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Hermann Dexler's "Beiträge zur Kenntnis des feineren Baues des Zentralnervensystems der Ungulaten." [1] An Annotated English Translation of the Original German Article

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Part V: Telencephalon – Adult Stages

(with Dexler's Figures 25-46)

Abstract

Dexler confirms and further elaborates the basic pattern of sulci that he described earlier in the foetal brain (see Part IV of the English translation). He gives a detailed description of the sulci on the hemisphere's medial, dorsal, lateral and ventral surfaces, i.e., among others, the Fissura callosomarginalis, Fissura lateralis (and the associated Fissura ento- and ectolateralis), Fissura suprasylvia, ectosylvia, diagonalis, Fissura longitudinalis lobi pyriformis. The Fissura Sylvii and the Fissura cruciata are described as being very variable in their locations and appearance. Dexler also focuses on some sulci that he classifies as inconstant. Moreover, the number and variations in the secondary grooves are so plentiful that it is very difficult to recognise the basic pattern of grooves. Both the constant and the inconstant sulci are discussed with regard to the literature at hand.

Despite the problems caused by the distinct heterogeneity of the sulci, Dexler puts a great deal of effort into elaborating a survey of the corresponding gyri. These are described and discussed with regard to comparative phylogenetic classifications. Again (see also Part IV), he rejects the attempts of other authors to adopt the principle pattern of the four arched convolutions of carnivores; he considers them as forced and of limited value in horses because such a procedure requires the acceptance of certain exceptions, like, for example, (1) a total reduction in size of the rostral portions of the third and fourth arched convolution, (2) the enormous enlargement and elongation of the second arch of the primal convolutions, and (3) a marked reduction in size of the first arch during development.

The descriptions of the telencephalon's nuclei and white matter provide substantial information on, for example, the Nucleus caudatus, amygdalae, lentiformis, Cornu ammonis, Fornix, and Corpus callosum, Tractus olfactorius. The comprehensive description of the ventricular system completes this final part of Dexler's article.

Keywords: Brain, Horse, Sulcus, Gyrus, Schematisation

[1] first published in: Gegenbaurs Morphologisches Jahrbuch **32**, pp. 288-389 (1904)

Introduction

Part I of the English translation comprised the first pages (i.e., pages 288-290) of Dexler's article presenting his general remarks on the problems and challenges of neuroanatomical descriptions of the brain. Part II (i.e., pages 290-322) dealt with the Rhombencephalon. Part III (i.e., pages 322-333) focussed on the Mesencephalon and the Diencephalon. Part IV (i.e., pages 333-347) referred to the Telencephalon in general and to that of Foetal Stages in particular.

Technical Notes: This English translation does not aim to transfer the characteristic rhetorical style of early 20th century German language into idiomatic English. Rather, it attempts to present Dexler's anatomical descriptions, interpretations and discussion in plain modern English. Dexler's personal rhetorical style has been maintained whenever necessary in order not to omit relevant information. Whenever any German wording or term could not be appropriately translated into adequate contemporary English, the text or a footnote presents the *German words in italics* together with equivalent English synonyms and/or relevant explanations, or the term is replaced by the current version according to the Nomina Anatomica Veterinaria [N.A.V.] (2017). Dexler's Latin nomenclature has been maintained in the text, even though it does not always conform to the current version of the N.A.V..

Dexler's original article contained only a small number of keywords that indicated a thematic division of the text; there were no true chapter headings. The following short list of topics has been compiled in order to give the readers of this translation at least a brief overview beforehand for better orientation (not all of them are headings that can be found in the text):

Contributions to the Knowledge of the Fine Structure of the Central Nervous System of Ungulates

By Prof. Hermann Dexler
(From the Veterinary Institute of the k.k.[2] German University in Prague)

Part V now continues with page 347 of the original article and completes the translation.

ADULT HORSE

In the brain of ADULT HORSES, the definite arrangement of the previously described features[3] becomes so complicated that we are bound to submit it to a special examination. Prior to this I would like to mention that all of the data from my own observation are derived from far more than forty hemispheres of horses suitable for the respective investigations. That is to say that their usability was not always the same. Quite often (particularly in brains of older animals and of those who had suffered from an acquired hydrocephalus) one could see such a firm apposition and adhesion of gyri that it was impossible to separate them. Such specimens, of course, had to be left aside because a mere superficial drawing of the cortical surface pattern was not sufficient. The examinations of the suitable brains were performed either in their fresh states or after fixation (formalin; chromium compound/chromate[4]). The depth of some grooves was verified in two series of sections (WEIGERT's stain).

THE HEMISPHERE'S MEDIAL SURFACE

The SULCUS CORPORIS CALLOSI is deepest next to the middle of the Corpus callosum. Its rostral end disappears exactly ventral to the Rostrum corporis callosi. From its caudal end, a groove branches off, separates the Gyrus callosus[5] from the Isthmus gyri fornicati[6], and then joins ventro-laterally with the Fissura hippocampi. Sometimes, it is separated by the next peripheral groove; this is the FISSURA SUBLIMBICA, which is located barely 5 mm from the Sulcus corporis callosi; the middle part of the Fissura sublimbica is often faded. Its rostral part forms an independent FISSURA SUBLIMBICA ANTERIOR seu ENTOGENUALIS, while the portion encircling the Splenium corporis callosi is the FISSURA SUBLIMBICA POSTERIOR seu ENTOSPLENIALIS.

[2] *k.k.:* imperial and royal (Austrian and Hungarian)
[3] in Part IV of this translation
[4] not specified; probably Müller's or Zenker's solution
[5] *Balkenwindung*: see Figure 36; Gyrus callosus is not a term of the N.A.V. (WORLD ASSOCIATION OF VETERINARY ANATOMISTS, 2017), but it is used and illustrated in neuroanatomical textbooks like, e.g., BÖHME (2004)
[6] not a term of the current N.A.V.; Gyrus fornicatus = Gyrus cinguli

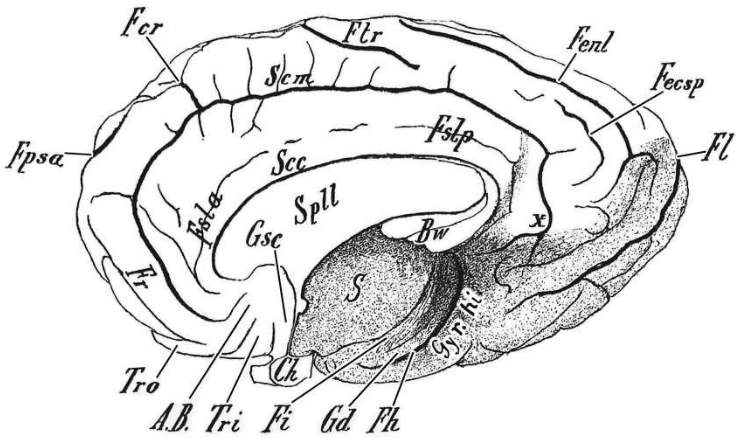

Fig. 25. Map of the cerebral sulci of an adult horse; medial view, half its natural size.

AB Area Brocae; **Bw** *Balkenwindung*, Gyrus callosus; **Ch** Chiasma opticum (cut in the median plane); **Fcr** Fissura cruciata; **Fecsp** Fissura ectosplenialis; **Fenl** Fissura entolateralis; **Fi** Fimbria; **Fh** Fissura hippocampi; **Fl** Fissura lateralis; **Fpsa** Fissura praesylvia anterior; **Fr** Fissura rostralis; **Fsla** Fissura sublimbica anterior; **Fslp** Fissura sublimbica posterior; **Ftr** Fissura transversa; **Gd** Gyrus dentatus; **Gsc** Gyrus subcallosus; **Gyr hi** Gyrus hippocampi; **Spll** Septum pellucidum; **S** Sectional area where the Diencephalon was cut in order to remove the brain stem; **Scc** Sulcus corporis callosi; **Scm** Sulcus callosomarginalis; **Tri** Trigonum olfactorium; **Tro** Tractus olfactorius; **x** Adhesion between the hemispheres.

Peripherally, 2 cm from the Rostrum corporis callosi and barely 1 cm from the Splenium corpus callosi, a third coronal fissure extends, i.e., the very deep FISSURA CALLOSOMARGINALIS[7] sive FISSURA SPLENIALIS. Like both the aforementioned fissures, it too begins far rostrally at the flat area ventral to the Genu corporis callosi and ends caudally, in a typical manner, with a bifurcation at the hemisphere's impression facing the Lamina quadrigemina. Its rostral part is often also accompanied by a short groove running parallel to the Pallium's border, i.e., the FISSURA ROSTRALIS. It begins ventro-rostrally, rostral to the Fissura callosomarginalis and its furcating end cuts into the Pallium's border; in many cases it is missing or is only vaguely indicated by a series of shallow notches.

The area between these three grooves is often crossed by many little depressions in the cortex. Also, from the convexity of the Fissura callosomarginalis plenty of short ramifications of grooves extend in radial directions towards the Pallium's border. One among these is important and easy to detect as it ascends from the caudal third in an oblique, dorsal direction, cutting the Pallium's Margo dorsalis [dorsomedialis] and extending to the hemisphere's dorsal surface to reach the Fissura suprasylvia. It is the medial branch of SCHELLENBERG's FISSURA TRANSVERSA; FLATAU and JACOBSEN regard it as a side branch which extends to the Fissura cruciata, while FORGEOT and LÈSBRE regard it as the Fissura cruciata accessoria; ELLENBERGER, according to his drawings, assigns it to the Fissura cruciata; the same is true for BRADLEY, KRUEG and his successors.

[7] Fissura callosomarginalis: named Sulcus callosomarginalis in Fig. 25

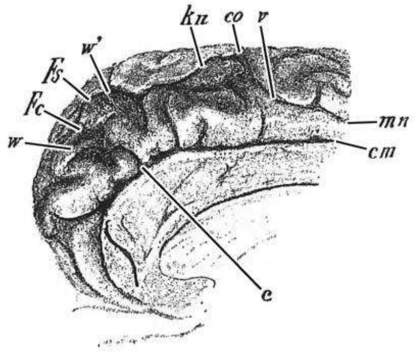

Fig. 26. Variations of the Fissura cruciata in horses; medio-dorsal view, three-fifths of its natural size.

c Insertion of the Fissura cruciata at the Fissura callosomarginalis (cm); **cm** Fissura callosomarginalis; it becomes very deep in the area where the Fissura cruciata (Fc) joins; **co** Junction of the Fissura transversa (mn) with the Fissura suprasylvia (Fs); **Fc** Fissura cruciata; **Fs** Fissura suprasylvia; **kn** *Kantennähe* (Proximity to the Border) of the Fissura suprasylvia; **mn** Fissura transversa; **v** Confluence of the ascending branch of the Fissura transversa with the horizontal branch of the Fissura transversa; **w, w'** Sigmoid-like agglomeration of gyri.

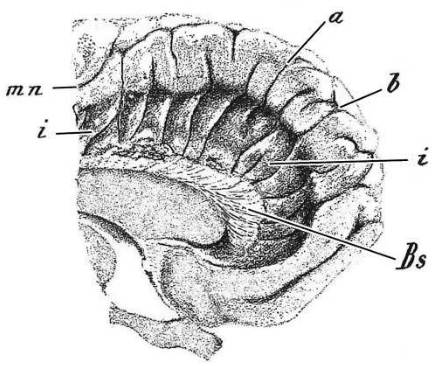

Fig. 27. Plucked specimen (*Abfaserungspräparat*).

a Radial groove that would appear as the Fissura cruciata in the intact brain if one considered its location; it is shallow and disappears soon after entering the Fissura callosomarginalis; **b** Radial groove that is much deeper and longer than (a) and hence has to be regarded as the Fissura cruciata, even though it appears to be located far more rostrally; **Bs** *Balkenstrahlung*, Radiatio corporis callosi; **i** Lateral wall of the Fissura callosomarginalis after breaking off the Gyrus cinguli; **mn** Medial branch of the Fissura transversa.

SCHELLENBERG refers to a branch cutting into the Pallium's Margo dorsalis almost in its rostral third and ending at the dorsal side after a short distance as a representation of the Fissura cruciata. Considering the comparison of findings on my own specimens of adult brains and, in particular, of the earlier mentioned foetal specimens[8], I would like support SCHELLENBERG's opinion. This Fissura cruciata is very deep in many brains; indeed, in some specimens I find what looks like a cove at the Pallium's border; it reaches 1.5 cm deep into the dorsal surface. Due to this, in contrast to SCHELLENBERG I found a formation resembling a Processus sigmoideus in more than 20% of my specimens. AND YET, I EXPLICITLY EMPHASISE THAT ONE CAN FIND THE SAME NUMBER OF HEMISPHERES IN WHICH THERE WAS DEFINITELY NO SIGN OF A FISSURA CRUCIATA. One branch after the other ascends from the Fissura callosomarginalis towards the Pallium's border and either slightly cuts the cortex, or forms only a shallow notch, or short, elongated indentations, which fade into the

[8] see Part IV of this translation

even cortical surface after a few millimetres. In many specimens, there is no delineation of a distinct Fissura cruciata. FORGEOT and LÈSBRE go even further in saying that in horses a real Fissura cruciata and, hence, a Gyrus sigmoideus does not exist; instead, however, a Fissura cruciata accessoria – i.e., our Fissura transversa – is very well developed. The assumption of a Fissura cruciata accessoria surely does not solve the problem of homologation because only a formal criterion is used here; it is not supported by ontogenetic evidence.

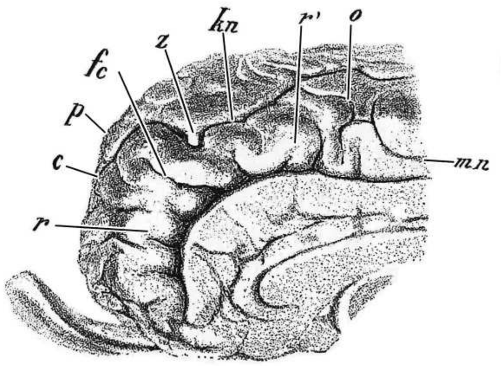

Fig. 28. [without title]

c Fissura coronalis; **fc** Fissura cruciata; **kn** *Kantennähe* (Proximity to the Border) of the Fissura suprasylvia; **mn** Fissura transversa; **o** Connection of the ascending branch of the Fissura transversa to the horizontal branch of the Fissura transversa (mn); **p** Gyrus prominens; **r, r'** Rostral part of the Gyrus marginalis that forms a sigmoid convolution around the deep and straight Fissura cruciata (Fc); **z** Dentiform process of a gyrus next to the *Kantennähe* (kn) of the Fissura suprasylvia.

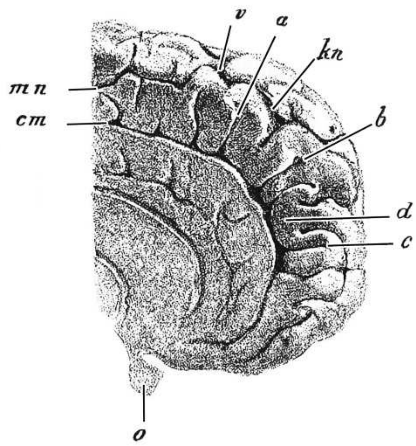

Fig. 29. [without title]

a, b, c Several radial branches of the Fissura callosomarginalis that come into consideration when a Fissura cruciata is to be identified; the deepest one of them lies ventral to the lid-like gyrus in the area where the character (**d**) has been placed; **cm** Fissura callosomarginalis; **kn** *Kantennähe* (Proximity to the Border) of the Fissura supra-sylvia; **mn** Fissura transversa; **o** Chiasma opticum; **v** Confluence of the Fissura transversa with the Fissura suprasylvia.

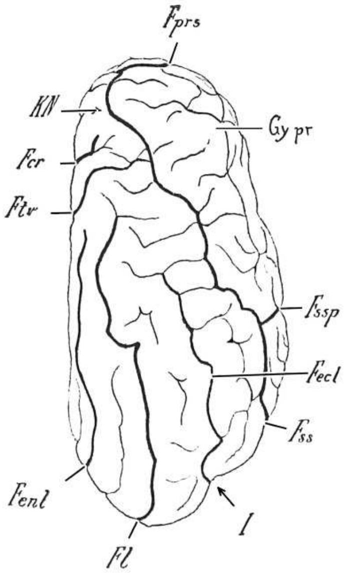

Fig. 30. Map of the cerebral sulci of an adult horse's hemisphere; dorsal view; drawn from a photograph of a brain fixed inside the Cranium; two-thirds of its natural size.

Fcr Fissura cruciata; **Fecl** Fissura ectolateralis; **Fenl** Fissura entolateralis; **Fl** Fissura lateralis; **Fprs** Fissura praesylvia; **Fss** Fissura suprasylvia; **Fssp** Fissura suprasylvia posterior; **Ftr** Fissura transversa; **Gypr** Gyrus prominens; **KN** *Kantennähe* (Proximity to the Border) of the Fissura suprasylvia; **I** The occipital brain's lateral indentation.

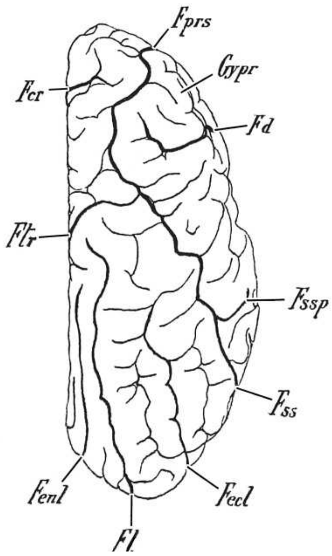

Fig. 31. Map of the cerebral sulci of an adult horse's hemisphere; dorsal view. Dissection and figure captions as in Figure 30.

The Fissura diagonalis (**Fd**) was well developed in this specimen. The Fissura suprasylvia posterior was interrupted. A groove far rostral had to be regarded as the Fissura cruciata; it was very deep and lay within an agglomeration of convolutions that was shaped like a sigmoid process; the latter pushed the Fissura suprasylvia in a lateral direction. If this groove was not assigned as the Fissura cruciata, three other radial grooves would remain (as candidates); none of these cut the medial surface of the hemisphere, but formed only (shallow) indentations.

THE DORSAL AND LATERAL SURFACES

Approximately in its middle part, the Pallium's Margo dorsalis is cut about 2 cm deep by the Fissura transversa. Due to this, the three longitudinal grooves extending from the caudal pole, namely FISSURA ENTOLATERALIS, FISSURA LATERALIS, and FISSURA ECTOLATERALIS, are terminated. This delineation becomes even more complete because (with few exceptions) the lateral branch of the Fissura transversa continues into the Fissura suprasylvia. Only once in 24 brains, and only on one side, did I find an interruption caused by a convolution inserted between these two grooves; this convolution is SCHELLENBERG's *Übergangswindung* (junctional convolution[9]) or *w*=*Windung* (convolution *w*).

[9] *Übergangswindung*: a gyrus that connects two main gyri (there is no English term to appropriately describe the German word *Übergang*; hence, the term "junctional convolution" is used)

The FISSURA ENTOLATERALIS begins with a deep bifurcation located at the border where the medial surface of the hemisphere continues into its Facies cerebellaris cerebri[10]; close to the Pallium's border, the fissure turns rostrally and, after a course of about 7 cm, it vanishes. Its most caudal part is accompanied on its way towards the Fissura callosomarginalis by a short bow of the FISSURA ECTOSPLENIALIS.

The FISSURA LATERALIS extends lateral and parallel to the Fissura entolateralis. It begins far ventrally at the middle portion of the Gyrus hippocampi, runs in a straight course towards the hemisphere's caudal pole, continues from there straight in a rostral direction towards the Fissura transversa, and ends rostral to the latter in either bifurcated or undivided.

As for the equine brain, I do not agree with FLATAU and JABOBSON's opinion (they see a rostral continuation of the Fissura lateralis into the Fissura coronalis) because I myself have never seen this. One may admit that such a connection can sometimes occur, due to the great variability in the secondary convolutions; however, this is certainly not standard.

Starting from the hemisphere's caudal pole, the Fissura lateralis is, for up to 5 cm, accompanied by a secondary groove that is also straight, but often only vaguely developed. Only lateral to this secondary groove, the FISSURA ECTOLATERALIS is located. It begins with a short bifurcation at the border where the hemisphere's Facies lateralis continues into its Facies cerebellaris, then takes a straight course and ends with a long transversal part at the level of the rostral end of the Fissura entolateralis. Usually it is also laterally accompanied by a longitudinal groove[11] or by a series of smaller grooves.

Lateral to it lies the long and deep FISSURA SUPRASYLVIA. It separates the entire hemisphere into a medial and a lateral portion. It usually originates from a 4-cm-long transverse groove, which is located at the aforementioned border between the Facies lateralis cerebri and the Facies cerebellaris cerebri and extends obliquely from dorsal to latero-ventral. From this origin, the Fissura suprasylvia ascends, taking an oblique zigzag course across the hemisphere's lateral surface until (rostral to the Fissura transversa) it approaches the Pallium's Margo dorsalis as close as 1 cm. In this position that we called "*Kantennähe*"[12], it extends 1-2 cm straight rostrally, then proceeds slightly laterally, turns ventro-caudally in a curve, and continues without any interruption into the Fissura rhinalis anterior in a positon ventral to the convolution of the Insula (*Inselwindung*). The medial part, extending along the Margo dorsalis and referred to as the "*Kantennähe*" of the Fissura

10 *Kleinhirnfläche der Hemisphäre*: Facies cerebellaris cerebri; medial surface of the hemisphere that faces the Cerebellum; this (inofficial) term is used here and throughout the rest of the translation

11 i.e., a secondary groove

12 *Kantennähe*: Proximity to the Border; here – and later in the text – Dexler uses this term to refer to the distinct part of the groove that takes a bent course close to the border (see Fig. 30)

suprasylvia, is equivalent to ELLENBERGER's FISSURA CORONALIS; the bow-like rostral end is equivalent to the FISSURA PRAESYLVIA. This entire deep groove, which can be spread to a finger's width in fresh and partly macerated[13] brains without rupturing the brain tissue in its depth, encircles the hemisphere just IN THE WAY IT IS REPORTED BY BRADLEY AND AS IT IS SCHEMATICALLY REPRESENTED IN KRUEG'S, ELLENBERGER'S AS WELL AS FORGEOT'S AND LÈSBRE'S SCHEMES; only with the difference that a more distinct separation in three parts is marked there. The striking similarity of my material to the statements of BRADLEY, KRUEG, and ELLENBERGER makes a further debate on FLATAU's and JACOBSON's scheme, which teaches that the Fissura coronalis continues as the Fissura lateralis, unnecessary. The same is true for SCHELLENBERG's scheme, which (for the sake of his *w-convolution* in ruminant brains) assumes the interruption of the Fissura suprasylvia to be standard; a reference to the photograms[14] provides sufficient proof thereof.

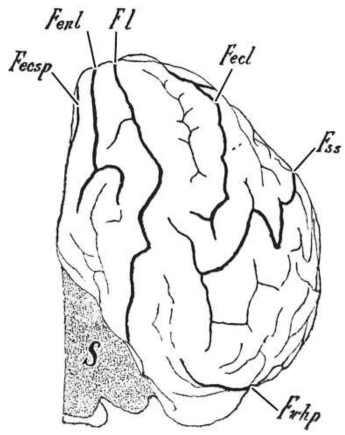

Fig. 32. Map of the sulci at the caudal pole of the right cerebral hemisphere of an adult horse; half its natural size.

Fecl Fissura ectolateralis; **Fecsp** Fissura ectospleni-alis; **Fenl** Fissura entolateralis; **Fl** Fissura lateralis; **Frhp** Fissura postrhinalis; **Fss** Fissura suprasylvia; **S** Sectional area where the Diencephalon was cut in order to remove the brain stem.

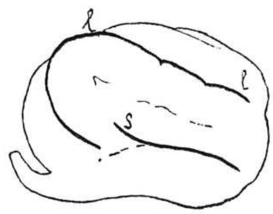

Fig. 33. Lateral surface of the cerebral hemisphere of a four-month-old equine foetus according to BRADLEY (there were no explanations for the labels "l" and "s" in Dexler's figure caption; the labelling in BRADLEY`S paper was: **l** Lateral fissure, **s** Sylvian fissure).

FORGEOT and LÈSBRE also describe the Sillon anterieur (Fissura coronalis) as the continuation of the Sillon ectosagittal (Fissura lateralis) of which they reported the continuation to be interrupted by the Fissura transversa and by the transverse gyrus accompanying it. And yet, they do not draw these two parts with the thickest line in their scheme, BUT PRECISELY THE COURSE OF THE FISSURA SUPRASYLVIA AS IT IS SHOWN IN OUR FIGURES. Their figure, which truly reflects the observation, contradicts their written explanation.

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13 *halb-mazeriert*: unclear; perhaps partly (not completely) fixated

14 *Photogramme*: blue-print drawings from photographs

I have a similar opinion concerning HOLL, who describes this fissure as anastomosing with the Fissura diagonalis (in the rostral region) and ending in the Fissura suprasylvia anterior accessoria. As an exception I saw (twice bilaterally, once unilaterally) a gyrus bridging this groove in the region of the Fissura coronalis; furthermore, the left hemisphere in ELLENBERGER's scheme seems to document such a unilateral occurrence; but, on the basis of my own findings, I cannot recognise this as being standard. The continuity of this groove is not interrupted by transverse walls lying deep within the groove. Rather, when the brain is lifted out of the water after removal of the adhesions of the Pia mater, the entire groove gapes widely and deeply. Even in older formalin-fixed specimens that have become rather rigid, it is possible to widen the entire groove; then, one can show that (occasional) small, transversally oriented parts of the convolutions (which may perhaps superficially appear to bridge over) are nothing but interdigitating processes reaching into recesses of the Fissura suprasylvia, declining everywhere right down to the bottom of the groove. In the structure of this large groove – BRADLEY calls it one of the deepest – we see a very important argument against a too far-reaching homologation of the equine brain's sulci. The Fissura lateralis of carnivores continues directly into the Fissura coronalis. This is not the case in the horse, where what we usually regard as the Fissura suprasylvia is in fact a continuation of the Fissura coronalis. It is questionable whether the homology of the Fissura suprasylvia or that of the Fissura coronalis, or both, are wrong; at least for the time being there is no substantial reason for either of these assumptions. However, it is certain that FLATAU's and JACOBSON's description of the correlation between the Fissura coronalis and the Fissura lateralis in horses cannot be kept. This conclusion results not only from my material and from ELLENBERGER's and KRUEG's depictions, but also from BRADLEY's explanation; particularly due to the continuation of the Fissura suprasylvia into the Fissura coronalis, BRADLEY wants the former to be regarded as the Fissura lateralis and, in doing so, contradicts OWEN and his successors.

Finally, one should not forget that, beginning with its first *Anlage* (Primordium) in the foetal brain, the respective groove is not composed of separate parts, but appears as a uniform structure right from the beginning.

In contrast to the relatively simple arrangements of grooves dorsal to the Fissura suprasylvia, those ventral to it are often so complicated (due to the occurrence of many atypical grooves) that a seemingly random disorder lies before our eyes. As we proceed along the already shown Fissura praesylvia towards that long dividing groove separating the Pallium from the Rhinencephalon, we delineate with its end a ventral gyrus that is as thick as a pencil; it crosses over the Lobus pyriformis and underneath the rim of the Pallium, which covers it like a lid. The border of this lid is cut by three to four short grooves; the one that makes the deepest cut is commonly regarded as the FISSURA SYLVII. In my brain specimens, I usually saw it in an oblique caudo-dorsal direction at a length of about 1 cm.

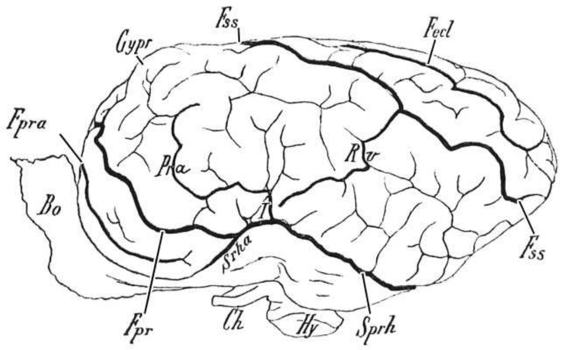

Fig. 34. Map of the cerebral sulci of an adult horse; lateral view; two-thirds of its natural size.

Bo Bulbus olfactorius; **Ch** Chiasma opticum; **Fecl** Fissura ectolateralis; **Fpr** Fissura praesylvia; **Fpra** Fissura praesylvia anterior; **Fss** Fissura suprasylvia; **Gypr** Gyrus prominens; **Hy** Hypophysis; **I** Uncovered part of the Insula; **Pra** Processus anterior fissurae Sylvii; **Rv** Fissura suprasylvia posterior; **Sprh** Fissura rhinalis posterior; **Srha** Fissura rhinalis anterior.

Lifting the cover carefully from its base, one proceeds into a deep cleft; its medial wall is partly formed by the Insula. This long and deep groove represents the rostral and caudal branches of the Fissura Sylvii; the first one, i.e., PROCESSUS ANTERIOR FISSURAE SYLVII, ascends in dorsally a wide curve from the lateral side of the frontal brain, where its end either nearly reaches the *Kantennähe* (Proximity to the Border) of the Fissura suprasylvia – KRUEG; FLATAU and JACOBSEN – or already ends much earlier – ELLENBERGER; SCHELLENBERG – ; I have specimens proving both modifications.

The PROCESSUS POSTERIOR FISSURAE SYVII extends caudally between the Pallium and the Rhinencephalon; after a short distance parallel to the lateral border of the Facies cerebellaris cerebri, it ends at the latter. When pushing the wall of this groove aside, and when breaking off the rim of the lid, one realises that the Fissura postrhinalis runs inside this cleft and is completely covered by the lid's rim and by the rim's continuation. Along its course in a caudal direction, this Fissura postrhinalis soon becomes shallow and flattens at approximately the level of the Processus mamillaris lobi pyriformis. Sometimes, it extends up to the caudal border of the hemisphere's lateral surface; indeed, even a bit beyond. In any case however, the length of the Fissura postrhinalis is always exceeded by that of the Processus posterior fissurae Sylvii enclosing it. The structure called Fissura rhinalis posterior in the common schemes of the equine brain may as well be regarded as the Processus posterior fissurae Sylvii. Medial to the exposed Fissura postrhinalis, a series of low, up to 2 cm long, palisade-like, oblique, dorso-caudally oriented parts of convolutions ascend; these are attributed to the Insula.

The ventral notches of the lid are caudally, dorsally, and rostrally encircled by some deep, mostly confluent sections of grooves which, as a whole, are equated with the FISSURA ECTOSYLVIA. Due to the disorder in their occurrence, I refrain from making a synoptic classification; in fact in many brains one can see series of grooves around one of these notches that alternatingly mark a Fissura Sylvii. The existence of a Fissura ectosylvia is without any doubt, but its association with a common arched groove is uncertain in a formal sense; genetically, its association has not yet been shown. An arcuate type was not recognisable in the shown foetal brain; and so many different courses existed in the brains of adult horses that I have to content myself in this question by referring to the schemes of ELLENBERGER and KRUEG.

Caudal to the Processus anterior fissurae Sylvii, and rostral to the homologue of the Fissura ectosylvia, there is yet another, often interrupted, sulcus extending towards the hemisphere's dorsal surface; according to KRUEG's and also SCHELLENBERG's opinion, it can be regarded as a rostral branch of the FISSURA ECTOSYLVIA; this is the FISSURA DIAGONALIS, which is explained by FLATAU and JACOBSON as being the anterior branch of the Fissura suprasylvia. I find SCHELLENBERG's statement confirmed in most of my specimens; in some others, the groove connects to all three neighbouring grooves; in others again it connects to none, so that it remains impossible to say which main sulcus it must belong to.

A groove far more constant in terms of structure is recognised in the branch descending vertically from the rostral end of the caudal third of the Fissura suprasylvia down to the rim of the lid and separating the periphery[15] of the Sylvian groove from the caudo-lateral area of the hemisphere's surface; this branch is very deep and constant and equivalent to the FISSURA SUPRASYLVIA POSTERIOR of FLATAU and JACOBSON or Ramus descendens fissurae Sylvii of HOLL. In CHAUVEAU's scheme, it appears under the inappropriate name of Fissura Rolando. Sometimes a junctional convolution[16] that is either located deep inside the groove, or lies rather superficially, separates the branch from the main convolution[17].

Finally, we have to address yet another groove far rostrally at the frontal pole, i.e., the SULCUS OLFACTORIUS. Its course is rather constant and becomes visible only after removal of the Tractus olfactorius. The Sulcus olfactorius begins where the latter fuses with the brain; it runs, single or doubled, in a dorsal direction at a distance of approximately 1 cm from the Pallium's border and ends near the Fissura cruciata. Often the Sulcus olfactorius is separated from the latter by two or three convolutions and, due to this, it is very short. Ventro-laterally, the Sulcus olfactorius joins the rostral end of the Fissura rhinalis anterior. Hereby, we have entered the border region of the cerebral hemisphere's ventral surface.

Let us remove from a partially fixated brain the brainstem as far as the borderline marking the Stria terminalis, and take a look at the hemisphere from below: We will see (Figs. 36 and 42) that the edge of the created hole is sharp at its rostral side but blunt and bulgy at its caudal side; the rostral sharp edge runs along the rostral border of the Tractus opticus; the area rostral to the sharp edge is the Rhinencephalon according to the scheme of HISS; the region that lies caudal to the thick, even bulge (Gyrus pyriformis) is the Facies cerebellaris cerebri; the latter is carved by plenty of grooves.

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[15] originally "*Umlegung*": probably a typing error; more likely: *Umgebung*, meaning vicinity, periphery, proximity

[16] *Übergangswindung*: a gyrus that connects two main gyri; see footnote 9

[17] unclear; perhaps it should read main "groove" instead of main "convolution" (meaning that the junctional convolution separates the side branch from the main groove)

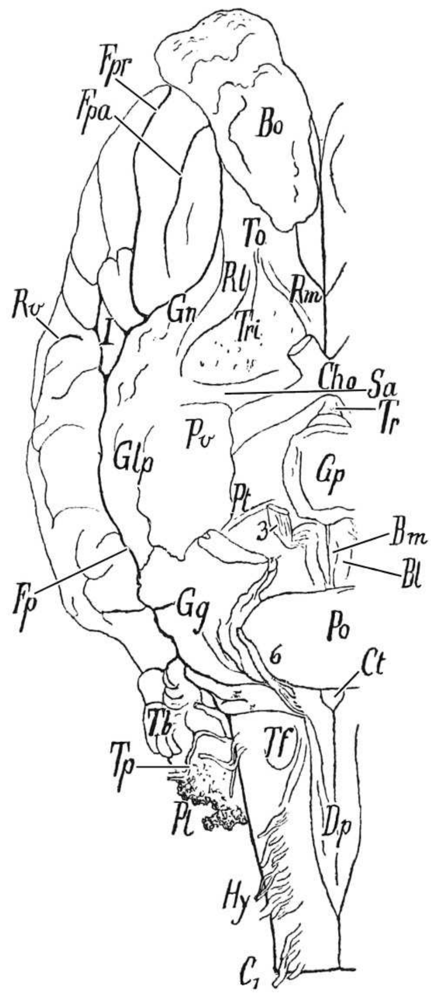

Fig. 35. The Cerebrum of an adult horse; ventral view; four-fifths of its natural size.

Bl lateral delineating bundle of the Fossa interpeduncularis; **Bm** medial delineating bundle of the Fossa interpeduncularis; **Bo** Bulbus olfactorius; **C_1** Ventral root of the first cervical segment; **Cho** Chiasma opticum; **Ct** Middle part of the Corpus trapezoideum; **Dp** Decussatio pyramidum; **Fp** Fissura postrhinalis; **Fpa** Fissura praesylvia anterior; **Fpr** Fissura praesylvia; **Gg** Ganglion Gasseri; **Glp** Sulcus longitudinalis lobi pyriformis; **Gn** Rostral process of the Lobus pyriformis; **Gp** Hypophysis; **Hy** Roots of the Nervus hypoglossus; **I** Uncovered part of the Insula; **Pl** Plexus chorioideus cerebelli; **Po** Pons; **Pt** Tractus peduncularis transversus; **Pv** Tip of the Lobus pyriformis; **Rl** Lateral olfactory root; **Rm** Medial olfactory root; **Rv** Fissura suprasylvia posterior; **Sa** Substantia perforata anterior; **Tb** "Tabulationes" of the Cerebellum; **Tf** Tuberculum faciale; **To** Tractus olfactorius; **Tp** Insertion of the Plexus chorioideus cerebelli (**Pl**); **Tr** *Trichter*, Infundibulum; **Tri** Trigonum olfactorium; **3** Nervus oculomotorius; **6** Nervus abducens.

The area of the cerebral hemisphere that faces the Cerebellum (Facies cerebellaris cerebri) is triangular and is cut by the ends of those main sulci that we have become familiar with at the medial, dorsal, and lateral surfaces. Ventrolaterally, we recognise, first of all, the end section of the Fissura longitudinalis lobi pyriformis[18]. Its lateral neighbour is the end section of the Processus posterior fissurae Sylvii[19]. Medially, another groove, i.e., the long end section of the Fissura lateralis, separates the entire area (Facies cerebellaris cerebri) into two halves[20]. Finally, the Fissura callosomarginalis and the Fissura entolateralis approach the medial border of the Facies cerebellaris cerebri[21].

Herewith, those sulci have been mentioned that are present at the Pallium's surface either regularly or at least in most of the individuals and that, as our explanations have shown, have been more or less successfully homologised with the sulci of the other mammals. Apart from these, several other grooves or complexes of grooves exist which, even though not absolutely constant, are frequently encountered.

[18] see Fig. 35, Glp
[19] see Fig. 35, Fp
[20] see Fig. 32, Fl
[21] see Fig. 25, Scm and Fenl

FLATAU and JACOBSON mention five of them.

(a) A sulcus that I have always found in foetal as well as, with many variations, in adult brains in the area delineated by the caudal part of the Fissura suprasylvia and by its ventral branch. In most cases, it consists of a longitudinal axis to which several transverse branches are added, all forming a figure that resembles the Latin letter H, or it is connected with the Fissura suprasylvia. It corresponds with the Fissura posterior of KRUEG (Fissura obliqua).

(b) A longitudinal groove lateral to the Fissura lateralis, either single or doubled, sometimes composed of a series of shorter parts; a lateral, parallel groove accompanying the Fissura ectolateralis is no less constant.

(c) Several branches of grooves appear in-between the Fissura coronalis and the Fissura diagonalis; they can be grouped to a linear or a stellate arrangement.

(d) The authors point out a deep, closed sulcus between the Fissura coronalis and the Margo dorsalis; it reaches over to the medial surface, but does not reach the Fissura callosomarginalis; the authors are probably referring to the Fissura cruciata of SCHELLENBERG.

(e) Two short grooves between the Fissura praesylvia and the Fissura rhinalis anterior. I could not find a special constancy in their occurrence.

Far more often one encounters a uniform sulcus that originates close to the ventral part of the Fissura praesylvia; it bends obliquely across the frontal pole towards the Pallium's border where it often joins the Fissura cruciata or, rostral to the latter, cuts the border and then ends, often in a bifurcated manner. This is the FISSURA PRAESYLVIA ANTERIOR (Sulcus supraolfactorius according to HOLL; Fissura infraorbitalis[22] according to BRADLEY); it may be regarded as one of the Sulci praesylvii lateroventralis of MARTIN.

I would like to mention another groove that I repeatedly saw at the Facies cerebellaris cerebri in a position medial to the Fissura lateralis. Parallel with the latter, it ran from the caudal edge of the hemisphere to the Gyrus hippocampi; it was often completely isolated, but equally often it joined the Fissura callosomarginalis, Fissura ectosplenialis, and Fissura entolateralis[23], so that it can be regarded as a groove originating from the unification of the ventral branches[24] of these respective grooves.

Although it has repeatedly been pointed out, I would like to reiterate that the number of possible variations, which are plentiful already among some main grooves (Fissura cruciata, coronalis, diagonalis, olfactoria, and so forth), is much higher again in the secondary grooves. Due to this, one hardly ever finds two identical patterns of grooves (apart from the very basic features), not even when a large number of specimens are examined. The principle pattern of grooves can be

[22] infraorbitalis: erratum because Bradley wrote "t" (intraorbitalis)

[23] see Fig. 25

[24] *Fußbügel*: the basal (ventral) section of a groove

elaborated with some accuracy only by examining several hemispheres. The main grooves (with the exception of the Fissura cruciata and the Fissura Sylvii) will always be easy to detect. But as for all the other grooves, we must be prepared not to be able to demonstrate two or more of them when examining a randomly chosen equine brain.

This explains why the ORGANISATION OF THE GYRI is even more complicated and not as obvious as claimed by some authors who did not go further into the matter. FLATAU and JACOBSEN characterise the convolutions as atypical and unclear when comparing them with those of the carnivore's brain; but, according to these authors, the designations of the convolutions conform to the primal convolutions[25] and, hence, they do not need a particular description. SCHELLENBERG agrees that no special description is necessary, but shares HOLL's opinion that the principle types of convolutions can easily be recognised (despite some difficulties) in ungulates (i.e., also in horses). And yet, he feels prompted to create three new frontal convolutions for strictly formal reasons in order to somewhat clarify the confusion in the arrangement of the convolutions. He finds a junctional convolution between the second and third primal convolution and describes the third one as being cut rostrally by the Fissura transversa, which is NOT the case in carnivores. According to HOLL, the hitherto assumption of a first arched convolution is wrong, and we have to designate it as the Insula. When such widely varying views have developed among authors even in such elementary matters, a very special light is shed on the often claimed easy transfer of the cortical pattern of carnivores to that of the horse; the extremely different interpretations of the main sulci (Fissura Rolando: CHAUVEAU; Fissura cruciata: MARTIN; Fissura Sylvii: HOLL; Fissura lateralis: BRADLEY; et cetera) support this view.

If we want the designation of the gyri to conform to that of the carnivore's brain, we have to consider:

(I) A GYRUS SYLVIACUS. Often, it is a meandering bulge of which the position is difficult to determine because the position of the Fissura Sylvia[26] is not always certain. In general, we have to localise it in the vicinity of the Fissura Sylvia and we have to keep in mind that it can lie dorsal, caudal, or rostral to it. Sometimes, it is a horseshoe-shaped bow that is arranged around the Fissura Sylvia. HOLL calls it Gyrus suprainsularis.

(II) The Gyrus ectosylvius can sometimes be bow-shaped, but it is better described as a dumbbell-shaped convolution. The clearly delineable, narrow part of the dumbbell may be recognised as the Gyrus ectosylvius medius between the Fissura ectosylvia and the middle part of the Fissura suprasylvia. In a rostral direction, the Gyrus ectosylvius anterior follows; it is the large convolution encircled by the Fissura praesylvia and by the Fissura coronalis; it is cut into multiple times

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[25] *Urwindungen*: primal convolutions

[26] i.e., synonym of Fissura Sylvii; sometimes Dexler writes Fissura Sylvia, sometimes Fissura sylvia

by the Fissura diagonalis, by the Processus anterior fissurae Sylvii, and by several secondary grooves.

Caudally, a large quadrangular agglomeration of convolutions is attached to the handle of the afore-mentioned dumbbell; it is delineated by the Fissura suprasylvia posterior of FLATAU and JACOBSON, by the caudal part of the Fissura suprasylvia, and by the Processus posterior fissurae Sylvii. This area of convolutions is subdivided into many parts by the alpha-gyrus of FLATAU and JACOBSON; among them, the Gyrus ectosylvius posterior of the carnivore's brain is hardly recognisable at all.

(III) The next gyrus, separated from the Pallium's border by the Fissura lateralis, is the GYRUS SUPRASYLVIUS. It consists of two convolutions the width of a thumb that merge caudally with the Gyrus hippocampi and rostrally become narrow like a wedge. They either end next to the so-called *Kantennähe* (Proximity to the Border) of the Fissura suprasylvia, or they merge with the homologue of the fourth primal gyrus; they all continue together into the labyrinth of convolutions delineated by the Fissura coronalis, Fissura praesylvia, and Fissura callosomarginalis. The joint convolution passes the *Kantennähe* of the Fissura suprasylvia not as a whole, but is usually cut into by the Fissura transversa or also by the Fissura cruciata.

(IV) If, on the other hand, (in order to respect FLATAU's and JACOBSON's description) we do not let the Fissura lateralis end at the Fissura transversa, but let it continue into the Fissura coronalis (loco citato, page 410, I[st] Volume), we would get a complete fourth primal, or marginal, convolution, i.e., the Gyrus marginalis, as is the case in the carnivore's brain. However, the third arched convolution is cut off at the junction of the Fissura lateralis with the Fissura suprasylvia and becomes the afore-mentioned wedge located between the third and fourth arched convolution. In this case, there is no separate third arched convolution in the rostral third of the hemisphere.

The impossibility of a detailed transfer of the convolution pattern from the carnivore's brain becomes most obvious in this particular part of the brain. The hemisphere of the brain of a horse is relatively narrow and long compared with the brain of a dog. In the case of uniformly well developed Gyrus fornicatus, the Gyrus ectosylvius ascends from the lateral side, so far towards the Pallium's border that this border becomes very narrow in its rostral third, i.e., in the region of the *Kantennähe* of the Fissura suprasylvia; due to this, both dorsal primal convolutions, located below, get narrower or are forced to merge. The rostral part, i.e., the genetically unclear marginal gyrus beginning at the *Kantennähe* of the Fissura suprasylvia, may be defined as the homologue to the Gyrus rectus hominis in some brains if one theoretically elongates the Sulcus olfactorius at the lateral side of the hemispheres; in other brains – I have a lot of them in my collection – this is not possible. Alternately, a doubling of the Sulcus olfactorius and its oblique embedding into the Pallium's border, together with a more pronounced development of the Fissura praesylvia anterior, causes an OBLIQUE, OFTEN EVEN A TRANSVERSE,

PARTITION OF THE FRONTAL POLE; THIS COMES CLOSE TO RESEMBLING THE SCHEME OF SCHELLENBERG (LOCO CITATO, FIGURE 16) AND MATCHES THE USUAL DESIGN. In addition to this, however, many exceptions occur; I would like to make special reference to one of the more frequent ones: The marginal gyrus splits slightly rostral to the *Kantennähe* of the Fissura suprasylvia to form two agglomerations of convolutions, which are separated by a deep, oblique or strictly vertical groove at the far frontal pole; the lateral part, as the seeming continuation of the marginal gyrus, turns in a curve in a ventro-caudal direction towards the Fissura rhinalis anterior; the medial part is wedged against the medial side of the frontal pole. Ventrally, both convolutions are in most cases connected by one or two transverse convolutions that bridge the root of the Bulbus olfactorius. The (above-mentioned) separating groove varies in terms of length and connections. With its dorsal end, it either cuts into the Pallium's border rostral to the Fissura cruciata or it directly connects to the latter. On the groove's other side, its ventral end extends towards the Sulcus olfactorius and joins it, or it merges with the Fissura rhinalis anterior, in this way forming a long Fissura praesylvia anterior. In any case, the positions of the regional convolutions differ. Only in a very general sense can we designate the lateral complex of convolutions as the GYRUS CORONALIS due to its topographical relationship with the Fissura coronalis, although it does not correspond to the dog's gyrus of the same name in all its parts; the medial complex of convolutions is the GYRUS FRONTALIS. Consequently, the identification of the GYRUS RECTUS would appear extremely forced, or not possible at all. It would correspond to the most ventral part of the Gyrus frontalis, between the Fissura rostralis and the Sulcus olfactorius, while the most ventral end of the Gyrus coronalis would correspond to the Gyrus infraorbitalis[27] of BRADLEY. By the way, particularly in the case of this part of the cortex area, I regard any prolonged considerations of existing homologies as futile, as long as we do not have a more consistent series of comparable schemes at our disposal. Here, the variations are so numerable that they again support the statement that the PATTERN OF CONVOLUTIONS OF THE DOG'S BRAIN DOES NOT COMPLETELY CONFORM TO THAT OF THE HORSE'S BRAIN.

The situation is far more organised in the caudal region of the marginal gyrus that runs along the border where the hemisphere's medial and lateral surfaces meet; then, the gyrus reaches the Facies cerebellaris cerebri and either anastomoses with the Gyrus hippocampi or is sharply cut off by the groove that medially accompanies the end branch of the Fissura lateralis.

(V) The voluminous GYRUS FORNICATUS winds around the Corpus callosum. Its rostral arch lies between the Genu corporis callosi and the rostral, initial part of the Fissura callosomarginalis. Here, as the Gyrus genualis, it merges with the flat area of the hemisphere's medial wall; lying in front of the grey Lamina terminalis, this area merges ventrally with the Trigonum olfactorium and deserves closer inspection.

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[27] infraorbitalis: erratum because Bradley wrote "t" (intraorbitalis)

This area is rostrally characterised by the medial olfactory root[28] radiating inwards from a ventral direction. The medial olfactory root continues into a 5 mm wide band that runs obliquely and dorsally; this band's rostral border is very indistinct, but its caudal border is sharply delineated by a groove on either side. The rostral, often indiscernible groove is homologised with the Sulcus parolfactorius anterior of FLATAU and JACOBSON; the caudal one should be regarded as the continuation of the shallow groove that ventrally separates the Trigonum olfactorium from the olfactory root.

Slightly rostral to the Lamina terminalis, a 4 mm wide, macroscopically hardly discernible, grey and white strip extends vertically; dorsally, it reaches the ventral side of the Rostrum corporis callosi and the base of the Septum pellucidum, respectively. This is the medial continuation of the Substantia perforata anterior, i.e., the GYRUS SUBCALLOSUS, of which the rostral, weakly developed delineating groove represents the SULCUS PAROLFACTORIUS POSTERIOR.

Just below the Genu corporis callosi, the macroscopically invisible Nervi Lancisii, the Gyrus subcallosus and the medial olfactory root merge into a very flat, grey and white field that is the AREA BROCAE or Carrefour olfactif; ventrally, the Gyrus subcallosus and the medial olfactory root are located on either side of the medially bent wing of the Trigonum olfactorium.

The GYRUS CINGULI, i.e., the part of the Gyrus fornicatus dorsal to the Truncus corporis callosi, is wider at its rostral than at its caudal end; in most cases, it is divided into a dorsal and a ventral portion by the Fissura sublimbica. A flat groove runs transversally across the Gyrus cinguli next to the caudal end of the Splenium corporis callosi in a dorsal direction towards the Pallium's Margo dorsalis. It is the impression of the Recessus suprapinealis and the Sinus rectus; the latter is pushed away from the Splenium corporis callosi by the Gyrus callosus (*Balkenwindung*) and turns in a flat curve towards the Sinus sagittalis dorsalis. Directly behind this groove we often find both hemispheres firmly connected.

Between the Splenium corporis callosi and the caudal branch of the Fissura callosomarginalis, the GYRUS FORNICATUS passes through a narrow, barely 1 cm wide space, i.e., the ISTHMUS GYRI FORNICATI, and reaches the GYRUS PYRIFORMIS. The latter is large in the horse and therefore also called LOBUS PYRIFORMIS; on the Facies cerebellaris cerebri, this gyrus is delineated by a line which one can imagine to be drawn between the ends of the Fissura callosomarginalis and the Processus posterior fissurae Sylvii; this demarcation line is very important because it separates a part of the Rhinencephalon, i.e., the hippocampus (*Hippocampus-formation*), from the Pallium to which it used to be assigned.

In the area of this demarcation line, the Lobus pyriformis is connected by means of one or several convolutions to the Gyrus marginalis as well as to the Gyrus suprasylvius (PLI DE PASSAGE RÉTRO-LIMBIQUE of BROCA).

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[28] *Riechwurzel*: olfactory root, i.e., Tractus olfactorius (Stria olfactoria)

On the lateral side, it is cut into by the Fissura longitudinalis lobi pyriformis and by smaller, inconstant grooves.

In contrast to this bulgy surface, the part of the Lobus pyriformis embracing the brain stem is quite even; this is the GYRUS HIPPOCAMPI or the Subiculum cornu Ammonis.

Starting next to the Splenium corporis callosi and following the even curve of the Gyrus hippocampi in a ventro-rostral direction one can see a narrow, grey convolution extending from the medial side of the protruding ventral tip of the Lobus pyriformis and turning dorsally towards the Fissura hippocampi; it continues into two small cortical lobules (*Rindenläppchen*) that are located ventro-rostrally to the Splenium corporis callosi. This convolution, which is ventrally slightly enlarged, but dorsally narrow, is the GYRUS DENTATUS or Fascia dentata Tarini; the lobules located below the end of the Corpus callosum represent the Gyrus callosus (*Balkenwindung*). The groove between the Gyrus dentatus and the Gyrus hippocampi is the FISSURA HIPPOCAMPI. It extends beneath the Splenium corporis callosi, where it joins either the Sulcus corporis callosi or the Fissura sublimbica posterior. The vaguely hook-like bending of the Gyrus hippocampi into the Gyrus dentatus could be regarded as the UNCUS[29] which, in the horse, is visible only from a ventro-medial view. The Gyrus dentatus in the horse is only sparsely notched and carries at its rostral side the border of the white matter, i.e., the Fimbria, which dorso-rostrally becomes the caudal branch of the Fornix. Often its dorsal end is flattened and, together with the Fimbria, it forms a shallow cavity in which the Corpus geniculatum laterale lies.

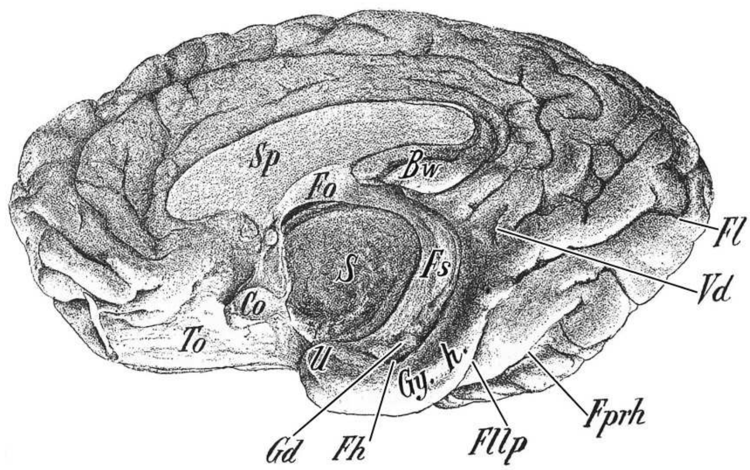

Fig. 36. Medio-ventral view of the right cerebral hemisphere of a young horse after removal of the brain stem; one-third of its natural size.

Bw *Balkenwindung*, Gyrus callosus; **Co** Chiasma opticum; **Fh** Fissura hippocampi; **Fl** Location of the bending of the Fissura lateralis; **Fllp** Caudal end of the Fissura longitudinalis lobi pyriformis; **Fo** Corpus fornicis; **Fprh** Caudal end of the Fissura postrhinalis; **Fs** Crus fornicis; **Gd** Gyrus dentatus; **Gyh** Gyrus hippocampi; **S** Sectional area in the Diencephalon; **Sp** Septum pellucidum; **To** Trigonum olfactorium; **U** Uncus; **Vd** Indentation by the Lamina quadrigemina.

29 Uncus: presently regarded as a structure characteristic for primates; the Uncus of higher primates is homologous to the Tuberculum hippocampi of other mammals; see N.A.V. (WORLD ASSOCIATION OF VETERINARY ANATOMISTS, 2017), CONSTANTINESCU and SCHALLER (2012)

The dorsal half of the arch of the Gyrus hippocampi has a flat impression that is bisected by a short groove and is caused by the Colliculus rostralis of the Lamina quadrigemina. The dorsal end of this arch does not reach the Corpus callosum, but is separated from it by the above mentioned GYRUS CALLOSUS *(Balkenwindung)*. According to SMITH and JAKOMINI, the Gyrus callosus is nothing but the modified (part of the) hippocampus that lies ventral to the Splenium corporis callosi. In the horse, the gyrus is 11.5 cm long, 7 mm wide, and club-shaped. It is divided into a dorsal and a ventral part. In many individuals, the rostral end of the latter does not continue into the dorsal part, but is separated from it by a bending of the Fissura hippocampi. Both portions join caudally and turn towards the Isthmus gyri fornicati from which they remain separated either by the Sulcus corporis callosi or by a small secondary groove accompanying the latter. After the two portions (i.e., dorsal and ventral) have joined (to form the Gyrus callosus), they rapidly get narrower, turn around the Splenium to the dorsal side of the Corpus callosum and, after some distance, become invisible to the naked eye. Yet in other cases, the Fascia dentata continues into the dorsal portion of the Gyrus callosus without any visible interruption.

The ventral portion of the Lobus pyriformis forms a 1.5 cm high protrusion at the brain's base; due to its vague resemblance to a teat it is commonly named PROCESSUS MAMILLARIS LOBI PYRIFORMIS (*Zitzenfortsatz*). Here, at its lateral side, the Lobus pyriformis shows two or more longitudinal grooves that run parallel to the Fissura postrhinalis or Processus posterior fissurae Sylvii, respectively. This is the SULCUS LONGITUDINALIS LOBI PYRIFORMIS with its secondary grooves. Rostrally, the Processus mamillaris declines rapidly towards the Rhinencephalon; laterally, it continues into the elongation of the Lobus pyriformis that runs as a 1 cm wide, 3 cm long, flat convolution along the Fissura rhinalis in a rostral direction, lying alongside the white lateral olfactory root. This elongation is the bayonet-shaped PROCESSUS NASALIS LOBI PYRIFORMIS.

If the demarcation line is not clearly formed (as occasionally occurs due to staining and fixation), the mentioned olfactory root seems to continue directly into the process of the Lobus pyriformis; in such cases, a distinction is possible only by histological means. The lateral border of the Processus nasalis lobi pyriformis is often markedly notched and grey; the adjacent olfactory root is white and even and spreads a thin layer of fibres across the grey matter of the adjacent convolution.

In order to avoid confusion with the older nomenclature, it shall be emphasised again that the Lobus pyriformis must not be regarded only as the button-shaped protrusion at the brain's ventral side in the temporal region, but it is rather the entire portion that extends ventral to the Isthmus gyri fornicati into a ventro-rostral direction and is embedded between the brain's base and the Fissura rhinalis; it extends to the Substantia perforata nasalis or continues into the lateral border of the lateral olfactory root, respectively.

According to the scheme of HISS, the structures lying rostral to it must be attributed to the proper RHINENCEPHALON. It is located rostral to the line along which the rostral border of the Tractus opticus and the Chiasma opticum attach to the brain's base. Directly rostral to this line, we find an 8 mm wide, white (or white and grey) transversal strip, i.e., the SUBSTANTIA PERFORATA NASALIS; it is perforated by many vascular foramina and continues medially into the GYRUS SUBCALLOSUS; laterally, the Substantia perforata nasalis ends where the Processus nasalis lobi pyriformis originates from the main part (i.e., the base) of the Lobus pyriformis. Rostral to it, and separated from it only by a shallow groove, lies the TRIGONUM OLFACTORIUM. It forms a flat, spherical protrusion with a grey surface pitted by several vascular foramina; its outline is triangular. The longest side of this triangle forms the demarcating groove towards the Substantia perforata nasalis; the shortest grove (line of the triangle) forms the demarcation towards the lateral olfactory root; the middle one delineates the medial olfactory root; the Trigonum is sandwiched between them. The medial tip of the triangle bends towards the hemisphere's medial surface. The LATERAL OLFACTORY ROOT is laterally delineated by a shallow groove which separates it from the tip of the rostral process of the Lobus pyriformis; the groove contains a large vein. There is also a shallow groove between the medial side of the lateral olfactory root and the Trigonum olfactorium; it ends in the region of the Substantia perforata anterior[30].

The MEDIAL OLFACTORY ROOT is medially separated from the adjacent cortical area by the shallow SULCUS PAROLFACTORIUS; laterally, an equally shallow groove separates it from the Trigonum olfactorium. Rostrally, next to the junction of both olfactory roots, one can clearly see very fine, wavy, white fibre bundles emerging from the Tractus olfactorius and vanishing into the grey surface of the Trigonum olfactorium. One can regard them as an indication of a THIRD OLFACTORY ROOT.

The 1 cm wide and flat Tractus olfactorius emerges from where the olfactory roots join; the large olfactory bulb is placed onto it as the end organ. The BULBI OLFACTORII are 1.5 cm wide and 4.5 cm long in horses. Their white wall, composed of the fibres of the Tractus olfactorius and of the Pars olfactoria commissurae nasalis, surrounds a spacious cavity like a stiff-walled sack. This lymphatic chamber[31] is connected to the cerebrum's lateral ventricles by a narrow canal passing through the Tractus olfactorius. The ventral side of the Bulbus olfactorius carries a 2 mm thick, brush-like, grey cover composed of the layer of the Fila olfactoria and the underlying Stratum griseum; the cover slightly encompasses the bulb's dorsal border at the medial and lateral sides; with its blunt tip it comes as close as 1 cm to the Trigonum olfactorium.

It remains to point out some special convolutions that are outside the general scheme but are of great importance for characterising the brain surface in horses.
The most important one is the convolution of the INSULA (*Inselwindung*). As we have seen, it differentiates from the rest of the cortex at a very early developmental stage.

[30] sometimes Dexler writes Substantia perforata nasalis, sometimes Substantia perforata anterior

[31] *Lymphraum*: lymphatic chamber (lymph: Liquor cerebrospinalis)

We have learned already when explaining the convolution scheme that, beginning at the Fossa sylvia, one can spread a cleft at the hemisphere's lateral side; this cleft is equivalent to the rostral and caudal branches of the Fissura Sylvii of which the dorsal border is formed by the overlapping portion of the Pallium that we call OPERCULUM; if this is lifted further up or broken off, the region of the Insula is clearly visible. Laterally, it is delineated by the dorso-lateral border of the Lobus pyriformis, which is separated from the proper cortex area by the Fissura postrhinalis. Medial to this groove, the hemisphere's surface emerges like a steep, palisade-like, grooved wall; the vertically arranged bulges appear like the continuations of the convolution that runs between the Processus anterior fissurae sylviae and the Fissura praesylvia[32] and then, in a more meandering manner, reaches underneath the operculum's border. Due to its topographical relationship with the Insula, it seems appropriate to call this convolution *Inselstiel*[33] or GYRUS PRAEINSULARIS. I would like to refrain from a denomination referring to the delineating grooves because the latter are highly variable. Just underneath the border, one can see another two clearly delineated transverse bulges; one of these or both are erroneously designated as the proper Insula in older schemes. The convolutions following caudally, also covered by the operculum, are less high but wider and less clearly demarcated, and form two groups: A rostral complex placed onto the border of the Lobus pyriformis and consisting of three to four, parallel pieces 1.5 cm in length, i.e., the GYRI BREVES; and a caudal complex, which lies slightly closer to the cerebral cortex than the afore-mentioned complex. The rostral group is characterised by its very regular appearance. Its convolutions[34] branch out fan-shaped or finger-like from a ventral, smaller base, i.e., from the so-called INSULA'S POLE, in a dorsal direction.

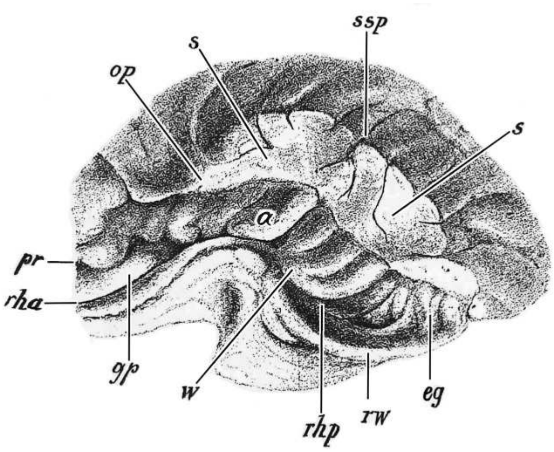

Fig. 37. Exposed area of the Insula of a young horse's hemisphere; two-thirds of its natural size.

a Uncovered part of the Insula; **eg** Caudal part of the insular cortex; **gp** Gyrus praeinsularis; **op** Rostral border of the Operculum; **pr** Fissura praesylvia; **rha** Fissura rhinalis anterior; **rhp** Bottom of the Fissura rhinalis posterior; **rw** Ventral marginal bulge of the Fissura rhinalis posterior; **s** Sectional area in the Operculum to display the Insula; **ssp** Fissura suprasylvia posterior; **w** Pole of the Insula.

[32] originally "Fissurae praesylviae": probably a typing error

[33] *Inselstiel*: insular peduncle; the handle-shaped part of the Insula

[34] literally: its rays; meaning that the convolutions have a radial arrangement

The caudal complex is far more irregular, consisting of five to eight pieces; these ascend mainly caudo-dorsally as a rope-like arrangement; yet, occasionally, they are completely absent, as FLATAU and JACOBSON reported, so that the entire field remains even. The rostral complex is homologised with the Insula in humans; the caudal one is assigned by HOLL to the superior area of the Rhinencephalon. It cannot be regarded as part of the Insula if the topographical relationship of the Insula's cortex to the Claustrum and to the Nucleus lentiformis is used as the criterion describing the Insula's outlines, as is usually done in the human brain. According to my specimens, the Insula is 1.5 cm high and 1.5 cm wide and can have two additional convolutions directed towards the caudal end, which form a kind of continuation to the afore-mentioned caudal complex. APART FROM ITS ROSTRAL PART, THE INSULA IS COMPLETELY COVERED IN THE INTACT BRAIN.

I emphasised above the apparent connection between the Insula and the insular peduncle (Gyrus praeinsularis[35]) because deep transverse grooves often interrupt the continuity to a great extent; furthermore, the entire appearance of the insula, if inspected with the naked eye, gives reason to attribute it to the Lobus pyriformis rather than to the other parts of the cortex. It should be mentioned here that a delineation of the Insula according to the area of the Claustrum does not yield satisfactory results in the horse because, as HOLL himself pointed out, the Claustrum extends beyond the Fissura rhinalis into the lateral part of the Rhinencephalon, which then, consequently, should be included in the Insula. Moreover, the Claustrum reaches so far into the frontal brain that one had to presume that there was also a proximal enlargement of the region of the Insula. Hence, one can say that the distal end of the insular peduncle (Gyrus praeinsularis), as an UNCOVERED PORTION, can be assigned to the Insula with an extension of 1-2 cm. However, we cannot agree with the statement of FORGEOT and LÈSBRE who include into the insular area also the proximal connections of the Gyrus praeinsularis with the orbital and frontal parts of the cortex; also, the authors seem to have referred to the uncovered part of the Insula only; at least that is how I interpret their statement (loco citato, page 118): "On voit …. l'insula sortir de la base de la scissure de Sylvius et se diviser bientôt en deux plis, qui se bifurquent à leur tour pour se continuer d'une part avec le lobule orbitaire, d'autre part avec la circonvolution commune anterieur."

Another remarkable convolution lies in the area of the second arched convolution, where it declines towards the hemisphere's frontal pole.

This convolution is medially delineated by the part of the Fissura suprasylvia that is closest to the Pallium's border; caudally, it is delineated by the dorsal end of the Fissura diagonalis, and rostrally by the gamma-complex of grooves described by FLATAU and JACOBSON. The caudo-ventral boundary of this complex is often difficult to detect due to the great irregularity of the two afore-mentioned grooves. The convolution is 1 cm wide and 3 cm long; next to the *Kantennähe* (Proximity to

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[35] see Fig. 37, gp

the Border) of the Fissura suprasylvia, it turns laterally where, after a short course, it declines steeply and then ends. In the diffuse labyrinth of the other gyri, the convolution is recognisable through the Pia mater because it protrudes markedly and is much more distinct from its surrounding than the rest of the gyri at the hemisphere's dorso-lateral surface. Occasionally, it is so prominent that a special impression is present in the cranium's wall, which is visible even externally, i.e., at the bottom of the Sinus frontalis. A comparison with our foetal specimens reveals that the gyrus developed from the most rostral pole of the Gyrus secundus; according to its shape, it can be designated as GYRUS PROMINENS (see Figs. 34, 30, 31 and 38).

Whenever the Fissura cruciata passes over to the hemisphere's dorso-lateral surface, a GYRUS SIGMOIDEUS is clearly developed even though its size does not compare with that of the canine brain. A sigmoid-like formation is not only visible in the presented figures, but it is also shown on the often rudimentary brain schemes in CHAUVEAU's textbook. It may be absent in many cases but definitely not in all cases, as is SCHELLENBERG's opinion.

I would like to point out yet another convolution that appears just where the hemisphere's lateral surface turns over to its Facies cerebellaris. It extends along this border from the caudal end of the Lobus pyriformis to the hemisphere's occipital pole at a length of 4 cm and is barely 0.5 cm wide and is straight. This gyrus is already included in ELLENBERGER's scheme (page 796) as an exception because it is occasionally cut into by the Fissura ectolateralis or by the Fissura suprasylvia. I find it present in a typical manner in 20% of my specimens; in another 50%, it is indented by shallow grooves, but its parts are arranged in such a strict line that they appear as one uniform convolution. It may be speculated that the Calvaria is involved in the formation of this gyrus insofar as initially separate convolutions were forced to fuse to a single gyrus when the hemisphere grew into the relatively deep angle between the tentorium's base and the cranium's lateral wall.

A noteworthy GENERAL CHARACTERISTIC of the hemisphere's outer shape is the fact that it is elongated and narrow. The medial surface is quite flat, apart from the groove that contains the Sinus rectus and ascends behind the Splenium corporis callosi; caudal to this groove, both hemispheres very often unite in one small place. The Facies cerebellaris cerebri is also quite flat and shows only a slight impression opposite the Colliculus rostralis of the Lamina quadrigemina (i.e., *Vierhügeldelle*). The hemisphere's largest curvatures are located close to the *Kantennähe* of the Fissura suprasylvia and dorsal to the Lobus pyriformis. In contrast, the lateral surface of the frontal brain and that medial to the Fissura ectolateralis are quite flat. For this reason, a transverse section of the frontal brain is high and narrow when compared to the caudal half (of the brain). The hemisphere displays a large prominence formed by the Gyrus prominens at the position where the flat frontal brain curves towards the dorsal surface. The hemisphere terminates caudally with a blunt edge. In the brains of older horses one may find a slight, groove-like impression at the ventro-lateral surface of the hemisphere's caudal part; the impression lies between the Fissura lateralis and the Fissura suprasylvia and runs towards the Lobus pyriformis.

As mentioned earlier, a DELINEATION OF LOBES cannot be performed quite like in dogs. The lobe that is outlined best is the LOBUS FALCIFORMIS; it comprises, like in carnivores, the proper Rhinencephalon, the Gyrus fornicatus, and the Lobus pyriformis. The remaining cortex areas, i.e., the Pallium, may be separated into the occipital brain or lobe which, as proposed by SCHELLENBERG, would be cut by a transverse plane touching the Splenium corporis callosi. Correspondingly, a FRONTAL BRAIN or lobe may be separated by a parallel plane through the Genu corporis callosi. The remaining intermediate portion allows a further partition only insofar as one would homologise the OPERCULUM above the Insula with a part of the TEMPORAL LOBE. A natural demarcation line between the latter and the remaining parietal lobe is not displayed at the Pallium; it is not present in the frontal or occipital brain either. If, for the sake of brevity, we have introduced the term Operculum, we have to accept the restriction that it is not determinable which part is equivalent to the Operculum fronto-orbitale, parieto-frontale et temporale hominis.

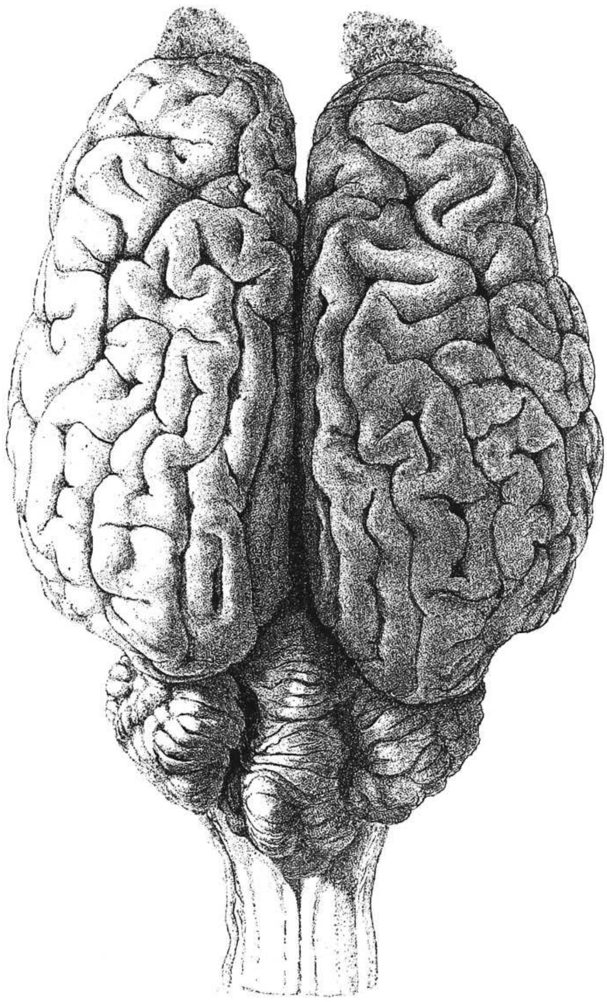


Fig. 38. Dorsal view of the brain of an adult horse; drawn from a photograph of a specimen fixed inside the Cranium; three-fourths of its natural size.

Finally, the Insula has to be mentioned. It is regarded as the Lobus insulae due to its evolution because it is a true lobe in primates, but rudimentary in horses. According to HOLL, the Insula is phylogenetically homologous to the first primal convolution of the carnivores' brain. As a consequence, the conventional first arched convolution becomes the second one, the authors' Fissura Sylvii becomes the Fissura ectosylvia, and so on. According to HOLL, a little groove running vertically from the Insula's parts of the Rhinencephalon towards the Fissura rhinalis would have to be regarded as an indication of the sylvian fissure. Sometimes, it is slightly deeper than the other grooves that are surrounded by the Gyri breves, yet often it is hardly discernible anymore. CLARKE calls it Fissura transinsularis.

Having in mind the lack of reliable ontogenetical and functional criteria for a homologous delineation between the temporal and parietal lobes, one can justify a strictly topographical principle of schematisation: THE HEMISPHERE'S OPERCULAR PART REACHING DORSALLY UP TO THE FISSURA SUPRASYLVIA WOULD BE REGARDED AS THE TEMPORAL LOBE. THE PARIETAL LOBE WOULD BE LOCATED DORSAL TO IT, SHARPLY CUT ROSTRALLY BY THE HORIZONTAL BRANCH OF THE FISSURA TRANSVERSA. Herewith, some easily visible and constant borderlines are available for at least a superficial orientation; they would be valid as long as morphological and physiological studies have not yielded further evidence of their homologies. The previously mentioned rostral and lateral borderlines seem to me all the more acceptable as they occur with even greater distinctness in ruminants.

Several general conclusions can be drawn from the comparative inspection of foetal and adult brains. As for the grooves, we can see that the so-called main grooves are generated at a very early developmental stage of the foetal period; from then on up to their completed state, they achieve a continuously refined structure. THE DEVELOPMENT OF CORTICAL GROOVES BEGINS IN THE FOURTH EMBRYONIC MONTH. There is no evidence that any of the grooves disappears again during development. Those of the Lobus falciformis and those delineating the insular area seem to appear earliest. The Fissura suprasylvia develops next, followed by the Fissura lateralis and by the Fissura ectosylvia. The Fissura Sylvii appears relatively late; it is followed only then by the Fissura cruciata, given that this one develops at all. As far as the latter is concerned, we are not readily able to make a decision about its existence in the horse, if we want to hold on to the characteristics of the main grooves, i.e., localisation, depth, constancy, and early *Anlage* (Primordium).

All we know until now is that the hitherto designated Fissura cruciata does not equate with the said groove but represents a different one, namely the Fissura transversa. The research group of MARTIN has proven the validity of the older descriptions by CHAUVEAU, according to which the Fissura cruciata is localised further rostral; the evidence from SCHELLENBERG's comparisons, based on the brains of ruminants, has confirmed this assumption. Yet it is important to emphasise that the development of the Fissura cruciata in horses is as such that, in order to maintain its existence, a continual comparison with brains of ruminants and porcine species is required; furthermore, all possibilities of ZIEHEN's law of variation should also be considered. Furthermore, the Sulcus cruciatus cannot be regarded as a temporary groove in the sense of ECKERT (as a groove that is at least present in a foetal stage and then disappears again) because it appears later than any of the main grooves and has a progressive development. Its definite formation is irregular. A particularly deeply carved groove accompanied by a sigmoid, limiting convolution is relatively common; BUT IT CAN ALSO BE COMPLETELY ABSENT. We therefore have to conclude: The Fissura cruciata has reached a relatively low developmental level in the horse; IT IS RUDIMENTARY AND NO LONGER COMPLETELY CONSTANT.

The GYRI of the Lobus falciformis are very typical and develop early. Initially, a large marginal convolution (*Randwindung*) and a lateral convolution (*Seitenwindung*), i.e., the Gyrus primus and the Gyrus secundus, develop on the hitherto completely even Pallium of the embryo. The caudal portion of the marginal convolution separates into two longitudinal bulges at a time when its rostral portion is still completely even. Only later does a transverse separation appear in the latter, which is relatively inconstant. The insular area becomes covered by the cortex and grooved only in the later foetal life.

The formation of the GYRUS SIGMOIDEUS is inconstant; that of SCHELLENBERG's *w*-convolution is very rare and belongs to a late foetal stage.

In the horse, the classification of the Pallium into four arched convolutions is incomplete unless it is forced; it is only possible if we make several exceptions like: Total reduction in size of the rostral portions of the third and fourth arched convolution; enormous enlargement and elongation of the second arch of the primal convolutions; a marked reduction in size of the first arch of the primal convolutions during development. Evidence for such a sequence of links in the developmental chain of the descending sequence of animals (*Tierreihe*) has not yet been provided.

The formation of secondary convolutions first occurs on the falciforme lobe; then, the finer subdivision of the foetal marginal convolution seems to appear, and thereafter that of the foetal Gyrus secundus. The subdivision of the frontal pole occurs last.

MEASUREMENTS

I have so far not given any measurements when describing the grooves and convolutions because this is of relatively little value due to their large variability. The following data also merely represent varying mean values, since the weight of the brain of adult horses can already lie between 560 and 715 grammes (62 measurements).

Length of the Hemisphere	12 cm
Height of the Hemisphere (at the level of the tip of Lobus pyriformis)	7.5 cm
Middle transverse diameter of the Hemisphere (across the Insula)	5 cm
Length of the Facies cerebellaris cerebri	5 cm
Width of the Facies cerebellaris cerebri	4.5 cm

Thickness of the Gyrus dentatus	0.5 cm
Length of the Gyrus hippocampi	4.5 cm
Thickness of the Gyrus hippocampi	1 cm
Greatest width of the Rhinencephalon at the brain's base	4 cm
Distance between the two Processus mamillaris gyri pyriformis	3.5 cm

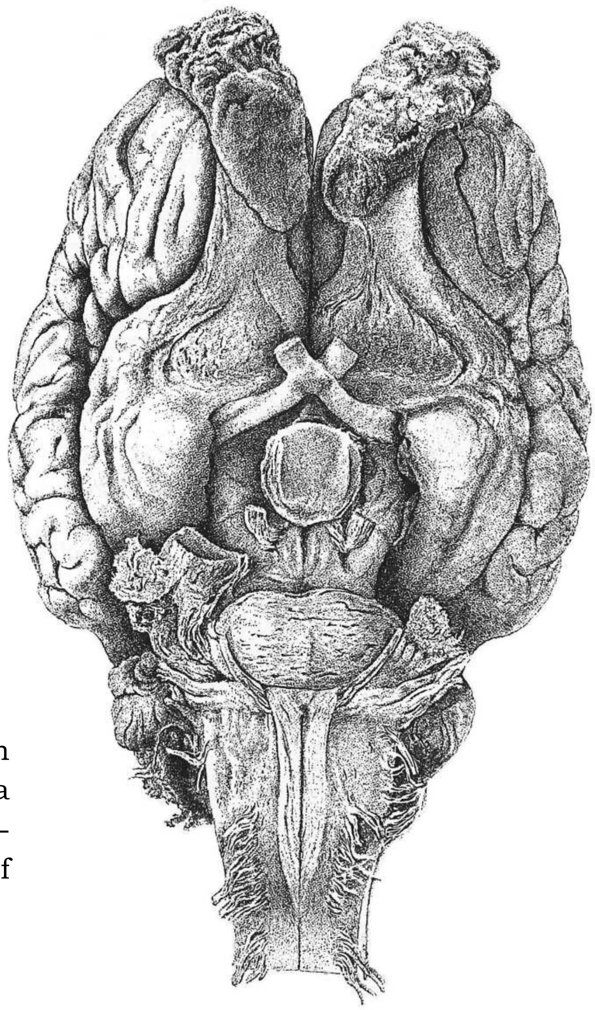


Fig. 39. Ventral view of the brain of an adult horse; drawn from a photograph of a specimen fixed inside the Cranium; three-fourths of its natural size.

The WHITE MATTER beneath the cortex is quite abundant in the frontal as well as in the occipital parts of the Cerebrum of the horse; accordingly, SCHELLENBERG supposes that there is a rostral and a caudal CENTRUM SEMIOVALE. Both centres merge with each other by means of substantial accumulations of fibres, which are located lateral to the cerebral ventricles and are summarised under the term sagittal medullary body (*sagittales Marklager*). Its periphery is separated by deep and numerous grooves into long and narrow protrusions of white matter. A stratification of the central masses of white matter is clearly visible with the naked eye in very fresh as well as in fixed (chromium compound/chromate; see footnote 4) specimens. The usual tri-partition of this sagittal medullary body (i.e., Tapetum, Radiatio optica, Fasciculus longitudinalis inferior) and the Radiatio corporis callosi can sometimes be demonstrated by breaking off pieces from transverse sections of fixed brains.

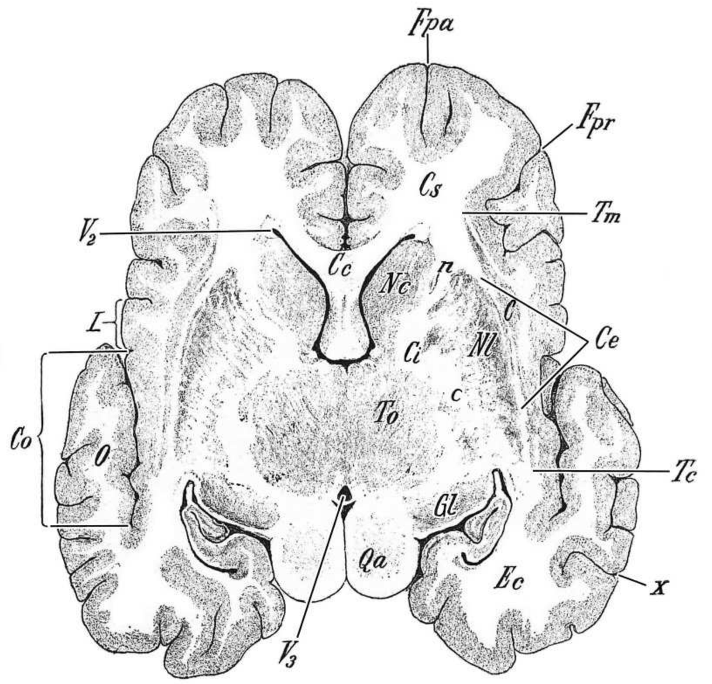


Fig. 40. Horizontal section of the Cerebrum of a new-born horse; three fifths of its natural size.

c Caudal branch of the Capsula interna; **C** Claustrum; **Cc** Corpus callosum; **Ce** Capsula externa; **Ci** Genu of the Capsula interna ; **Co** Covered part of the insular cortex; **Cs** Centrum semiovale; **Ec** Central medulla of the occipital brain; **Fpa** Fissura praesylvia anterior; **Fpr** Fissura praesylvia; **Gl** Ganglion geniculatum laterale; **I** Uncovered part of the Insula; **n** Rostral branch of the Capsula interna; **Nc** Nucleus caudatus; **Nl** Nucleus lentiformis; **O** Operculum; **Qa** Colliculus rostralis laminae quadrigeminae; **Tc** Caudal end of the Claustrum (C); **Tm** Rostral end of the Claustrum (C); **To** Thalamus opticus; **V_2** Cornu anterius of the Ventriculus lateralis connected to the contralateral one by the Foramen interventriculare (Monroi); **V_3** Ventriculus tertius; **x** Branch of the Sulcus H of FLATAU-JACOBSON.

The position of the CENTRAL NUCLEI[36]: The delineation of the Nucleus caudatus, Nucleus amygdalae, Nucleus lentiformis can only be insufficiently studied in fresh specimens; the same refers to the courses of fibres that belong to the Radiato thalami (*Stabkranz*) or to the cerebrum's Commissurae.

The NUCLEUS CAUDATUS protrudes with its medial side into the Ventriculus lateralis; a small portion of it is embedded in the hemisphere's Medulla. Its intraventricular surface is even, grey, sometimes it has shallow impressions; its Caput is laterally compressed and quite flat. Rostrally, one finds this nucleus at a transverse plane located 0.5 cm rostral to the Genu corporis callosi; here, its profile is almond-shaped. In the region of the Genu corporis callosi it is already 3 cm high and 0.5 cm wide, and it begins to become laterally separated from the Nucleus lentiformis by means of thick fibre bundles; both nuclei are joined at the rostral pole of the Nucleus caudatus. The ventral surface of the latter is separated from the barely 2 mm thick grey matter of the Trigonum olfactorium by a thin cover of fibres and contributes to the protrusion of the Trigonum. At the level of the rostral border of the Chiasma opticum, the Caput nuclei caudati has moved away from the brain's

[36] *Ganglienmassen*: masses/accumulations of ganglia; here and later in the original text, ganglion is used as a synonym for nucleus

base; in the transverse section, it appears as an arch (*Bogenzweieck*[37]) with a very flat outer contour. It is placed on a thick layer of white matter, which [.....[38]] represents the Capsula interna. At the level of the Corpus mamillare, the Cauda nuclei caudati has ascended beyond the dorsal surface of the Thalamus opticus and is now only 1 cm high and 0.4 cm wide. Caudally, its width decreases rapidly and it continues as a barely 3 mm thick, grey thread running like a ventrally open bow towards the Cornu temporale (*Unterhorn*[39]) of the Ventriculus lateralis next to the Uncus[40].

The NUCLEUS LENTIFORMIS which, as mentioned earlier, cannot be separated from the rostral pole of the Nucleus caudatus, is located caudo-ventrally to the latter; it is 3 cm long, 2 cm high, and 5 cm wide; it reaches its largest size at the level of the Tuber cinereum and has decreased again at the level of the Corpus mamillare. The topographical relationship of both nuclei is best visible in fresh specimens in a horizontal section approximately 1 cm above the Trigonum olfactorium; this section is performed so that the Epiphysis cerebri or the Colliculus rostralis of the Lamina quadrigemina is cut. As a result, one can see the Nucleus caudatus in a rostro-medial position and the Thalamus opticus in a caudo-medial position (see Fig. 40). The Nucleus lentiformis is placed in-between the two nuclei, separated from both by the 6 mm wide Capsula interna; a lateral and a medial part of the Nucleus lentiformis is indistinctly visible. At its lateral side, a narrow, white band, i.e., the Capsula externa, runs along; lateral to the latter, an even narrower grey band extends; it is separated from the Cortex of the Fissura Sylvii posterior by thin strands of white matter and is homologous to the CLAUSTRUM hominis.

Far caudal, the NUCLEUS AMYGDALAE attaches to the Nucleus lentiformis. It is best developed in the frontal plane of the Nuclei habenulae[41] and it protrudes, from a rostral direction, slightly into the tip of the Cornu temporale (*Unterhorn*) of the Ventriculus lateralis. It is 1 cm long, 1 cm high, 6 cm wide, and inseparable from the Nucleus lentiformis in fresh specimens.

The CORNUA AMMONIS are two arched bulges, each 8-12 mm thick. The border of the hemisphere's wall turns medially, thus forming the Gyrus hippocampi, then turns back again after a course of barely 1 cm to form the Gyrus dentatus, and finally forms the large bulge that we recognise as the Cornu ammonis, which is so well developed in the horse. The border between the Gyrus hippocampi and the proper Cornu ammonis or Pes hippocampi is localised where the Gyrus dentatus and the Gyrus hippocampi adhere by means of a highly vascularised duplication of the Pia mater. Both Cornua ammonis, representing the caudal wall [of the caudal

[37] *Zweieck*: digon; a polygon with two edges, two tips and two vertices

[38] originally: "..... which is inserted between it (the Nucleus caudatus) and the white matter and represents the Capsula interna". Unclear, because this would mean that white matter was adjacent to another portion of white matter.

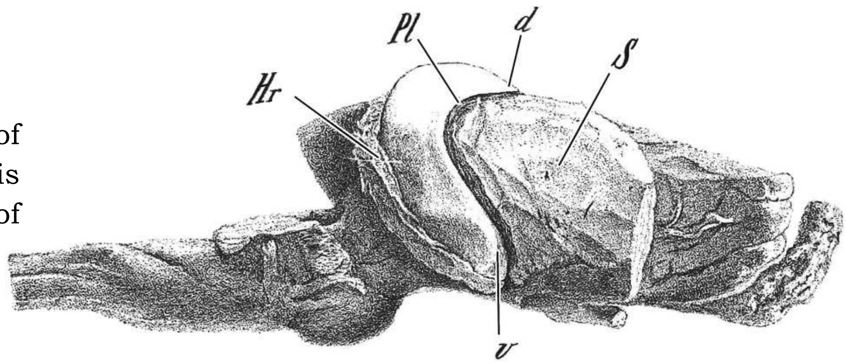
[39] see footnote 50

[40] Tuberculum hippocampi; see footnote 29

[41] Nuclei habenulae: Ganglion habenulae in the original text

horns][42] of the Ventriculus lateralis, encircle the brain stem in a wide, rostrally open bow, which begins at the Uncus (Tuberculum hippocampi) and ends beneath the Splenium corporis callosi. Their dorsal portions touch in the median plane dorsal to the optical hill (*Sehhügel*)[43]. A careful dissection reveals that not the entire Formation of Ammon (*Ammonsformation*) ends ventral to the Corpus callosum, but that shortly behind the Splenium, the caudal end of the Gyrus callosus or the continuation of the Gyrus dentatus, respectively, bilaterally transforms rapidly into a thin strand that cannot be further differentiated macroscopically; it extends rostrally as a fine, grey band placed above the middle part of the Corpus callosum, representing the Gyrus supracallosus or Stria longitudinalis Lancisii; in the rostral area, its further course can be recognised only in serial sections.

Fig. 41. Lateral view of the right Cornu ammonis of a horse; two-thirds of its natural size.



d Dorsal end of the Cornu ammonis; **Hr** Cut-off border of the hemisphere; **Pl** Band of the Plexus chorioideus of the ventricle's Cornu temporale (*Unterhorn*); **S** Sectional area after removal of the frontal Pallium; **v** Ventral end of the Cornu ammonis.

The surface of the Ammon's horn, which is facing the ventricle, is covered by a thin white fibre layer, i.e., the ALVEUS, of which the elements are compressed at the rostral border of the Hippocampus to form a white narrow band, i.e., the Fimbria. The Fimbria slowly widens in its rostro-dorsal extension, flows together with the contralateral one directly in front of the Gyrus callosus, thus forming a triangular field, i.e., the body of the FORNIX VENTRALIS. Both Fimbriae are also designated as the caudal branches of the Fornix, i.e., the CRURA FORNICIS. In a dorsal view, visible after opening the lateral ventricle, the Fornix ventralis appears as a white, 4 mm thick, arrowhead-shaped layer that descends from the convex dorsal ends of the Hippocampus across the rostral part of the surface of the Thalamus from which it is separated only by the Tela chorioidea. The borders of its

[42] *Hinterhorn*: unclear terminology, perhaps meaning Cornu ventrale (ZIETZSCHMANN et al. 1943), which is now Cornu temporale

[43] *Sehhügel*: optical hill; ambiguous; according to BÖHME (2004) the proper *Sehhügel* is the Corpus geniculatum laterale (Metathalamus).

sides lie in the deep grooves that extend bilaterally between the Thalamus and the Nucleus caudatus, i.e., the THALAMUS-STRIATUM-GROOVE[44] (*Thalamus-Striatum-furche*); the Fornix ventralis narrows rapidly in a rostral direction and, on its way towards the brain's base, turns further and further away from the Corpus callosum. Far rostral, it is only 4 mm wide and, together with the Thalamus, encloses the connection between the third and the lateral ventricle, i.e., the FORAMEN INTERVENTRICULARE MONROI. It then bifurcates into two round bundles, i.e., the COLUMNAE FORNICIS. These pass by the middle part of a white, transverse fibre strand, i.e., the Commissura nasalis, and then descend into the brain's base. In general, the Fornix ventralis of horses is insignificant compared to the other structures that protrude into the Ventriculus lateralis; hence, one only encounters the Nucleus caudatus and the Cornu ammonis when opening the ventricle without pulling apart the brain tissue. The vast Plexus lateralis[45] lies in-between the Nucleus caudatus and the Cornu ammonis; it must be pushed aside or cut off in order to visualise the body of the Fornix, which is barely 1.5 cm wide at its base; usually, its borders are ventrally folded and lie in the THALAMUS-STRIATUM-GROOVE.

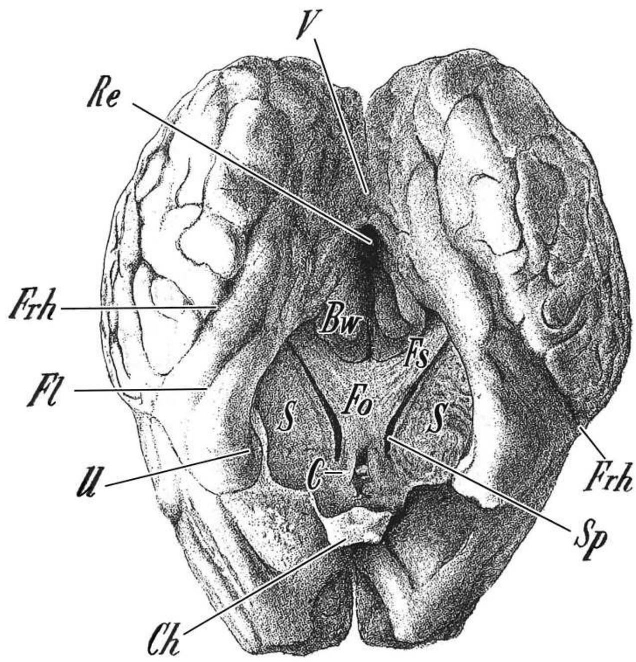


Fig. 42. Ventral view of a horse's Cerebrum after removal of the brain stem; the Tela chorioidea and the Plexus chorioideus have been removed as well; two-thirds of its natural size.

Bw *Balkenwindung*, Gyrus callosus; **C** Columna fornicis; **Ch** Chiasma opticum; **Fl** Fissura longitudinalis lobi pyriformis; **Fo** Fornix ventralis; **Frh** Fissura rhinalis posterior; **Fs** Crus fornicis; **Re** Hollow space between the hemispheres containing the Recessus suprapinealis; **S** Sectional area in the Diencephalon; **Sp** Cleft between the border of the Fornix and the Nucleus caudatus containing the Plexus chorioideus; **U** Uncus; **V** Location of adhesion of the hemispheres.

[44] There is no term equivalent to this one in the N.A.V. (WORLD ASSOCIATION OF VETERINARY ANATOMISTS, 2017); in Fig. 44 it is referred to as the Terminal groove between the Thalamus and the Nucleus caudatus

[45] Plexus choroideus ventriculi lateralis

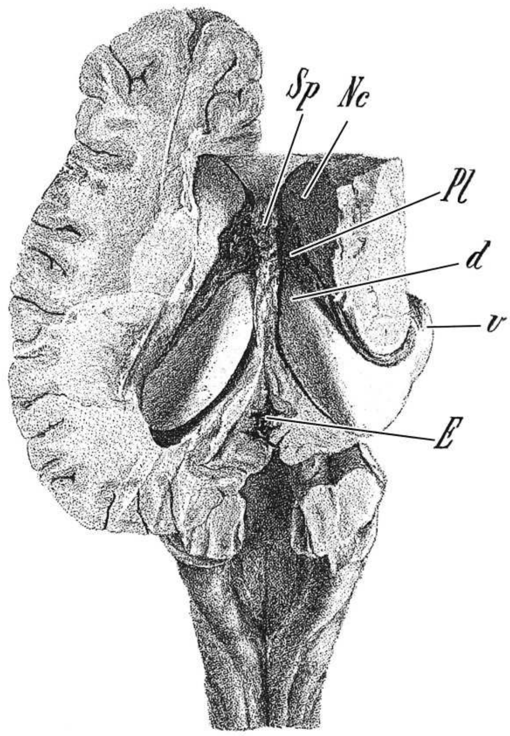


Fig. 43. Bottom of the lateral ventricles in a horse's brain after removal of the hemispheres' dorsal parts; two-thirds of its natural size.

d Dorsal end of the Cornu ammonis; **E** Cross section of the Recessus suprapinealis; **Nc** Nucleus caudatus; **Pl** Plexus lateralis with a small Cholesteatoma; **Sp** Septum pellucidum; **v** Ventral end of the Cornu ammonis.

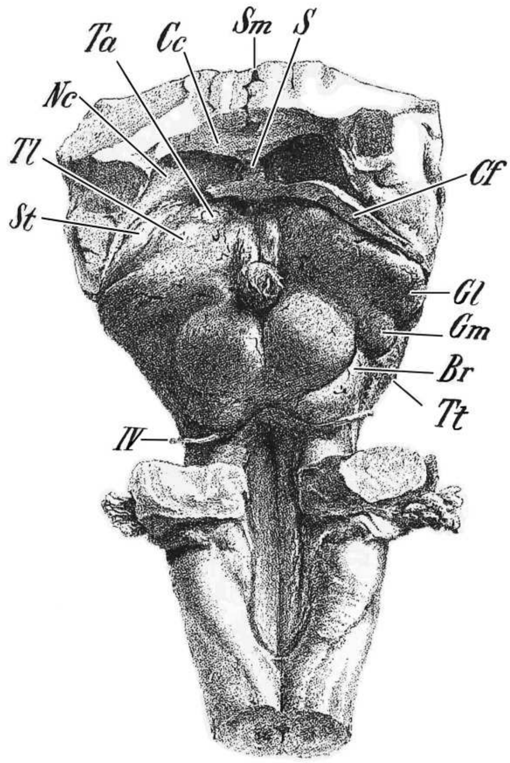


Fig. 44. Diencephalon and Mesencephalon of a young horse; dorso-caudal view; two-thirds of its natural size.

Br Caudal arm of the Lamina quadrigemina; **Cc** Corpus callosum; **Cf** Crus fornicis; **Gl** Ganglion geniculatum laterale; **Gm** Ganglion geniculatum mediale; **Nc** Nucleus caudatus; **S** Fornix longus; **Sm** Fissura longitudinalis cerebri; **St** Terminal groove between the Thalamus and the Nucleus caudatus; **Ta** Tuberculum anterius thalami; **Tl** Tuberculum laterale thalami; **Tt** Tractus peduncularis transversus; **IV** Nervus trochlearis.

The SEPTUM PELLUCIDUM is spread between the median, ventral surface of the Corpus callosum and the median, dorsal surface of the Fornix; it lacks a ventricle in the horse.

The CORPUS CALLOSUM is relatively poorly developed. It is approximately 6 cm long and 5 mm thick. Its Splenium is only slightly thicker than its Truncus. The rostrally unfolded, thin end of the Splenium sharpens quickly and is placed like a transverse, white band between the dorsal ends of the right and left Cornu ammonis. As far as can be seen from the plucked specimens and from the brain slices, the most rostral part of the Splenium enters the medulla of the Gyrus callosus at the rostral tip of the Cornu ammonis; more caudally, the fibres of the Corpus callosum cross over the Gyrus callosus and extend into the medulla of the Gyrus hippocampi. Even those fibres coming directly from the Splenium corporis callosi take this course and, doing so, form a bow with its opening oriented caudally, while its convexity, lying in the Splenium, is directed rostrally. The fibres of the most rostral portion are short and are oriented strictly transversally; the fibres from the caudal portion continuously increase in length and bend caudo-ventrally. All together they form a fibrous plate which, coming from a caudal and ventral direction, runs in a transverse direction around the dorsal ends of the Cornua ammonis; it extends with a tongue-shaped protrusion between the two and contributes to the formation of the medial and ventral wall of the Ventriculus lateralis. The portion that is placed in-between the Cornua ammonis represents the PSALTERIUM, Commissura ammonis; towards the Splenium corporis callosi, its elements continue into the ventral fibre arrangements of the Forceps caudalis without externally visible separation.

Hence, the entire caudal curvature of the Corpus callosum is pushed away from its body by the distance of the height of the Cornu ammonis, which protrudes beneath the Corpus callosum. Due to this, the situation is considerably different from that in humans. That is to say that the Corpus fornicis and the Psalterium do not lie directly adjacent to the Corpus callosum (as in humans), but remain at a distance of 2-3 mm from it. The resulting space in-between is medially separated by a 3 mm thick, white septum, which rostrally joins the Septum pellucidum without a sharp delineation; this is the FORNIX LONGUS seu DORSALIS, which firmly connects to the body of the Fornix ventralis in the area of the ends of the Cornua ammonis. The most caudal portion of the Septum pellucidum rests on top of it.

Every hemisphere contains a cavity, the Ventriculus lateralis; it is connected to the third ventricle[46] and to that of the other hemisphere through the Foramen/Canalis Monroi on the one hand and, on the other, is connected with the cavity of the Bulbus olfactorius (Ventriculus bulbi olfactorii, see Fig. 45) by means of a long and narrow canal (Isthmus, see Fig. 45)[47]. Each cavity represents a large capillary space[48], the arched shape of which matches the convexities of the Nucleus caudatus and of the Cornu ammonis. Only ventral to the Truncus corporis callosi do the walls of the middle part of the PARS CENTRALIS or CELLA MEDIA ventriculi lateralis move apart from each other, so that the cavity becomes 2 cm wide and 3 mm high. The Pars centralis rostrally continues into the CORNU ANTERIUS seu NASALE[49] without a visible demarcation, and caudally continues into the CORNU

[46] *Zwischenhirnkammer*: cavity in the Diencephalon (*Zwischenhirn*)
[47] i.e., the Recessus olfactorius according to BÖHME (2004)
[48] *Lymphspalt*: a recess containing lymph (lymph: Liquor cerebrospinalis)
[49] Cornu rostrale according to the N.A.V. (WORLD ASSOCIATION OF VETERINARY ANATOMISTS, 2017)

INFERIUS seu CAUDALE[50]; both cornua reach their most ventral position dorsal to the medial olfactory root and in the Processus mamillaris lobi pyriformis. There is no Cornu posterius. The Cornu nasale is aligned obliquely from a medio-ventral to a dorso-lateral direction. The Pars centralis is aligned in a mainly horizontal position; its lateral side is slightly higher than its medial side. The Cornu inferius forms a narrow duct of a semi-lunate cross-section; its most ventral end is widened to a transversally oriented chamber, 6 mm wide and 2 mm high, into which the surface of the Nucleus amygdalae protrudes from a rostral direction. The opposite wall occasionally shows some small, irregular, longitudinal impressions. Due to the adhesion between the dome of the Hippocampus and the caudal wall of the Cornu caudale (which I find in approximately 30% of all brains), the cavity is separated along its entire length into two narrow canals; these canals rejoin inside the Lobus pyriformis.

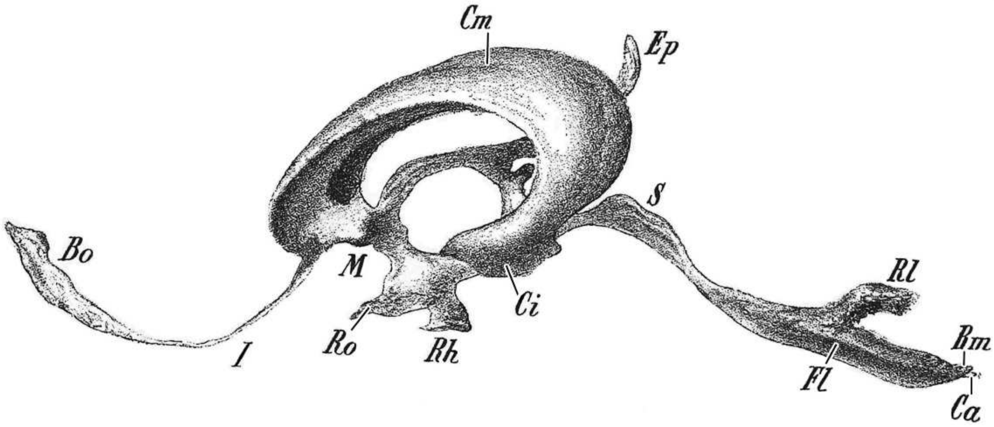


Fig. 45. Metal cast of the cerebral cavities of a 14-year-old horse; the cast was dissected from the fixed organ up to the median plane; natural size.

Bo Cast of the Ventriculus bulbi olfactorii; **Ca** Cast of the Calamus scriptorius of the Ventriculus quartus; **Ci** Cornu temporale (*Ventralhorn*) of the cast of the Ventriculus lateralis; **Cm** Pars centralis of the cast of the Ventriculus lateralis; **Ep** Cast of the Recessus suprapinealis; **Fl** Cast of the Sulcus limitans fossae rhomboidalis; **I** Isthmus to the Cornu anterius of the cast of the left Ventriculus lateralis; **M** Connecting branch to the Ventriculus tertius; Canalis Monroi; **Rh** Cast of the Recessus hypophyseos; **Rl** Connecting branch between the Ventriculus quartus and the lateral recesses; **Rm** Cast of the Recessus medianus; **Ro** Cast of the Recessus opticus; **S** Cast of the Ventriculus mesencephali.

Beginning at the Foramen interventriculare, the Ventriculus lateralis is demarcated by a very delicate cover membrane, which medially inserts at the border of the Fornix ventralis[51], and further caudally inserts at the Fimbria. This is due to the fact that the border of the Fornix is suddenly reduced to a single-layered

[50] In the legends of Figs. 41 and 45, and in some parts of the text, it is alternatively called *Unterhorn*, or *Ventralhorn* (Cornu ventrale); it is the Cornu temporale according to the N.A.V. (WORLD ASSOCIATION OF VETERINARY ANATOMISTS, 2017)

[51] Corpus fornicis according to the N.A.V.

epithelial sheath that adheres to the Tela chorioidea and inserts at the opposite Stria terminalis. Accordingly, only the rostro-lateral surface of the Fimbria faces the cavity of the ventricle. Hence, the resulting membranous demarcation lies opposite the Tractus opticus and extends along the latter up to the level of the Corpus geniculatum externum[52]. Its ventral end is located approximately 1 cm dorsal to the tip of the Uncus (Tuberculum hippocampi)[53]. Rostrally, it soon narrows because the Fimbra very closely approaches the Stria terminalis, and with this reduced width of barely 4 mm, it continues as far as the Foramen interventriculare. In the region of the *Unterhorn*[54], the part of the Tela chorioidea that supports the aforementioned Lamina epithelialis is very delicate and contains only few longitudinal folds in the region of the middle third of the arch of the Cornu ammonis; however, on entering the Pars centralis it increases markedly in size and forms a soft, reddish-grey to yellowish-grey body with a tubercular[55], velvety surface, i.e., the PLEXUS CHORIOIDEUS LATERALIS. The Plexus is thickest (3-4 mm) just above the Foramen interventriculare where it forms a club-shaped intumescence, which very often contains hard, mother-of-pearl-like shining or yellow inclusions of the size of a grain of sand or hemp. The club is laterally slightly flattened, protrudes a short distance into the Cornu nasale, and then steeply declines towards the Foramen interventriculare; here, the club handle turns medially in a slight, horizontal curve and then unites with the tip of the Tela chorioidea media. As mentioned earlier, the Plexus lateralis completely fills the Thalamus-Striatum-groove[56] and covers the Fornix. We find a second plexus in the most ventral third of the Cornu caudale where the Tela increases to form a 2 cm long and 3 mm thick band covered with choroidal villi; it is ventrally connected to several branches of the Arteria chorioidea anterior. Hence, the PLEXUS LATERALIS is divided into a DORSAL and a VENTRAL PORTION. The middle portion of the Chorioidea that is located in-between the two portions also contains a few, microscopically small vascular loops, which however do not unite to form a proper Plexus.

The limitation of the lateral ventricle in the region of the Cornu anterius is created by the surface of the Nucleus caudatus, by the Septum pellucidum, and by the Corpus callosum together with a part of the Fornix ventralis. In the Pars centralis, the space of the narrowing tail of the Nucleus caudatus is taken over by the TAPETUM that increases in width and now forms the lateral wall as far as to the level of the end of the Cornu temporale (*Unterhorn*); in contrast, its base is formed by the Alveus of the Cornu ammonis, while the medio-ventral wall is formed by that part of the caudal Radiatio corporis callosi (*Balkenstrahlung*), which runs through

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[52] Corpus geniculatum laterale according to the N.A.V.

[53] see footnote 29

[54] see footnote 50

[55] literally: *drusig*; the noun *Druse* refers to a body with many small cavities containing crystalline elements and hence appearing tubercular; *Druse*, strangles, designates also the Streptococcus equi infection in horses, which, however, is not meant here

[56] the groove between the Thalamus and the Nucleus caudatus, see footnote 44

the Splenium corporis callosi and through the ventral elongation of the latter. At the lateral side, the previously described membranous demarcation is found.

In a metal cast (see Figs. 45, 46), the lateral ventricles appear as two conchiform wings that are placed on the circular cast of the third ventricle; their concavity is directed towards the brain's ventral surface. Rostrally, they are each connected to a flat, club-shaped body by a junctional part shaped like a very thin club handle. Three edges originate where this handle meets the wing: A short, very sharp one lying ventral to the branch that connects to the cast of the diencephalon; a dorso-lateral one representing the lateral contour; and a third, blunt, dorso-medial one representing the medial contour of the cast. Both the latter ones extend along the cast's sides as far as to the end of the caudal bending; they divide the convex dorsal side of the wing's cast from its ventral side. The former, i.e., the dorsal side, is very slightly transversally grooved in its rostral half, otherwise completely even on its other surfaces. The latter, i.e., the ventral side, is composed of a rostral, shallow excavation and a caudal, deeper excavation; they are separated by a deep, irregularly outlined groove running from medio-rostral to caudo-lateral.

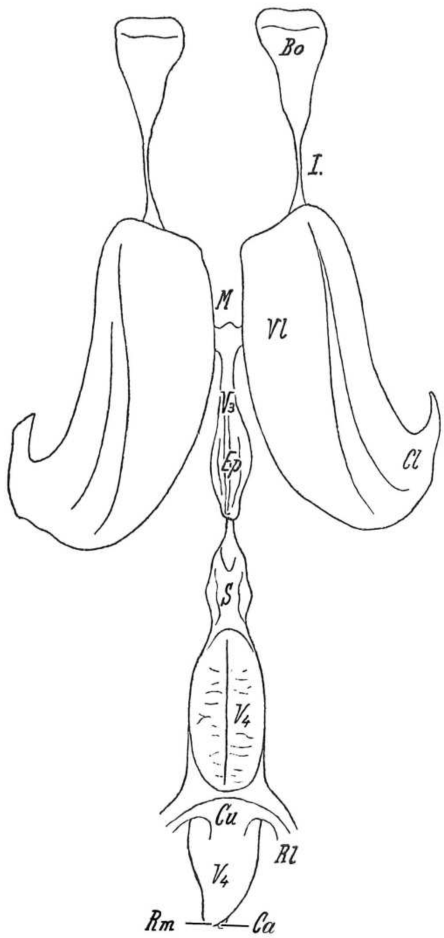

Fig. 46. Drawing of the outlines of a metal cast of the cerebral cavities of a horse; dorsal view, slightly reduced in size.

The casts of the lateral ventricles are slightly bent apart to allow inspection of the third ventricle; normally, they are 3 mm apart, depending on the thickness of the Septum pellucidum.

Bo Ventriculus bulbi olfactorii; **Ca** Calamus scriptorius of the Ventriculus quartus; **Cl** Cornu ventrale of the Ventriculus lateralis; **Cu** The highest elevation of the Ventriculus quartus next to the medullar body of the Cerebellum; **Ep** Recessus suprapinealis; **I** Isthmus to the Cornu anterius of the left Ventriculus lateralis; **M** Connecting branch to the Ventriculus tertius; Canalis Monroi; **Rl** Connecting branch between the Ventriculus quartus and the lateral recess; **Rm** Recessus medianus; **S** Ventriculus mesencephali; **Vl** Cella media; **V3** Ventriculus tertius; **V4** Ventriculus quartus; its cast shows a median groove and shallow transverse grooves caused by the lobules of the Vermis.

Interpreting the described surfaces and lines is easy. The rostral club represents the cast of the ventricle of the Bulbus olfactorius together with the canal connecting it to the lateral ventricle. The dorsal surface of the wing's convexity is the lateral ventricle's dorsal wall adjacent to the Corpus callosum; it vaguely indicates the transversal fibre arrangement of the Corpus callosum. The rostral portion of the concavity is moulded by the Caput nuclei caudati; the concavity's caudal portion is moulded by the Cornu ammonis, and the diagonal groove represents the Plexus chorioideus lateralis.

MEASUREMENTS

Dorso-ventral diameter of the arch of the Cornu ammonis	5 cm
Width of the Cornu ammonis	1.2 cm
Length of the Fornix ventralis, from its base to the Fissura anterior	2.2 cm
Width of the Fornix ventralis at its base	1.5 cm
Width of the Fornix ventralis dorsal to the Commissura anterior	0.5 cm
Length of the Caput nuclei caudati visible in the Ventriculus lateralis	4 cm
Greatest thickness of the Caput nuclei caudati	1.2 cm
Greatest width of the Ventriculus lateralis dorsal to the Cornu ammonis	1.7 cm
Greatest width of the Ventriculus lateralis dorsal to the Nucleus caudatus	1.5 cm
Greatest length of the Ventriculus lateralis ventral to the Corpus callosum	5.5 cm
Thickness of the Fimbria	0.2-0.4 cm
Thickness of the Fornix longus	0.3 cm
Thickness of the Fornix ventralis	0.3 cm
Thickness of the Septum pellucidum	0.1-0.3 cm
Length of the Septum pellucidum	4 cm
Greatest height of the Septum pellucidum	1.2 cm

MEASUREMENTS OF TWO METAL CASTS

Cavum bulbi olfactorii: length 3.0 cm, width 1.2 cm, thickness	0.5 cm
Diameter of the connecting canal to the lateral ventricle	0.1 cm
Length of the connecting canal to the lateral ventricle	2.5 cm
Lateral ventricle:	
Length between the rostral and the caudal poles	5.7 cm
Width dorsal to the Nucleus caudatus	1.7 cm
Width dorsal to the Cornu ammonis	1.7 cm
Width of the convexity of the Cornu ammonis	1.3 cm
Width of the groove of the Plexus lateralis dorsalis	0.6 cm
Length of the groove of the Plexus lateralis dorsalis	0.3 cm
Width of the connecting arm to the third ventricle	0.5 cm
Thickness of the connecting arm to the third ventricle	0.15 cm
Length of the connecting arm to the third ventricle	0.5 cm

(To be continued.)[57]

--------------------- End of Part V ---------------------

End of the Original Article

[57] To the best of our knowledge, no continuation of this article is available.

APPENDIX 1

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mentioned in this part of his article
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