosal fibres which begin in this region have their origin in other cells than the giganto-pyramids. I hope to be able to prove this shortly by means of other material.

reaction and regeneration varies of course according to many anatomical and physiological circumstances. It is very probable that there are cells from which a callosal fibre originates as *a collateral,* among those which are found to be injured. I am, for instance, inclined to include herein some star-shaped cells between the broadened lamina IV of the area striata, perhaps even cells from the polymorphic lamina VI. It should, however, be borne in mind that similar changes — especially the presence of glia-elements in different stages of activity — also occur where fibres and fibre-terminations have degenerated. The studying of medullary-sheath preparations, cannot fully trace the course of these last. The circumstance that a clearly heightened activity of the neuroglia cells was met with, also where there was but little to be seen of ganglia cell changes (lamina IV and even lamina III, cat), makes it probable that callosal fibres also rise as far as, or even above, the inner granular layer. That they, moreover, on their course thither, give off end-collaterals in the deeper layers V and VI, may be concluded from the same glia-position being found in similar circumstances.

As to the manner of connection of the two hemispheres, i.e. whether the callosal fibres run only between symmetrical places or whether they connect dissimilar cortical regions, no certainty could be obtained from the above experiments. Positive secondary changes in regions which were separated by the operation from the symmetrical tracts of the other hemisphere, I have not found, not even in the case of lesion of the cortex. Experiments of the latter kind are probably not delicate enough.

The results of partial cutting of the psalterium can be more easily reviewed. The only absolutely clear results were the changes in a part of the Ammon's pyramids, as described and illustrated, and which without doubt are of a temporary nature. The extremely slight glia-spreading in the secondarily-injured region is remarkable. It may be inferred from this that the psalterium, in so far as this lies between the two ammon's formations, under the caudal and medial part of the corp. call., consists of fibres which are collaterals of other fibres (fimbria, fornix). Where they end could not be determined by my experiments.

With regard to the course taken by the fibres of the constituents of the corpus callosum, the experiments demonstrate that this in the cat and rabbit inclines strongly towards the dorsal and dorso-lateral regions of the hemisphere.

A tapetum corp. callosi is only formed on the lateral ventricle; where the latter, moreover, also absorbs the lower horn (considered

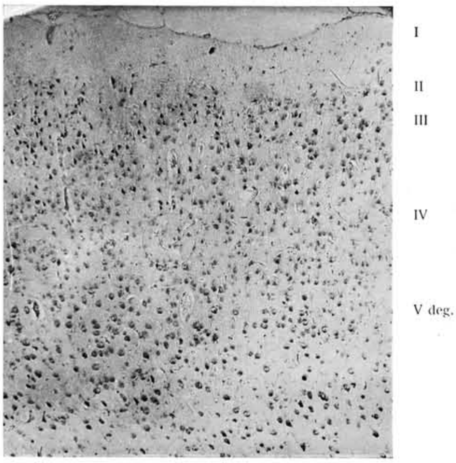

Fig. 9.

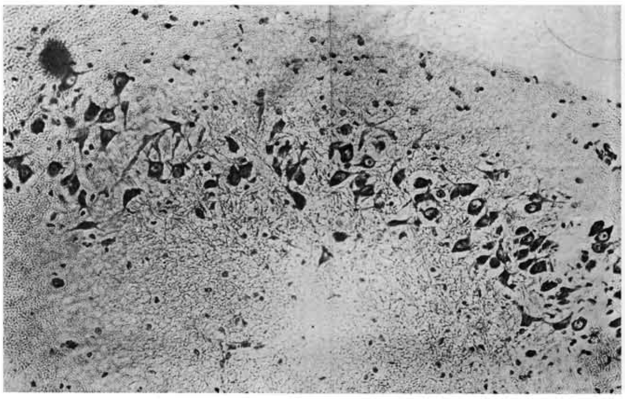

Fig. 11.

Fig. 10.

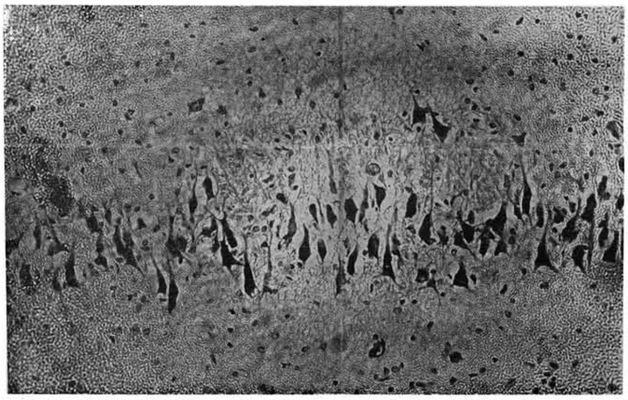

Fig. 12.

from an anthropomorphic point of view), thus forming a vertically distended slit, on the transverse section, it possesses only on its dorsolateral wall any fibre layer on the "substance subependymare" to which the name of callosal tapetum might be given.

From this point the fibres — such as have not already turned dorsally — proceed laterally. Itmay clearly be deduced therefore that, especially in the occipital region, cell changes etc. will be found after cutting of the corpus callosum, chiefly or solely in the dorsal (medial and lateral) portions of the cortex. The fact that I took my examples exclusively from these convolutions or tracts is due to the circumstance that the secondary abnormalities in the ventral cortical regions could not be shown at all, or with any degree of clearness.

The degeneration in the *fimbria* cannot be seen in the Pal-preparations. This must be ascribed partly to the fact that the psalterium fibres, some of which must of course be degenerated in a normal state, are but slightly medullated. Their lesion is visible in VAN GIESON preparations by the too diffuse reddish colour of the fimbria.

If we consider the results from a more general point of view we must first bear in mind the fact that in all mammals three commissural systems in principle communicate between the two hemispheres of the cerebrum. Adopting the nomenclature introduced by EDINGER and ELLIOT SMITH, continued and extended by ARIENS KAPPERS [1]), we can distinguish fibres running between the two secondary olfactory regions (the *palaeopallia*): the *pars olfactoria commissurae anterioris*; fibres running between the two tertiary olfactory regions (the *archipallia* i.e. the ammon's formations): the *psalterium*; and fibres between the two cortices cerebri after deducting the above-mentioned regions (the *neopallia* i.e. which in the majority of the mammals is the larger part of the covering of the brain): *pars temporalis comm. ant.* and *corp. callosum*. The archicommissura and the callosal part of the neocommissura have been examined by my experiments.

Both are shown to originate in cells beneath the inner granular layer if KAPPER's (l. c.) theory, derived from lower animals (reptiles) on the evolution of the Ammon's formation be accepted.

These two commissura systems, moreover, have the same horizontal localisation for their place of origin as the projection systems examined in this respect, but originate as far as concerns the callosum, either

[1]) ARIENS KAPPERS und THEUNISSEN, Die Phylogenese das Rhinencephalons etc. Folia Neurobiologica, Bd. I.

not at all, or only for a part (as collateral) from the same cell elements as these, while with regard to the part of the psalterium situated under the callosum, it must be assumed that all the fibres are collaterals of the ammonal projection neurites [1]).

In a physiological respect, what has been found supplies an anatomical substratum for the closely connected, simultaneous working of both hemispheres in all functions, the inciting stimulus of which has its last and "most peripheral" cortical origin in the sub-granular layers of the cortex. On the other hand, the ending of many fibre-branches seen in higher cortical layers (in lamina III and IV) proves that the stimulus from the other side co-operates with the higher cortical preparation for the bodily function to be innervated.

Further, our results point to the probability that the neopallial commissura, the fibres of which originate for a great part in their own cells, has attained a higher degree of differentiation, independence, than the old archipallial, the functioning of which appears in every case to be connected with the working of the projection-fibres arising from the same cells.

That, moreover, among mammals with the constantly developing callosum — in a quantitative respect — there is a qualitatively greater influence of the one hemisphere on the other, is likewise very conceivable. Even in cat and rabbit it is clear that the result of callosal section can be traced to higher layers of the cortex in the former than in the latter; and these changes must be attributed to the degeneration of the callosal *endings*.

Now, whereas nothwithstanding this, with the usual methods of investigation of cats [2]), not a trace of any disturbance is to be found some time after the callosal section, we find such often very clearly in man in the case of existing foci of the c. callosum.

The corpus callosum is in man larger — also relatively — than that of any mammal. And in man also a differentiation with regard to the function of the two hemispheres is first found in mammalia.

The great functional value of the left half of the cerebrum is seen, for instance, in the fact that with foci of the anterior half of the c. callosum functional disturbances of a high order (apraxia) occur in the left side of the body, which is governed by the right

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1) How this is with respect to the pars temporalis of the anterior commissura (ventral c. callosum) will, possibly, appear from the dissertation to be made by I. DE VRIES in the Central Institute for Brain Research, which will be devoted to the cortex and commissural systems of the mouse.

2) And even in monkeys, see LÉVY—VALENSI: Le corps calleux etc. Thèse de Paris 1910.

hemisphere. Here, if anywhere, from a physiological point of view, is it clear that the endings of the c. callosum are to be found in those cortical layers in which the preinnervatory action especially takes place.

Without doubt, in the higher mammals also, where the c. callosum has been cut, symptoms of lesion must be present, temporary perhaps, but nevertheless constant. They have, however, not been discovered as yet in clinical investigation. The asymmetrical function of the cerebrum of man, added to the possibility of applying more delicate methods of investigation, bring, in the case of disturbed co-ordination of the hemispheres, irregularities to light as described by LIEPMANN, HEILBRONNER and others. That anatomy too, assists us to understand the manner of the termination of the c. callosum and especially the nature of the symptoms observed, can be assumed from what has been found in the cat. It is by no means impossible that still more complicated connections are present in man. A careful cytoarchitectonic study of the cortex cerebri, in cases where the callosal connections have been severed before death, will throw light upon this point.

Anatomy. — "*On the mesencephalic nucleus and root of the N. Trigeminus*. By Dr. C. T. VAN VALKENBURG. (Communicated by Prof. L. BOLK).

(Communicated in the meeting of March 25, 1911).

Among the brain nerve nuclei in man already known to us, the only one about the functions of which we do not know anything with certainty is the mesencephalic cell-group from which a portion of the trigeminus fibres originate. Histology, anatomy, embryology, experiments and clinical observations with pathalogical-anatomical researches, none of these have succeeded in solving the riddle of the function of this nucleus.

After a period when sensory functions were attributed to the above nucleus and root (MERKEL, WERNICKE, MEYNERT), there came a time when its motor character was universally accepted, chiefly on the base of experiments in degeneration (FOREL, BREGMAN, H. v. GUDDEN, SCHUZO-KURE), but partly also owing to histological research (KÖLLIKER, CAJAL etc.), while of late the sensory nature of these cells and the afferent character of their neurones has again found considerable support (JOHNSTON, v. LONDEN).

This being the case, it may be expected *a priori* that the opinions