THE STRUCTURE OF THE DOG'S BRAIN. By J. N. LANGLEY, M.A., F.R.S. *Fellow of Trinity College, Cambridge.* (Plates VII. and VIII.)

THIS account I divide for convenience into three parts.

(1) A description of the fissures and convolutions. (2) An account of the literature relating to the fissures and convolutions. (3) A brief description of a series of transverse sections through the brain.

PART I.

The Fissures and Convolutions of the Dog's Brain.

Attempts have been made with various degrees of success to find what parts of the brain of the dog and of man are homologous, and many of the names already used for the brain of man have been applied to the supposed homologous parts in the dog. Generally speaking I shall not use these names since different observers are not agreed about them and since no observer has been able thus to map out the posterior part of the cortex of the dog. I prefer to use as a rule indifferent descriptive names since these can be easily thrown aside when a more satisfactory basis of nomenclature has been obtained.

The fissures of the dog's brain have been excellently described by Krueg(19)[1] and by Pansch(18); Krueg uses in most cases the names given by Owen(4), with some exceptions I adopt this revised nomenclature[2].

It is only after much hesitation that I have given names to the various parts of the main convolutions described by Leuret and Gratiolet(1), since several of these parts can be distinguished from one another in a few dogs only; in others their boundaries are doubtful and may seem hopelessly obscured. Nevertheless this sub-division seems to me for several reasons worth attempting. In a certain number of brains the corresponding convolutions can be divided into corresponding parts, and I am inclined to think that after fuller investigation the corresponding parts in all dogs' brains may be determined. Further whatever

[1] These and similarly placed figures refer to the List of Papers on p. 276.

[2] The sources of the names which I have adopted will be found in the account of the Literature of the subject pp. 265—276.

difficulty there is in determining the corresponding parts of a main convolution in different dogs exists also to nearly the same extent in determining the limits of the main convolutions under similar circumstances, so that even if we confine ourselves to dividing the cortex into first, second, third and fourth convolutions, we cannot always be certain to which of these a particular portion of the cortex belongs any more than if we sub-divide each main convolution we can always be certain about the limits of each sub-division. Lastly some such subdivision seems worth attempting since the different parts of any one main convolution are said by those who uphold the localization theory to have different functions.

The division of the cortex depends upon its fissures, consequently the value of the division depends on the assumption that corresponding fissures always occur along corresponding lines of the cortex. Unfortunately we know very little about the cause of the formation of fissures; they might be produced by two causes working independently or together; (1) by unequal growth of the portions of the cortex, (2) by unequal resistance to the growth of the cortex in different directions. In all dogs there are certain primary fissures which make their appearance during fœtal life; if these primary fissures vary in position according as resistance to growth in different directions varies, then it is clear that in one brain a portion of the cortex may form part of say the superior convolution, and in another brain the corresponding portion may form part of the median convolution; and a division of the cortex into areas according to the fissures can have very little value.

But whatever be the original cause of these primary fissures there can I think be little doubt that they are now inherited in dogs, and consequently run along corresponding lines of the cortex and are uninfluenced by pressure[1]. Now the convolutions marked out by these primary fissures vary in relative size in different animals and often vary also in the halves of the brain of any one animal; from this it follows that the primary convolutions have unequal relative growths in different dogs, and in the two halves of the brain of any one dog.

Further if this is the case, we have every reason also to believe that the different parts of any one convolution may also vary in extent of development in different dogs; and from this cause alone quite independently of any variations in resistance to growth in different directions

[1] Amongst the various facts which show this may be mentioned the difference which exists between the histological structure of the cortex at the summit of a convolution and at the bottom of the limiting primary fissure of the convolution.

we must of necessity have considerable variations in the brains of different dogs. In a brain it not infrequently happens that a fissure which on one side runs unbroken, is on the other side divided into two parts, i.e. a portion of the cortex which on one side is at the bottom of a fissure has on the other side risen to the level of the neighbouring convolutions. It seems more likely that this is caused by unequal growth than by unequal resistance to growth in different directions.

But if unequal growth of the various parts of the cortex, which without doubt takes place, might give rise to the apparent variations which occur in the position of the fissures, is there any necessity for supposing that variations in pressure can at all influence the real position of the fissures? The cortex between the fissures will no doubt take various forms according to the pressure in different directions, but will not the cortex at the bottom of any one fissure arise in all cases from corresponding cells? There are however some facts which tell rather in favour of pressure affecting the position of the fissures; in curved convolutions the minor fissures are usually found where the bend is sharpest; still it is possible that this may be due to unequal growth. Further in Goltz' dog it seems probable that the traction of the scar has been sufficient to render one fissure deeper and to efface another. The question can only be settled by observations on development.

But if the real position of the fissures can be altered to any considerable extent by variations of pressure, then all details with regard to the fissures and convolutions seem to me to form merely an uninteresting collection of unimportant facts; if on the other hand the fissures are determined by the relative rates of growth of the surrounding parts of the cortex, then such details are most valuable, affording a basis for comparing the development of the different portions of the cortex in different animals. At the same time a great deal remains to be done before the brains of different dogs can be at all accurately divided into corresponding areas; for it is clear that some variation in the real position of the fissures might still take place[1].

[1] In any case the division of the cortex into areas is only approximate for it is impossible to say to which of the boundary convolutions the cortex at the bottom of the fissure belongs, if indeed it does belong to one more than to the other; this can only be done when we find a difference in histological structure. But what I wish to point out is that if the apparently corresponding fissures do not run along corresponding lines of the cortex, experiments made on the functions of the parts of the cortex in one dog afford very inadequate data for mapping out the cortex of the brains of other dogs, and *à fortiori* of mapping out the cortex of the brains of other animals.

To simplify our knowledge of the fissures and convolutions of the dog's brain it is very much to be desired that an examination of the brains of pure breeds of dogs and of the brains of their crosses should be made; the differences in the two sides of the brain (cf. Fig. 6, Pl. VII.), in the mongrels ordinarily obtainable in the laboratory may well arise from different brain-forms inherited from different breeds.

I shall take as a basis for description a regular form of brain which occurs not infrequently in dogs. With some variations it was present in all of the half-dozen terriers that I have examined. This form is represented semi-diagrammatically in the text by three wood-cuts (Figs. 1, 2 and 3). In these figures the fissures which are represented in all dogs yet examined are marked with thick lines, those fissures which are commonly represented, though often shallow are marked by thin lines, those which occur less frequently, often only as mere depressions are marked with dotted lines. There are a few remaining rare fissures not given in these figures, they are mentioned in the text with the divergencies from the regular form of cortex which have been described or which I have myself observed; the figures to illustrate these divergencies and the rare fissures are given in the plates at the end of this paper. In all the figures the lettering of the convolutions is in capitals, that of the fissures in small italics, that of other parts of the brain is in small roman type.

If we view the brain of the dog from the side (Fig. 1) we see in the anterior and ventral region the *olfactory lobe* (OL), passing backwards into the *uncinate lobe* (U). A part only of each of these lobes is seen from this point of view (cf. p. 263 and Fig. 20, Pl. VIII.).

In the posterior part of the olfactory lobe is a fissure running in an antero-posterior direction, the *intra-olfactory fissure* (*i. ol*) it is usually very shallow and is often absent.

The fissure above the olfactory lobe and its continuation to the apex of the uncinate lobe is the *rhinal fissure* (*rh*) the continuation of this fissure backwards above the rest of the uncinate lobe is the *post-rhinal fissure*(5)[1] (*p. rh*) (cf. Fig. 20, Pl. VIII.). The post-rhinal fissure although always present is shallow (cf. Fig. 5, Pl. VII.). Above the anterior part of the rhinal fissure is a wedge-shaped convolution appearing to curve round from the median anterior surface of the brain, this is the *orbital lobe* (OR). In the orbital lobe is a fissure running in an antero-posterior

[1] This and similarly placed numbers refer to the list of Papers on p. 276.

direction, the *intra-orbital fissure* (*i. or*); it varies very considerably in development in different dogs and is often absent.

Anteriorly the rhinal fissure runs into the space between the olfactory tract (OL. T) and the cortex of the brain, when the olfactory tract is cut away a fissure is seen in the surface exposed, this is the *olfactory fissure* (*ol*) of Krueg(19) the ecto-rhinal fissure of Wilder(7) (cf. Plate VIII. figs. I. and II.).

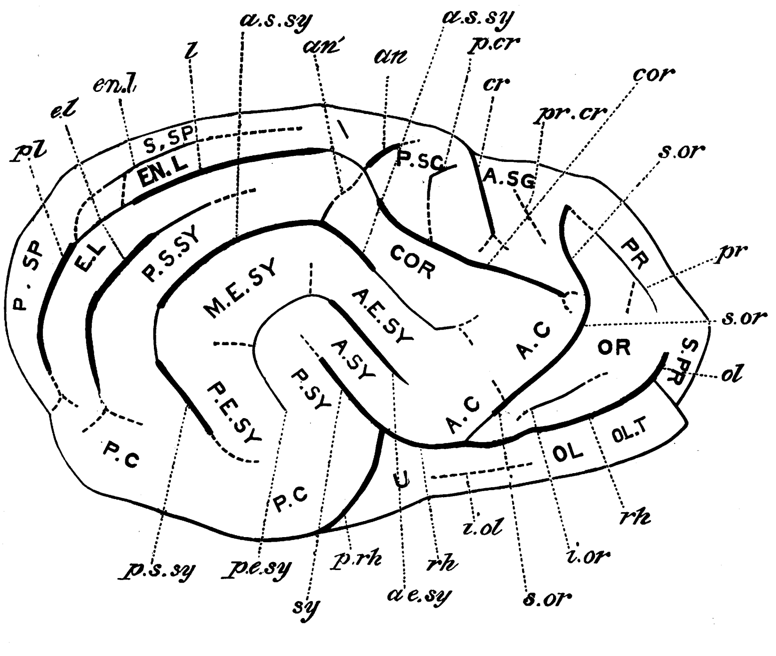

FIG. 1. **Fissures.** *a. e. sy.*, anterior ecto-sylvian; *a. s. sy.*, anterior supra-sylvian; *an.*, ansate; *an'.*, ansate minor; *cor.*, coronal; *cr.*, crucial; *e. l.*, ecto-lateral; *en. l.*, ento-lateral; *i. ol.*, inter-olfactory; *i. or.*, inter-orbital; *l.*, lateral; *ol.*, olfactory; *p. cr.*, post-crucial; *p. e. sy.*, posterior ecto-sylvian; *p. l.*, post-lateral; *p. rh.*, post-rhinal; *pr.*, prorean; *pr. cr.*, pre-crucial; *p. s. sy.*, posterior supra-sylvian; *rh.*, rhinal; *s. or.*, supra-orbital; *sy.*, sylvian. **Convolutions.** A. C., anterior composite; A. E. SY., anterior ecto-sylvian; A. SY., anterior sylvian; A. S. G., anterior limb of sigmoid gyrus; COR., coronal; E. L., ecto-lateral; EN. L., ento-lateral; M. E. SY., median ecto-sylvian; OL., olfactory lobe; OR., orbital lobe; OL. T., olfactory tract; P. C., posterior composite; P. E. SY., posterior ecto-sylvian; PR. prorean; P. S. SY., posterior supra-sylvian; P. S. G., posterior limb of sigmoid gyrus; P. SP., post-splenial; P. SY., posterior sylvian; S. PR., sub-prorean; S. SP., supra-splenial; U., uncinate.

Bounding the orbital lobe dorsally and posteriorly is the *supra-*

orbital fissure (*s. or*)[1], posteriorly this fissure joins in nearly all cases the posterior part of the rhinal fissure, near the point of junction it becomes less deep (cf. Fig. 5, Pl. VII.). Pansch(18) figures a brain in which these fissures were not connected (copied in Fig. 8, Pl. VII.).

Medially of the orbital lobe is the *prorean fissure* (*pr*) this usually runs downwards and forwards parallel to the inter-hemispherical fissure, it is not infrequently joined with the supra-orbital (cf. Fig. 2, Pl. VII.); when isolated it is often a mere triangular depression; it may be absent. The convolution medially of this fissure we may call the *prorean convolution* (PR).

The *Sylvian fissure* (*sy*) runs upwards and backwards from roughly speaking the point of junction of the rhinal and post-rhinal fissures at the apex of the lateral surface of the uncinate lobe. It may have one to three small branches at or near its apex, some variations of the Sylvian fissure and some points with regard to its relation with the rhinal and post-rhinal fissures will be considered later (p. 263).

Around the Sylvian fissure is the *first* or *Sylvian convolution* which may be considered as consisting of an *anterior Sylvian* (A. SY) and a *posterior Sylvian* convolution (P. SY).

The Sylvian convolution is bounded by the *ecto-sylvian fissure* which consists of the united *anterior ecto-sylvian* (*a. e. sy*) and *posterior ecto-sylvian* (*p. e. sy*) fissures. In the regular form of brain a short process runs from each sharp bend of the ecto-sylvian fissure into the convolution above (cf. Fig. 1).

The convolution above, i.e. dorsally of the ecto-sylvian fissure is the second or *inferior convolution*, it may be divided into an *anterior ecto-sylvian* (A. E. SY), a *median ecto-sylvian* (M. E. SY) and a *posterior ecto-sylvian* (P. E. SY) convolution.

This regular form of the first and second convolution is frequently departed from. The junction of the anterior and posterior ecto-sylvian fissures is sometimes absent; Krueg found it to be absent in 8 out of 57 hemispheres examined by him. This absence of union is shown in Fig. 8, Pl. VII. copied from Pansch(18); in this figure it is seen also that there are three dorsal processes from the anterior ecto-sylvian and one from the posterior, there may similarly be more than two processes when the fissures are united. Wilder(7) considers the ecto-sylvian fissure to consist of *three* fissures united, an anterior, a posterior and a median,

[1] The presylvian fissure of Owen and others. The term supra-orbital was I think first used by Flower (Anat. of Proteles cristatus, *Proc. Zool. Soc.* p. 479. 1869).

the median however does not as far as is known occur isolated. The posterior ecto-sylvian varies more than the anterior, it is often short and is sometimes connected by a depression (cf. Fig. 17, Pl. VIII.), or by a fissure with the Sylvian fissure. In two cases only have I seen it run on as a deep fissure (6 to 7 mm.) into the Sylvian. It is according to Krueg always present but Wilder(7) figures a hemisphere (Fig. 9, Pl. VII.) in which its presence is not very certain, probably however this is a special case of a short posterior ecto-sylvian running into the Sylvian fissure near its summit; one such case I have met with. In the brain of one dog figured here (Figs. 2 and 3, Pl. VII.) the posterior ecto-sylvian fissure seems to me to be absent on both sides, since the shallow vertical fissure which might perchance represent it in this brain is not infrequently present in brains which have an obvious posterior ecto-sylvian fissure. I have said that the Sylvian fissure has sometimes two or more processes running into the inferior convolution, perhaps the unusually long Sylvian fissure represented in Fig. 2, Pl. VII. is a special case of this. In one case I have seen the Sylvian join the anterior ecto-sylvian fissure (Fig. 3, Pl. VII.), here at the point of junction the fissure was five millimetres deep. In one case further I have seen the anterior ecto-sylvian join the short dorsally directed fissure which not infrequently runs from the supra-orbital (cf. Fig. 5, Pl. I.), so that the ecto-sylvian and supra-orbital fissures were connected; the fissure at the junction was however only 2 to 3 millimetres deep. In brains which vary much from the regular form, there are commonly several shallow fissures or depressions running across the first and second convolutions (cf. Figs. 2, 3, 5, Pl. VII.). Some of these variations are shown by Wilder(7) in his Figs. 21, 22, 23, 24, of the brains of Pomeranian dogs.

Dorsally of the inferior convolution curves the 3rd or *median convolution* between them is the supra-sylvian fissure which is usually considered to consist of two fissures the *anterior* (*a. s. sy*) and *posterior supra-sylvian fissures* (*p. s. sy*) joined at the posterior bend of the median convolution. In the adult dog I have in no case observed an indubitable[1] separation of these fissures, neither apparently has Krueg; but Wilder figures a brain (his Fig. 14, Pl. III.) in which the posterior supra-sylvian is either absent or not joined to the anterior; it is impos-

[1] In one instance I have seen a fairly deep fissure starting a little in front of the posterior end of the supra-sylvian fissure and running downwards and forwards in a line with the direction of the supra-sylvian, but it is possible that this fissure represented the nearly vertical fissure sometimes seen in the posterior ecto-sylvian convolution (cf. Figs. 3 and 8, Pl. VII.) and not the posterior supra-sylvian fissure.

sible to say which is the case since no side view of the brain is given. At the anterior bend of the median convolution running medially and forwards from the supra-sylvian is a fissure which may be called the *ansate minor* (*an'*) (cf. Fig. 2); it sometimes cuts the median convolution in two (cf. Figs. 1, 6, 7, Pl. VII.).

It occasionally happens that the anterior supra-sylvian and anterior ecto-sylvian fissures are connected by a fissure running transversely across the anterior ecto-sylvian convolution as in Fig. 10, Pl. VII. a semi-diagrammatic representation of the first and second convolutions of the dog's brain. A variation of this is shown in Fig. 3, Pl. VII. In Fig. 5, Pl. VII. the supra-sylvian joins the anterior ecto-sylvian fissure so that at first sight it appears as if the second convolution forms no part of the anterior composite convolution (cf. p. 260). The supra-sylvian fissure extends forwards to a very different extent in different dogs (cf. Fig. 2, Pl. VII. Fig. 17, Pl. VIII.).

The part of the median convolution which is in front of the ansate minor fissure may be called the *coronal convolution* (COR) or anterior supra-sylvian.

In the posterior part of the median convolution is the *ecto-lateral fissure* (*e.l*) (cf. Figs. 1 and 2) it varies considerably in length and depth (cf. Figs. 1 and 4, Pl. VII.); since the ecto-lateral fissure is always present and may extend as far back as the posterior end of the posterior supra-sylvian fissure and anteriorly may nearly reach the ansate minor, we may divide that part of the median convolution which lies between the coronal convolution and the posterior composite convolution (cf. p. 260) into the *ecto-lateral* (E. L) and *posterior supra-sylvian* (P. S. SY) convolutions, the former curving mesially around the latter.

In one dog's brain which in all other respects had a fairly typical arrangement of convolution and fissures, the ecto-lateral convolution was proportionately very large, and in its posterior portion there was a fairly long and deep additional fissure, posteriorly and laterally of the ecto-lateral; in this case there was also a small fissure running into the posterior composite convolution laterally of the inferior recurrent fissure (cf. p. 258).

Bounding the inter-hemispheral fissure is the *first* or *superior convolution* (Fig. 2); at about its anterior third it is broken by the *crucial fissure*[1] (*cr*) running out and slightly forwards from the inter-

[1] Dareste(2) considers the crucial fissure to have no type importance since according to him it is absent in some carnivora; Meynert(15) says it is absent in the bear but Pansch(17) and Krueg(19) consider the fissure called by Meynert the central fissure in the bear to be the crucial.

hemispheral fissure. The crucial fissure sometimes ends in two processes (cf. Fig. 4, Pl. VII.). Pansch considers this to be due to its uniting with a

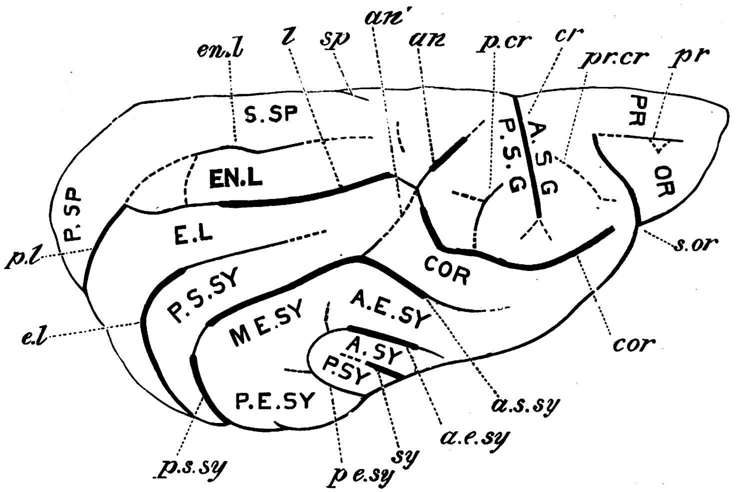

FIG. 2. **Fissures.** *a. e. sy.*, anterior ecto-sylvian; *a. s. sy.*, anterior supra-sylvian; *an.*, ansate; *an'.*, ansate minor; *cor.*, coronal; *cr.* crucial; *e. l.*, ecto-lateral; *en. l.*, ento-lateral; *l.*, lateral; *p. cr.*, post-crucial; *p. e. sy.*, posterior ecto-sylvian; *p. l.*, post-lateral; *pr.*, prorean; *pr. cr.*, pre-crucial; *p. s. sy.*, posterior supra-sylvian; *s. or.*, supra-orbital; *sp.*, splenial; *sy.*, sylvian. **Convolutions.** A. E. SY., anterior ecto-sylvian; A. SY., anterior sylvian; A. S. G., anterior limb of sigmoid gyrus; COR., coronal; E. L., ecto-lateral; EN. L. ento-lateral; M. E. SY., median ecto-sylvian; OR., orbital; P. E. SY., posterior ecto-sylvian; PR., prorean; P. S. SY., posterior supra-sylvian; P. S. G., posterior limb of sigmoid gyrus; P. SP., post-splenial; P. SY., posterior sylvian; S. SP., supra-splenial.

small neighbouring fissure (? pre-crucial). The bend of the superior convolution around the crucial fissure is the *sigmoid gyrus*[1] the part of it in front of the crucial fissure being the anterior limb (A. S. G), the part of it behind being the posterior limb (P. S. G).

The fissure which separates the sigmoid gyrus from the median convolution is the *coronal fissure* (*cor*), that which separates the superior and median convolutions in the middle part of their course is the *lateral fissure* (*l*), that which separates them in the posterior part is the *post-lateral* (*p. l*). As a rule the coronal and lateral and the lateral and post-lateral fissures are united, exceptions are shown in the Figs. in Pl. VII. As

1 This term was I think first introduced by Flower (Anat. of Proteles, *Proc. Royal Soc.* p. 479, 1869).

mentioned by Krueg the lateral and ecto-lateral fissures are occasionally united posteriorly, in this case the post-lateral is generally unconnected with any other fissure (Fig. 1, Pl. VII.). The lateral and ecto-lateral fissures may also be united anteriorly (Fig. 6, Pl. VII.). The lateral fissure is occasionally broken by bridging convolutions.

The post-lateral fissure varies considerably, when it is isolated it usually runs transversely; it may be visible on the dorsal surface of the brain for the greater part of its course or it may lie in the part of the cortex overlying the cerebellum, so that on the dorsal surface little or none of it is seen (Fig. 6, Pl. VII.); it may be broken up into two or three short fissures, and may be connected, usually by a shallower fissure, with the ecto-lateral (Figs. 1 and 6, Pl. VII.) or with the ento-lateral.

The post-lateral is called the medilateral by Krueg, but since Owen (4) does not recognize a medilateral in the dog but uses it in the bear and some other animals for a fissure in the 4th convolution which is not homologous with the post-lateral of the dog, and since Wilder (7) sometimes (cf. his Fig. 16) uses medilateral for the ento-lateral fissure of the dog[1], I think it better to use for the dog the more descriptive name post-lateral.

At about the place of junction of the coronal with the lateral fissures, a short fissure runs forwards and medially in the superior convolution, this is the *ansate fissure* (*an*). The ansate fissure is usually joined both with the coronal and with the lateral fissures, in 57 hemispheres examined by Krueg the junction failed eight times with the coronal and eight times with the lateral. For isolation of the coronal compare Fig. 9, Pl. VII. (copied from Wilder) and Figs. 7, 8, Pl. VII. (copied from Pansch). I have myself not seen any brain in which the ansate fissure was isolated, in Figs. 1 and 6 of Pl. VII. some curious varieties in the coronal, ansate, and lateral are given; on both sides in Fig. 6 and on the right side in Fig. 1, the coronal is connected with a fissure, possibly the post-crucial, running into the posterior limb of the sigmoid gyrus; in Fig. 1 this might be mistaken for the ansate. In Fig. 6 the lateral is divided into two parts, the anterior being connected with the ansate, the posterior being on the right side isolated, on the left side connected by a shallow fissure with the ecto-lateral.

It will be noticed that whilst the fissure bounding the median convolution dorsally is divided into coronal, lateral and post-lateral; the fissure bounding it ventrally is only divided into anterior and posterior supra-sylvian; the posterior supra-sylvian probably corresponds to the post-lateral and it seems

[1] Wilder in his later paper on the brain of the cat (20) adopts the names used by Krueg.

not unlikely that the anterior supra-sylvian is really formed (as was suggested by Wilder) of two separate fissures joined together at and with the ansate minor just as the coronal and lateral fissures are usually joined at and with the ansate.

In the more richly fissured brains it sometimes happens that there is a fissure running from the supra-sylvian in front of the ansate minor into the coronal convolution, it is shallower than the ansate minor (cf. Fig. 4, Pl. VII.). In these cases there is often a fissure running in the opposite direction from the posterior part of the coronal fissure into the coronal convolution (cf. Fig. 4, Pl. VII.). For modifications of this cf. Figs. 1 and 6, Pl. VII.

In the anterior limb of the sigmoid gyrus a shallow fissure the *pre-crucial* (*pr. cr*) sometimes occurs.

In the posterior limb of the sigmoid gyrus the *post-crucial fissure* (*p. cr*) is generally present, it is possibly this fissure that is connected with the coronal in Figs. 1 and 6, Pl. VII.; in one case I have seen it joined by a fissure 2 m.m. deep with the base of the ansate.

Some little distance behind the sigmoid gyrus, in the superior convolution the shallow *ento-lateral fissure* (*en. l*) (the *fissura confinis* of Krueg) is generally present; occasionally this fissure is connected posteriorly with the posterior part of the lateral or with the post-lateral; although usually short and shallow it may be 4 to 5 mm. deep and run forward nearly to the ansate fissure.

Turning now to the surface of the brain exposed by a median longitudinal section (Fig. 3) it is seen that the dorsal portion is formed by the superior convolution, this in the median and hind part of its course is bounded ventrally by the combined *crucial* (*cr*) and *splenial fissures* (*sp*); in rare cases the junction of these fissures is wanting (Krueg); one such case is figured by Lussana and Lemoigne(6). Anteriorly the splenial fissure curves forwards and upwards nearly or quite to the surface of the brain[1]; posteriorly it joins in nearly all cases the post-rhinal fissure: Krueg found the junction absent in 3 hemispheres out of 32.

From about the point of junction of the splenial and post-rhinal fissures two fissures usually run into the posterior composite convolution (cf. p. 260), these we may call the *superior* and *inferior recurrent fissures* (*s. r* and *i. r*). In the regular type of brain, they run nearly parallel to one another, the superior recurrent a little mesially of the end of the

[1] The anterior end of the splenial may run forward within 3 or 4 mm. of the ansate, usually it ends much farther back.

post-lateral fissure, the inferior recurrent a little mesially of the end of the ecto-lateral fissure; the inferior recurrent may be joined by a shallow

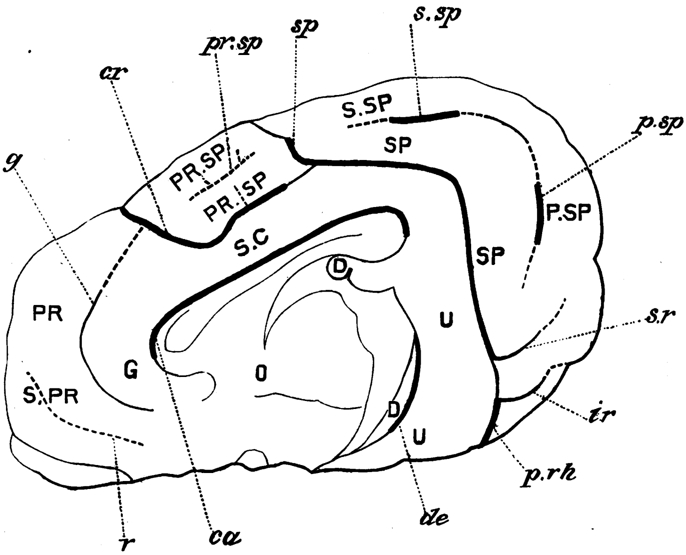

FIG. 3. **Fissures.** *ca.*, callosal; *cr.*, crucial; *de.*, dentate; *g.*, genual; *i. r.*, inferior recurrent; *p. rh.*, post-rhinal; *pr. sp.*, pre-splenial; *p. sp.*, post-splenial; *r.*, rostral; *s. r.*, superior recurrent; *sp.*, splenial; *s. sp.*, supra-splenial. **Convolutions.** D., dentate; G., genual; PR., prorean; PR. SP., pre-splenial; P. SP., post-splenial; S. C., supra-callosal; S. PR., sub-prorean; SP., splenial; S. SP., supra-splenial; U., uncinate.

fissure with the ecto-lateral. When the post-lateral and ecto-lateral fissures depart from the typical arrangement the position of the recurrent fissures varies considerably, in one case the inferior recurrent was connected by a shallow fissure with the supra-sylvian. The inferior recurrent was present in all the brains that I have examined, the superior recurrent was absent in one only; the former probably represents the end of the post-rhinal fissure, the latter possibly the end of the splenial fissure.

In front of the anterior curving part of the splenial fissure (*sp*) and above the posterior part of the crucial fissure (*cr*) is usually a shallow fissure which we may call the *pre-splenial* (*pr. sp*). In the posterior part of the superior convolution above the splenial fissure (*sp*) is the *supra-splenial fissure* (*s. sp*), posteriorly to this and usually connected with it is the *post-splenial fissure* (*p. sp*). We may conveniently divide the superior convolution into tracts corresponding to these fissures.

The posterior limb of the sigmoid gyrus we may consider as bounded medially by the ansate fissure and by a line passing from the end of the ansate fissure to the crucial. That part of the median surface of the superior convolution which lies between the crucial and splenial fissures we may call the *pre-splenial convolution* (PR. SP.) including in this the part of the dorsal surface which lies medially of a line drawn from the splenial fissure to the ansate. The part of the superior which lies between the splenial fissure on the one hand and the supra- and post-splenial fissures on the other we may call the *splenial convolution*, the remainder of the superior we may divide into the ento-lateral *convolution* (EN. L) to the outside of the ento-lateral fissure (*en. l*) and the *supra-splenial* and *post-splenial convolutions* (S. SP and P. SP) corresponding with the supra-splenial and post-splenial fissures.

Short shallow transverse foldings are not uncommon in the middle third of the mesial border of the superior convolution; in Fig. 4, Pl. VII. for example there is one such which simulates the end of the splenial fissure; on the dorsal surface there is very commonly a shallow transverse depression between the ansate and ento-lateral fissures (cf. Fig. 2), this may join the lateral.

Both in front and behind, the ends of the superior, median, inferior and Sylvian convolutions are seen to run together (Fig. 1). The convolutions which are formed by their junctions anteriorly and posteriorly I call the *anterior* and *posterior composite convolutions* (A.C and P.C). I introduce these names because I find them necessary for the description of the uninjured portion of the brain in Goltz' dog. In this animal the ends of the limiting fissure of the external convolutions are for the most part destroyed so that it is impossible to say to which convolution the remaining portions belong; even in the normal brain such a division of these unfissured portions must be somewhat arbitrary. The anterior-composite convolution corresponds very closely to the *operculum* of Meynert, except that he includes in the operculum the anterior Sylvian convolution.

In the anterior and posterior composite convolutions there occur in different dogs various shallow fissures (cf. Figs. 2, 3, 5, Pl. VII.). The most common are, a nearly vertical fissure in front of the anterior ecto-sylvian fissure, and a similar usually longer fissure behind the posterior ecto-sylvian fissure. Each may be connected by a depression or shallow fissure with any one of the neighbouring fissures.

Krueg figures a diagonal fissure in several carnivora but not in the dog although he does not say that it may not be present; in his figures it is a fissure running nearly horizontally either connected with the anterior ecto-sylvian and between the anterior ends of the ecto-sylvian and supra-sylvian fissures or still farther forward in the anterior composite convolution.

Wilder (20) figures the diagonal in the cat as a more vertical fissure in front of the end of anterior ecto-sylvian (with which it may be connected) and as a small triangular depression in the anterior composite convolution below the ecto-sylvian fissure. A horizontal fissure as figured by Krueg is occasionally present but placed more anteriorly; short nearly vertical fissures and small depressions like those figured by Wilder as the diagonal in the cat are not uncommon in the posterior part of the anterior composite convolution of the dog.

In the anterior part of the mesial surface of the brain (Fig. 3), the *genual fissure* (*g*) is seen curving round the genu of the corpus callosum. In one case I have seen this connected by a shallow depression with the crucial, the genual fissure is very variable in position and size, since it is however usually present we may distinguish the fold between it and the corpus callosum as the *genual convolution* (G). The posterior portion of the genual convolution passes into the septal area of Huxley[1].

Krueg does not figure a rostral fissure in the dog; in Fig. 19, Pl. VII. there is a shallow fissure in front of the genual which may perhaps represent the *rostral fissure* (*r*); in no other dog's brain have I seen more than mere indications of it.

Between the corpus callosum and the combined crucial and splenial fissures is the *supra-callosal convolution*[2] (S. C.) anteriorly this joins the genual convolution, posteriorly it joins the uncinate (U) (cf. p. 262). In its posterior part there is occasionally a shallow fissure running parallel to the splenial.

Immediately above the corpus callosum is a shallow fissure the *callosal* (*ca*).

In the great majority of dogs it would appear from the dissection of the brain that the supra-callosal convolution rises to the dorsal surface in front of the crucial fissure to form the anterior limb of the sigmoid gyrus. This view was put forward by Leuret and Gratiolet. In some other carnivora however[3] the anterior limb of the sigmoid gyrus is cut off from

[1] Huxley. "The structure and classification of Mammalia." *Medical Times and Gazette*, March 5, 1854, p. 256.

[2] This is part of gyrus fornicatus of Meynert, part of internal convolution of Leuret and Gratiolet.

[3] e.g. Proteles, cf. Flower, *Proc. Zool. Soc.* 1869, p. 481, Fig. 4

the supra-callosal convolution by the junction of the genual fissure with the crucial. I have mentioned above an approach to this in the dog; another variation I give in Fig. 11, Pl. VII. Hence it seems to me preferable to limit the anterior limb of the sigmoid gyrus mesially to the line which the genual takes when it joins the crucial; anteriorly it is bounded by the line which would be taken by prolonging the supra-orbital to the genual.

In those dogs in which the genual fissure is only indicated by a trifling depression the separation of a genual convolution may seem very arbitrary, but in transverse sections it is seen that the cortex which curls round the corpus callosum has a different structure from the cortex of neighbouring parts; mesially and inferiorly the genual convolution bounds the lateral ventricle.

According to Leuret and Gratiolet the sub-orbital lobe (cf. p. 267) as well as the anterior limb of the sigmoid gyrus is formed by the continuation forwards of the internal convolution. In this case we could diagrammatically represent the chief convolutions and fissures of the brain as in Fig. 12, Pl. VII. Meynert (op. cit. p. 266) considers that the genual and supra-callosal convolutions are parts of the gyrus fornicatus (cf. p. 267), and are quite distinct from the sub-orbital lobe and the sigmoid gyrus. On this view, which I am inclined to follow, the diagrammatic representation of the dog's brain would be as in Fig. 13, Pl. VII. At (62) in each figure the fissures are with varying degrees of frequency not continuous.

From the arrangement of the strands of white fibres in the cortex anteriorly to the genual convolution (cf. below p. 278), I divide this portion of the cortex into a dorsal part belonging to the *prorean* convolution (PR) (cf. above p. 253), and a ventral part, the *sub-prorean* convolution (S. PR); from the lateral view of the brain (Fig. 1), part of this can be seen, normally it is almost or entirely hidden by the olfactory tract. The olfactory fissure may be considered as the dorsal lateral boundary of the sub-prorean convolution.

The supra-callosal convolution curves round the splenium of the corpus callosum and is continuous with the uncinate convolution (U). The uncinate convolution (Fig. 3) curves a short way under the splenium; and below this curves laterally; this curving portion is separated by the shallow *dentate*[1] *fissure* (*de*) from the *dentate convolution* (D). The dentate and uncinate convolutions form the mesial wall of the posterior part of the lateral ventricle; the dentate convolution ends with a free edge (except for the posterior pillars of the fornix) and

[1] This term was introduced by Huxley ("Brain of Ateles paniscus." *Proc. Zool. Soc.* of London p. 255, 1861.

runs in approximately a semicircle from the corpus callosum to the end of the descending cornu of the lateral ventricle: the dentate fissure runs parallel to the free edge and marks the fold which the cortex here makes upon itself.

The uncinate and dentate lobes together are called by Leuret and Gratiolet the hippocampal, Flower uses hippocampal lobe in the same sense. Meynert marks the posterior part of the uncinate which can be seen in a mesial view, as the posterior part of the gyrus fornicatus. Krueg uses the term hippocampal lobe for the mesial curved part of the uncinate lobe, the lateral part he calls the pyriform lobe[1]. In some cases the hippocampal lobe is used vaguely for that part of the cortex in which lies the dentate fissure and which is represented by the hippocampus of the lateral ventricle. For the nomenclature used by Broca cf. Part II., p. 274.

The posterior boundary of the hippocampus is not marked externally by a fissure, it corresponds roughly to the anterior and the dorsal edge formed by the uncinate convolution as it curves laterally to form the mesial wall of the lateral ventricle. On a mesial view of the brain with optic thalamus and corpora geniculata intact but with corpora quadrigemina and underlying parts removed only the edge of the outer surface of the hippocampus can be seen, on such a view the dentate (hippocampal) fissure is hidden; in the figures of Owen and Krueg the lateral continuation of the so-called transverse fissure is marked as the hippocampal.

When the Sylvian fissure is opened or better when the Sylvian convolution is cut away (Fig. 16, Pl. VII.) a flat triangular space, the *island of Reil* (I. R), is seen, normally this is overlapped by the anterior and posterior Sylvian convolutions and by small adjacent portions of the anterior and posterior composite convolutions. The rhinal and postrhinal fissures are connected; both of them being here shallow, they form the dorsal lateral boundary of the olfactory and uncinate lobes.

The island of Reil varies somewhat in size and shape in different dogs; in alcohol-hardened brains its medial lateral surface is often pressed up into the Sylvian fissure between the anterior and posterior Sylvian convolutions. Between it and each of these convolutions is a depression the fissura Sylvii anterior and fissura Sylvii posterior of Krueg, these depressions are usually united dorsally and give off an upward process; this is the fissura Sylvii acuminis of Krueg; the anterior may join either the rhinal or supra-orbital fissures (cf. Figs. 14, 15, Pl. VII.

[1] That part of the lateral region of the uncinate lobe which is anterior to the lateral ventricle might perhaps be called the pyriform lobe, although this part is not well defined on the surface.

copied from Krueg), the posterior occasionally joins the post-rhinal. It may be doubted whether the fissura acuminis should be considered as a separate fissure. For the views of Broca cf. Part II. p. 274.

Thus not all the fissures bounding the island of Reil are separately represented on the surface of the brain (cf. Fig. 1); of the fissures seen on the surface it seems to me most convenient to restrict, as I have done in the foregoing account, the Sylvian fissure to that between the anterior and posterior Sylvian convolutions, and to call the anterior prolongation of this above the olfactory lobe the rhinal fissure and the posterior continuation above the uncinate lobe the post-rhinal fissure. It is to be remembered that when the posterior part of the rhinal is opened a part of the f. Sylvii anterior, and sometimes the end of the supra-orbital, is seen in addition to the rhinal, and when the anterior part of the post-rhinal is opened, a part of the f. Sylvii posterior is seen as well as the post-rhinal.

Wilder calls that part of the rhinal fissure which stretches from the junction of the supra-orbital to the Sylvian fissure the basi-sylvian fissure.

Meynert takes the island of Reil as stretching forwards underneath the anterior composite convolution and including the posterior part of the orbital lobe (cf. his Fig. 5, op. cit.).

Summing up the convolutions of the dog's brain we have

1. The 1st or Sylvian convolution subdivided into
   The anterior Sylvian.
   The posterior Sylvian.

2. The 2nd or Inferior convolution subdivided into
   The anterior ecto-sylvian.
   The median ecto-sylvian.
   The posterior ecto-sylvian.

3. The 3rd or Median convolution subdivided into
   The coronal or anterior supra-sylvian.
   The posterior supra-sylvian.
   The ecto-lateral.

4. The 4th or Superior convolution subdivided into
   The anterior limb of the sigmoid gyrus.
   The posterior limb of the sigmoid gyrus.
   The pre-splenial.

The splenial.
The supra-splenial.
The post-splenial.
The ento-lateral.

5. Adjuncts to the above four External convolutions
The anterior composite.
The posterior composite.

6. The Internal convolution subdivided into
The genual.
The supra-callosal.
The uncinate.
The dentate.
The island of Reil.
The olfactory.

7. The Sub-orbital convolution subdivided into
The orbital.
The prorean.
The sub-prorean.

PART II.

Literature relating to the Fissures and Convolutions of the Dog's Brain.

The following two Tables show the names which have been used for the fissures and convolutions by those observers who have attempted to describe the brain at all fully. In the short abstracts of the papers bearing on the subject, which come after these Tables, the points which have been already mentioned in the account of the brain or in the Tables are as a rule omitted; one or two papers have required no further account.

Table of Synonyms of Fissures of Dog's Brain.

Names adopted in this Paper.	Symbol	Owen 1868	Lussana and Lemoigne 1871	Wilder 1873	Meynert 1876	Broca 1878	Pansch 1879	Krueg 1880	
1. Rhinal	*rh.*	rhinal or ecto-rhinal		ecto-rhinal and rhinal	ant. part = sulcus rectus post. part = horizontal part of sylvian	part of limbic f. (cf. below)	limiting f. of olfactory lobe	f. rhinalis	1.
2. Post-rhinal	*p. rh.*						limiting f. of hippocampal lobe	f. rhinalis posterior	2.
3. Supra-orbital	*s. or.*			pre-sylvian	ascending branch *sy.*	f. of Rolando	anterior vertical chief f.	f. prae-sylvia	3.
4. Prorean	*pr.*	super-frontal						f. prorea	4.
5. Anterior ecto-sylvian	*a. e. sy.*	ant. branch *e. sy.*	parallel	ant. branch *e. sy.*	parallel or lower radial or 1st parieto-temporal		lowest curved f.	f. anterior	5.
6. Posterior ecto-sylvian	*p. e. sy.*	post. branch *e. sy.*		post. branch *e. sy.*				f. posterior	6.
7. Anterior supra-sylvian	*a. s. sy.*	super-sylvian	occipito-temporal	super-sylvian	inter-parietal or 2nd parieto-temporal or posterior radial	primary parietal = inter-parietal	lateral curved chief f. = inter-parietal of man	f. supra-sylvia	7.
8. Minor ansate	*an′*			branch *s. sy.*					8.
9. Posterior supra-sylvian	*p. s. sy.*	post-sylvian		super-sylvian				f. supra-sylvia posterior	9.
10. Coronal	*cor.*	coronal		coronal	f. of Rolando		upper longitudinal chief f. (coronal = f. of Rolando)	f. coronalis	10.
11. Ansate	*an.*	lateral		branch of lateral	retro-central			f. ansata	11.
12. Lateral	*l.*			lateral				f. lateralis	12.
13. Post-lateral	*p. l.*				? part of retro-central			f. medi-lateralis	13.
14. Ecto-lateral	*e. l.*			ecto-lateral			posterior lateral f.	f. ecto-lateralis	14.
15. Ento-lateral	*en. l.*			medi-lateral				f. confinis	15.
16. Genual	*g.*					sub-frontal		f. genualis	16.
17. Crucial	*cr.*	frontal	cruciate	frontal	calloso-marginal	sub-parietal	medial chief f.	f. cruciata	17.
18. Splenial	*sp.*	super-callosal			occipital			f. splenialis	18.
19. Pre-crucial	*pr. cr.*							f. præ-cruciata	19.
20. Post-crucial	*p. cr.*							f. post-cruciata	20.
21. Supra-splenial	*s. sp.*	marginal					posterior medial f.	f. supra-splenialis	21.
22. Post-splenial	*p. sp.*							f. post-splenialis	22.

Table of Synonyms of Convolutions of Dog's Brain.

Names used in this Paper	Symbol	Leuret and Gratiolet 1859	Owen 1868	Lussana and Lemoigne 1871	Meynert 1876	Broca 1878	Pansch. 1879	
1. Olfactory	OL.	olfactory ⎱ ? part of	olfactory	olfactory	olfactory	olfactory	olfactory	1.
2. Island of Reil	I. R.	island of Reil ⎰ internal	island of Reil	island of Reil	(cp. below)	sub-sylvian lobule	island of Reil	2.
3. Orbital	OR.	sub-orbital	mid-frontal	process of descending internal		asc. frontal		3.
4. Prorean	PR.		lateral part = super-frontal		parts of frontal		supra-orbital	4.
5. Sub-prorean	S. PR.	? part of sub-orbital				part of frontal	[cinguli	5.
6. Genual	G.	? part of internal		descending internal	parts of gyrus fornicatus		? part of gyrus	6.
7. Supra-callosal	S. C.	internal		horizontal internal		limbic	gyrus cinguli	7.
8. Uncinate	U.			post. mesial part = asc. int. lateral part = mastoid.	(cp. below)		hippocampal	8.
9. Dentate [gyrus	D.							9.
10. Ant. limb sigmoid	A. S. G.			process of desc. internal	anterior central	(cp. below)	anterior frontal	10.
11. Post. limb sig. gyr.	P. S. G.		lateral part = post-frontal	process quadrilateral	posterior central		posterior frontal	11.
12. Pre-splenial	PR. SP.	superior or 4th external	part of these seen on dorsal surface = medial	mesial part = quadrilateral		4th parietal or sagittal		12.
13. Supra-splenial	S. SP.						marginal	13.
14. Post-splenial	P. SP.			occipito-temporal				14.
15. Ento-lateral	EN. L.							15.
16. Splenial	SP.			Peripheral occipital				16.
17. Coronal or Ant. supra-sylvian	COR.		super-sylvian or lateral	the part of 3rd conv. behind coronal f. = external occipital	upper parietal			17.
18. Ecto-lateral	E. L.	median or 3rd external			(cp. below)	3rd parietal	supra-sylvian	18.
19. Post. supra-sylvian	P. S. SY.		post-sylvian					19.
20. Ant. ecto-sylvian	A. E. SY.	inferior or 2nd external			2nd parietal	2nd parietal	outer sylvian	20.
21. Post. ecto-sylvian	P. E. SY.			2nd temporal	2nd temporal			21.
22. Ant. sylvian	A. SY.	sylvian or 1st external		part of operculum	1st parietal	1st parietal or sylvian	inner sylvian	22.
23. Post. sylvian	P. SY.			1st temporal	1st temporal			23.
24. Anterior composite	A. C.	parts of the four external		part of operculum	part of operculum	ant. part=asc. parietal (cp. below		24.
25. Posterior composite	P. C.							25.

Other fissures referred to in the text which have not received several names and some of which are newly introduced are—The dentate (*de*) or hippocampal (cf. p. 263); the Sylvian (*sy*) called by Meynert the posterior branch of the Sylvian (cf. p. 273); the f. Sylvii anterior (*sy. a*), f. Sylvii posterior (*sy. p*) and f. Sylvii acuminis (*sy. ac*) of Krueg (cf. p. 263); the olfactory (*ol*) (cf. p. 252); the diagonal of Krueg (cf. p. 260); the intra-olfactory (*i. ol*); the intra-orbital (*i. or*), the superior recurrent (*s. r*); the inferior recurrent (*i. r*); the rostral (*r*); the callosal (*ca*) (Owen); the pre-splenial (*pr. sp*).

In the following Abstracts the names used by the Authors of the Papers are translated into the nomenclature used in Part I. of this Paper, wherever it has seemed possible that the two might be confused the names used by the Authors are put in italics.

Leuret and Gratiolet(1). The fox, dog, wolf make up the 3rd group of mammals classified according to the arrangement of the convolutions of their brains. Each hemisphere in this group has six convolutions, four external, the internal and the sub-orbital. The line of junction between the internal and sub-orbital is not given. Most of the fissures are figured but un-named with the exception of that to which Leuret and Gratiolet gave the name of crucial.

Dareste(2) considers the chief convolutions of the brain in mammals and divides them into four types. Of these carnivora form one; having a sub-type of the canidæ. The canidæ he says besides the sub-orbital have four chief convolutions which are united at their ends only (from Owen, Wilder and Krueg we know that they may also be united at certain parts along their course). He names the convolutions the reverse way to that done by Leuret and Gratiolet so that it is the second (the third or Median of L. and G.) in which he describes a fissure (the ecto-lateral of Wilder) as often occurring. The supra-callosal and uncinate convolutions are not mentioned. He does not mention or give any figures of the brains of dogs. In his earlier papers[1] he had pointed out that the complexity of convolutions of the brains of animals of the same genus depends largely upon the size of the animal.

Pansch(3) devotes himself chiefly to an account of the development of the fissures in man and apes; he gives also a short description with figures of the chief fissures of the fœtal and adult dog; in the fœtal dog there are three curved fissures on the lateral surface of the hemisphere,

[1] Dareste. *Ann. des sc. Nat.* Third Ser. t. XVII. p. 34, 1882; Fourth Ser. t. I. p. 73, 1883.

the upper one (= coronal and ? lateral) probably corresponds, he says, to the third radial primary fissure of man, the fourth typical fissure of higher apes, it bounds the post-central convolution; the middle and lower curved fissures of the dog are not represented in man and apes. The inner fissures (= crucial and splenial fissures) probably correspond to the inner primary fissure of man and apes. What these fissures represent in the adult brain of man and apes he does not say. He points out that in the adult dog the fissures may differ somewhat in the two sides of the brain; his figures 41 and 42 of the dog's brain differ so much from any brain I have seen that I am inclined to doubt their accuracy.

Owen(4) gives no direct account of the brain of the dog; in his general description of the brain of mammals he gives the sub-class of canidæ and takes the fox as the type of it. The account (p. 117) is short but the figures given have most of the fissures and convolutions lettered and on a reference to the index (p. 137) can be determined. Reference to the figures given of the brain of the cat and of other carnivora also helps to determine the names which the fissures and convolutions of the brain of the dog would receive in Owen's nomenclature.

The crucial fissure is taken as dividing the pre-frontal from the post-frontal regions; the *post-frontal region* is however limited to the lateral part of the posterior limb of the sigmoid gyrus, apparently it is bounded medially by the post-crucial fissure; the median part of the posterior limb of the sigmoid gyrus belongs to the *medial fold.*

The supra-orbital fissure is apparently considered to be part of the Sylvian fissure.

The middle part of the second convolution is called part of the Sylvian; in the figure of the fox's brain the ends of this convolution are marked ento-rhinal, in the figure of the cat's brain the anterior end is marked as the pre-sylvian fold. In higher mammals falcial and sub-falcial fissures probably corresponding with the genual and rostral are given, but they are not described in carnivora. An ecto-lateral fissure is figured in the fox, but on the lateral view of the brain it receives no name and on the surface view it is, probably by an engraver's error, called the post-sylvian.

Gervais(5) gives a general account of the forms of the brain and of the arrangement of convolutions in carnivora accompanied by excellent figures: for the dog's brain he adds however little to the description of Leuret and Gratiolet, the sigmoid gyrus he calls the frontal area, he compares the shape of the brain in different species of dogs; his figures of the dog's brain are unfortunately for our purpose taken from casts of the inside of skull so that the minor fissures cannot be satisfactorily made out.

Lussana and Lemoigne(6) follow Leuret and Gratiolet in dividing the cerebral cortex of the dog into an internal and four external convolutions; the mesial surface of the internal they divide into an ascending, a horizontal and a descending portion as given in the Table above. The *descending portion* gives off three processes, one corresponding roughly to the sub-prorean; one, the *frontal*, corresponding roughly to the prorean and orbital combined, and one corresponding to the anterior limb of the sigmoid gyrus.

Lussana and Lemoigne consider that the *internal convolution* is connected with the *fourth external* between the crucial and splenial fissures (we have seen that in dogs these fissures are usually united so that this junction cannot be considered as normal). The part of the fourth convolution on the mesial surface between these fissures they call the quadrilateral lobe. From this lobe several processes are given off, one corresponding to the posterior limb of the sigmoid gyrus, another including that part of the surface of the fourth or superior convolution which stretches from the sigmoid gyrus to the level of the splenial fissure, a third the *occipito-temporal* corresponding to the splenial, and a fourth the *peripheral occipital* corresponding to the remainder of the superior convolution, i.e. roughly to the supra-splenial, post-splenial and confined convolutions. The anterior composite convolution together with the anterior Sylvian convolution they call the operculum.

Hitzig(9) divides the cortex of the dog's brain into frontal, parietal, temporal and occipital regions. He takes the united ansate and ansate minor fissures together with the part of the supra-sylvian fissure which lies in front of the ansate minor to correspond to *the fissure of Rolando* of primates. This conclusion is founded chiefly upon the results of a comparison of the motor areas of the dog and the ape. The various regions of the brain are thus divided to a great extent independently of the fissures. The *frontal lobe* includes the sub-orbital lobe, and that part of the anterior limb of the sigmoid gyrus which lies mesially of a line drawn in a sagital direction from the anterior end of the crucial fissure to the supra-orbital fissure. The *parietal lobe* includes all the parts of the four external convolutions which lie in front of a line drawn from the posterior end of the sylvian fissure through the ansate minor and ansate fissure, with the exception of the portion of the anterior limb of the sigmoid gyrus spoken of above as belonging to the frontal lobe (i. e. includes the lateral part of A. S. G, the P. S. G, COR., A. E. SY., A. SY and the A. C.). The *occipital lobe* includes the part of the superior convolution which lies behind the ansate fissure, the ecto-lateral and posterior supra-sylvian convolutions except an ill-defined posterior which is considered to belong to the temporal lobe; to the *temporal lobe* also belong the posterior ecto-sylvian and posterior-sylvian convolutions.

Hitzig considers that the posterior limb of the sigmoid gyrus, the lateral portion of the anterior limb, and the coronal convolution, correspond to the *gyrus pre-centralis* or anterior central convolution of man and apes. This is included by Hitzig in the parietal, and not in the frontal lobe, since in man the anterior central convolution lies under the parietal bone.

Betz(10) bases his conclusions chiefly on the histological structure of the parts of the brain. The cortex of the brain of man and higher apes he finds is divided into two regions by the fissure of Rolando, the part in front of this fissure is distinguished by having giant-pyramidal cells arranged in groups; these cells occur in greatest number in a portion of the medial surface which he calls the para-central lobe, it is separated by fissures from the medial surface of the first frontal convolution in front of it, from the gyrus fornicatus below it and from the quadrate lobe behind it; apparently then it corresponds to posterior part of the marginal convolution, although it is a little difficult to see how the whole of this can be said to be in front of the fissure of Rolando.

Similar giant-cells arranged also in groups he found in the dog in the convolution bounding the surface part of the crucial sulcus (sigmoid gyrus) and in the anterior half of the convolution behind and abutting on it (? coronal convolution) and in these only. He concludes that these parts in the dog are homologous with the para-central lobe of man, that the central convolutions of man are not represented in the dog, and that the frontal lobe of man is represented by the cortex anterior to the giant-cell area of the dog (i.e. roughly by the sub-orbital convolution).

Pansch(11) contests the views of Hitzig and Betz with regard to the regions of the brains of dogs and apes which are equivalent. All mammals which have fissured brains—except the lowest apes with slightly fissured brains—show in the fœtal stage three primary fissures on the lateral surface. From the fissures which these give rise to in the adult he concludes that the anterior bent fissure of the dog (= supra-orbital) corresponds with the prae-central (first primary fissure); the anterior part of the middle curved fissure of the dog (anterior suprasylvian, ? part in front of ansate minor) corresponds with the interparietal (third primary fissure); the anterior part of the upper curved fissure of the dog (coronal fissure) corresponds with the fissure of Rolando (second primary fissure), thus the anterior ends of the third and fourth convolutions of the dog correspond with the central convolutions of man and apes.

Wernicke(12) considers with Leuret that the surface cortex of all mammalian brains consists typically of four convolutions curved around the Sylvian fissure; in primates he considers these convolutions are divided by two, roughly speaking transverse, fissures, the fissure of Rolando and the lower occipital fissure, in the (e.g.) dog these fissures are absent and the convolutions thus run without break, nevertheless their anterior middle and posterior regions are homologous with the anterior, middle and posterior regions into which the convolutions of the primate are divided by the fissure of Rolando and lower occipital fissure. It needs hardly to be pointed out that this does not agree with the conclusions of most observers.

Ferrier(13) names the four external convolutions in the reverse order to that used by Leuret and Gratiolet, so that with him the superior is the first, the Sylvian the fourth convolution.

Benedikt(14) attempts to show from observations on the brains of criminals which he regards as degradation forms (Rückfall's Gehirne) that the surface cortex of the brain of man consists of four convolutions like that of carnivora. (It may be remarked that in some carnivora, e.g. the bear, there are only three external convolutions; probably the ectosylvian fissure, variable in most carnivora, is absent in the bear, cf. Meynert, Pansch, Krueg.)

Meynert(15) compares the convolutions and fissures of the brains of carnivora, apes and man.

The coronal fissure he considers to be homologous with the central fissure or fissure of Rolando of man, this then divides the frontal from the parietal regions.

The first two convolutions he calls the first and second parieto-temporal convolutions, the parietal being apparently divided from the temporal portions by a line continuing the Sylvian fissure upwards and backwards.

The third or median convolution he calls the upper parietal (occipital) convolution [Dritterscheitel (Hinterhaupt), Bogen] but in the Figs. of the brain of a bear (his Fig. 17) and of a lion (his Fig. 23) the lower posterior end of this—partly posterior supra-sylvian convolution, partly posterior composite convolution—is marked as a third temporal convolution. The lateral part of the uncinate convolution (cf. his Fig. of brain of bear,) is also included in the temporal lobe.

The occipital lobe is not specially defined, presumably it includes the posterior part of the fourth convolution and the median posterior part of the third (= ecto-lateral convolution) together with the parts of the posterior composite convolution in which they end.

The small piece of cortex curving round the anterior end of the supra-orbital fissure is called by Meynert the gyrus transitorius.

The sigmoid gyrus forms the *central convolution* and is divided into an anterior and posterior part by the *calloso-marginal fissure* (crucial).

In the gyrus fornicatus Meynert includes the genual and supra-callosal convolutions and the posterior mesial portion of the uncinate.

The anterior composite convolution together with the anterior Sylvian forms the operculum, the operculum is bounded by the Sylvian fissure, which is divided by Meynert into three portions, an anterior branch corresponding to the supra-orbital fissure, a median horizontal branch corresponding to the posterior part of the rhinal, a posterior branch corresponding to the Sylvian fissure as used here. It will be noticed that this division is made from the appearance of the fissures on the surface of the brain, the fissures which are shown on exposing the island of Reil are neglected, cf. p. 263. The posterior part of the orbital lobe is considered by Meynert to belong to the island of Reil, the anterior part he calls the rhinal convolution.

According to Schmidt[1] the sulcus calloso-marginalis of man arises from two fissures curving in opposite directions which unite along the greater part of their medial course. The posterior ascending branch of the united fissure in man, apes and bear is a fissure rising up in front of the quadrate lobe. The anterior ascending branch of the united fissures is according to Meynert the crucial fissure of Canidæ, and is absent in man, apes, the bear and some other carnivora; the crucial fissure of Canidæ thus corresponds to the anterior end of the upper curved fissure of Schmidt, the marginal fissure (Randfurche).

Broca(16) compares the convolutions of the brains of mammals, considering more particularly the relations of the limbic lobe (the internal convolution of Leuret and Gratiolet). The brain of the dog

[1] Schmidt. "Beiträge zur Entwickelungsgeschichte des Gehirns." *Zeitschr. f. Zoologie*. p. 55, 1862.

he considers to be formed of (1) *The limbic lobe*[1] and (2) The external convolutions (*la masse circonvolutionnaire*). (1) The *limbic lobe* is made up of the *lobe of the corpus callosum* and of the *olfactory and hippocampal lobes*; the *lobe of the corpus callosum* consists of the genual, the supra-callosal and its continuation behind the splenium as far as the end of splenial fissure, it includes thus part of the mesial surface of the uncinate lobe. The *lobe of the corpus callosum* includes also that part of the anterior limb of the sygmoid gyrus, which lies mesially of a line drawn from the end of the crucial fissure to the end of the supra-orbital fissure. The *hippocampal lobe* includes the dentate and that part of the uncinate not forming part of the lobe of the corpus callosum. (2) 'La masse circonvolutionnaire' forms two lobes, the *frontal* and *parietal*. The *frontal* lobe corresponds to the sub-orbital lobe, the parietal includes the rest of cortex except the *limbic lobe* and *sub-sylvian lobule*. The *parietal* convolutions are numbered 1, 2, 3 and so on starting from the Sylvian fissure; in the fissure of the brain of the otter three parietal convolutions are marked (the united Sylvian and inferior making the first), in the figure of the brain of the fox four parietal convolutions are marked, in that of the dog, five (apparently the ecto-lateral convolution is the fourth); in all cases the convolution (superior) bounding the inter-hemispheral fissure is called the *sagittal*, the *sagittal* includes the lateral part only of the anterior limb of the sigmoid gyrus.

The anterior composite convolution excluding that part which is formed by the continuation forwards of the Sylvian convolution is called the *post-Rolandic gyrus*, it is considered to be homologous with the ascending parietal convolution of primates.

The part of the posterior composite convolution which lies between the Sylvian and inferior recurrent fissures is called by Broca the *temporal lobule of the parietal lobe*, this lobule uniting with the *hippocampal lobe* (atrophiée) gives rise to the temporal lobe of primates, it is also from the temporal lobule 'que procèdent quelques-uns des éléments que forment chez les primates le lobe occipital.'

The *limbic fissure* includes the rhinal, the post-rhinal, the splenial and the crucial; the genual (*sub-frontal*) is also considered as an isolated portion of it. The limbic fissure is broken by certain annectant convolutions (*plis de passage*), one the *retro-limbic* is at the posterior end of the *sub-parietal fissure*, it is the piece of cortex between the superior and inferior recurrent fissures; others (not always present) are the *posterior*

[1] The terms used by Broca are put in italics.

parieto-limbic running across the splenial fissure at the junction of the supra-callosal and uncinate convolutions, and the *anterior parieto-limbic* at the junction of the splenial and crucial fissures; anteriorly and mesially are two more, the *pre-limbic* or *fronto-limbic* between the crucial and genual fissures, and another (unnamed) ventrally of the genual fissure. In the anterior and in the posterior ventral part of the *sub-sylvian lobule* (island of Reil), there is according to Broca a trace of a *temporo-parietal fold;* the cortex at the junction of the orbital lobe and the island of Reil he calls the *temporo-frontal annectant* convolution.

Pansch(17) lays stress on the conclusion arrived at by him in his earlier work that the only satisfactory method of determining the homologous parts of the brains of various mammals is by the study of the development of the fissures. The earlier a fissure appears in the fœtal brain the deeper it is in the adult.

He contests Meynert's view that the supra-orbital fissure (of this paper) is the anterior branch of the Sylvian, since it is, as he had shown before(3), always a separate fissure in the fœtus, and is sometimes so in the adult dog; hence he argues that the parts of the brain of carnivora considered by Meynert to be homologous with the frontal lobes and gyrus transitorius of primates cannot in the main be homologous.

He contests also Meynert's view of the origin of the crucial fissure from the 'Randfurche' of Schmidt (cf. supra). From the observation of fœtal dogs' brains he finds that the crucial fissure arises before and independently of the *sulcus-calloso-marginalis* (splenial) which corresponds, if any correspondence can be said to exist, to the combined fissures of Schmidt. He points out further that according to Schmidt the posterior ascending branch of the 'Randfurche' rises up behind the quadrate lobe and not as would appear from Meynert in front of it. He dissents also from Meynert's calling the splenial fissure (of this paper) the occipital. He agrees with Meynert that the coronal and supra-sylvian fissures of the dog are homologous with the fissure of Rolando and interparietal of primates, but remarks that these homologies were pointed out by Owen in 1868 and by himself in 1873. He argues also against Wernicke's views.

Pansch(18) in a general account of the fissures of the brains of mammals gives a good description of the fissures of the dog. Most points mentioned by him have been referred to or included in the Text and Tables above. According to him the brain of a large dog does not necessarily have many minor fissures (cf. Dareste, supra).

Krueg(19) in his account of the fissures of zono-placental mammals gives a careful description of the fissures of the Canidæ: his description has been most valuable to me as a basis for my own account. He gives excellent figures illustrating the time of appearance of the fissures in carnivora, in fœtal and early extra-uterine life.

Wilder(20) gives an account of the brain of the cat, and proposes many simplifications in the names given to the parts of the brain. His nomenclature for fissures is in the main that adopted by Krueg. Krueg's genual and rostral however he calls falcial and sub-falcial, Krueg's supra-splenial and post-splenial he calls marginal and post-marginal and Krueg's pre-sylvian, super-orbital.

LITERATURE.

1. Leuret et Gratiolet. *Anatomie comparée du système nerveux.* T. I. p. 373. Atlas. Planche 4. (1839—1857.)

2. Dareste. "Troisième Mémoire sur les circonvolutions du Cerveau chez les Mammifères." *Annal. d. sci. naturelles.* 4th Sér. (Zoologie), T. III. p. 65. 1855.

3. Pansch. "Ueber d. typische Anordnung d. Furchen u. Windungen auf den Grosshemisphären der Menschen u. der Affen." *Arch. f. Anthropologie.* Bd. III. p. 227. 1868.

4. Owen. *On the Anatomy of Vertebrates.* Vol. III. p. 116. 1868.

5. Gervais. "Mémoire sur les formes cérébrales propres aux Carnivores vivants et fossiles, suivi de remarques sur la classification de ces animaux." *Nouv. Arch. d. mus. d'hist. nat.* T. VI. p. 103. 1870.

6. Lussana e Lemoigne. *Fisiologia dei centri nervosi encefalici.* Padova, 1871.

7. Wilder. "The outer cerebral Fissures of Mammalia (especially Carnivora) and the Limits of their Homology." *Proc. American Assoc.* 1873, p. 214.

8. Wilder. "Cerebral variation in domestic Dogs and its bearing upon scientific Phrenology." *Proc. American Assoc.* 1873, p. 234.

9. Hitzig. *Untersuchungen über das Gehirn.* (Leipzig), 1874.

10. Betz. "Anatomischer Nachweis zweier Gehirncentra." *Centralb. f. d. med. Wissensch.* 1874, p. 578 and p. 595.

11. Pansch. "Ueber gleichwerthige Regionen am Grosshirn der Carnivoren und der Primaten." *Centralb. f. d. med. Wissensch.* No. 38, p. 641. 1875.

12. Wernicke. "Das Urwindungssystem des menschlichen Gehirns." *Arch. f. Psychiatrie.* Bd. VI. p. 298. 1876.

13. Ferrier. *The Functions of the Brain,* p. 145. 1876.

14. Benedikt. "Der Raubtypus am menschlichen Gehirne." *Centralb. f. d. med. Wissensch.* 1876, p. 930.

15. Meynert. "Die Windungen der convexen Oberfläche des Vorderhirns bei Menschen, Affen und Raubthieren." *Arch. f. Psychiatrie.* Bd. VII. p. 256. 1877.

16. Broca. "Anatomie comparée des circonvolutions cérébrales. Le grand lobe limbique et la scissure limbique dans la série des Mammifères." *Rev. d'Anthropologie.* 2nd Ser. T. I. p. 385. 1878.

17. Pansch. "Bemerkungen über die Faltungen des Grosshirns und ihre Beshreibung." *Arch. f. Psychiatrie.* Bd. VIII. p. 235. 1878.

18. Pansch. "Beiträge zur Morphologie des Grosshirns der Säugethiere." *Morphol. Jahrb.* Bd. V. p. 193. 1879.

19. Krueg. "Ueber die Furchen auf der Grosshirnrinde der zonoplacentalen Säugethiere." *Zeitschr. f. Zoologie.* Bd. XXXIII. p. 595. 1880.

20. Wilder. *The Brain of the Cat.* (Read before the American Philosophical Soc. July 15, 1881.)

PART III.

Transverse Vertical sections of the Brain of the Dog.

Figures I.—X. Pl. VIII. represent successive vertical sections of the right half of the brain of a dog. The half brain which was so sliced up is represented from different points of view in Figs. 17 to 21, in all except the last of these the positions of the sections is marked; so that by a comparison of the two sets of figures a general idea of the relations of the various convolutions to the deeper parts of the brain can be obtained.

Since however there are considerable differences in the relative size and position of the parts of the brain in different dogs, it follows that the convolutions cut through in a vertical section through any given spot, such as the anterior commissure or middle of the soft commissure, vary also considerably in different dogs.

I do not propose to give more than a brief account of the salient features of these cross sections and I shall confine myself in the main to those features which are useful in determining what parts have been destroyed in the brain of Goltz' dog; some conspicuous structures not mentioned in the following account are indicated in the figures by the lettering. In these figures the dotted parts indicate grey substance and the shaded part white substance, so far as these can be discerned without the use of the microscope.

In a section made through the anterior portion of the brain in front of the anterior sigmoid gyrus we find that the fibres appear to radiate from the centre of the section in three main strands, one to the orbital, one to the prorean and one to the sub-prorean convolution (Fig. I. Pl. VIII.).

In a section through the anterior limb of the sigmoid gyrus in its anterior portion (Fig. II. Pl. VIII.), three white strands continuous with the previous are still distinct, but the strand which is continuous with the prorean bends laterally and passes over into the white substance of the anterior limb of the sigmoid gyrus and into whatever parts of the other external convolutions there may be in the section; in Fig. II. these parts are represented by a small portion of the anterior composite convolution.

It is noteworthy that a not inconsiderable part of the anterior limb of the sigmoid gyrus lies over the orbital and prorean convolutions, being separated from them by the deep supra-orbital fissure. In the similarly projecting part of the anterior composite convolution a beginning division of the white substance into two bundles corresponding to the strands of the third and second convolutions may not infrequently be seen although the cortex is without any sign of a fissure. Fig. 22 shows this, it is taken from a dog in which the forward projection of the sigmoid gyrus and anterior composite convolution was perhaps greater than usual.

On making successive thin vertical sections of the anterior limb of the sigmoid gyrus from the front posteriorly, it is seen that the top of the vertical strand continuous with the prorean becomes flattened, then concave, so that in its posterior portion (Fig. III.) the sigmoid gyrus has two strands, one medial, the other lateral; connected with these is the strand running to the anterior composite convolution; in some cases the median convolution is in such a section fairly distinct.

Passing backwards the vertical median strand becomes shorter, forming the white substance of what may now be considered the supra-callosal convolution, the lateral strand curves medially to the posterior limb of the sigmoid gyrus (Fig. IV.). In this figure the median convolution is now distinct from the anterior composite and the latter shows in the arrangement of its strands an indication of its being formed by the united inferior and Sylvian convolutions.

Fig. V. is taken from a section through the posterior part of the posterior limb of the sigmoid gyrus; the ansate fissure (*an*) is cut through, laterally of this up to the coronal fissure (*cor*) is the posterior limb of the sigmoid gyrus. The first three external convolutions are here distinct from one another.

In Fig. VI. the floor of the Sylvian fissure, i.e. the island of Reil, is seen to be overlapped by the anterior end of the posterior composite convolution. The post-rhinal fissure (*p. rh*) is shallow. It will be noticed that the strand running to the superior convolution is nearly vertical: in Fig. V. the strand running to the part of the superior convolution medially of the ansate fissure goes obliquely upwards, hence the position of the strand gives some indication of the place of junction of the sigmoid gyrus with the part of the superior convolutions lying behind it.

Fig. VII. passes through the middle of the soft commissure and just behind the summit of the Sylvian fissure as it is seen from the surface; in the section however the Sylvian fissure—a longish narrow slit—is seen to be arched over by the Sylvian convolution, the posterior Sylvian convolution is here distinct from the posterior composite.

Between sections VI. and VII. the first mesial infolding of the uncinate lobe occurs.

Sections VIII. and IX. in their mesial dorsal portions were not parallel to the previous sections. For the course taken by them cf. Figs. 17 to 20. A little behind section VIII. the connection of the thalamencephalon with the cerebral hemispheres ceases. The curving posterior part of the second or inferior convolution is seen in Fig. VIII. to be cut through, the small gap shown in it is the ecto-sylvian fissure cut across at its posterior dorsal curve. The infra-callosal portion of the uncinate lobe is seen.

In Fig. IX. the ventral recurved portion of the third or median convolution is seen below the inferior convolution. In this and in the previous figure the shallow post-rhinal fissure lies a little laterally of the end of the descending cornu of the lateral ventricle, so that the uncinate convolution forms a small part only of the lateral boundary of the descending cornu.

Fig. X. passes close to the end of the supra-callosal convolution. Owing to the curved course of the ecto-lateral fissure it is twice cut in this section.

It will be noticed that this section passes posteriorly of the descending cornu of the lateral ventricle; from Figs. 19, 21, Pl. VIII. it will be seen that behind this section there is a not inconsiderable portion of cortex.

One point further remains to be mentioned; the position of the corpora geniculata is in the dog very different from that which they have in man (cf. Forel[1], Tartuferi[2]). I give two figures to illustrate this. Fig. 24 is a ventral view of a dog's brain, on the left side of the brain the parts of the cortex which overlap the optic tract have been cut away; the optic tract is seen to run anteriorly and laterally of the internal corpus geniculatum; the external corpus geniculatum not being visible from this point of view. Fig. 23 shows the same brain from the dorsal side, the cortex is sliced away unequally on the two sides; on the left side the optic tract is seen curling dorsally and apparently forming the projection of the external corpus geniculatum; this body thus occupies in the dog very nearly the position of the posterior part of the pulvinar of the brain of man, it is called by Tartuferi the eminentia thalamo-geniculata since, according to him, the external corpus geniculatum forms the superficial portion only of the eminence, the inner grey mass being part of the pulvinar; the internal corpus geniculatum lies below behind and mesially of the external. On the right side it is seen that the cortex of the uncinate lobe extends between the corpora quadrigemina and the corpora geniculata.

DESCRIPTION OF FIGURES.

Plate VII.

In Figures 1 to 8 inclusive the relative depth of the fissures is indicated after the method of Pansch by the thickness of the lines representing them.

Figs. 1, 2, 3 are taken from one dog. Figs. 4 and 5 from another. Fig. 6 from the brain of a puppy. In Figs. 2, 3, and 5, *ol* marks the space between the olfactory tract and the orbital lobe, the breadth of the line

[1] Forel. Beiträge zur Kenntniss des Thalamus opticus und der ihn umgebenden Gebilde bei den Säugethieren Sitzungsb. d. k. Akad. in Wien. Bd. LXVI. p. 25, 1872. "Unters. ü. d. Haubenregion u. ihre oberen Verknüpfungen in Gehirne d. Menschen u. einiger Saugethiere." *Arch. f. Psychiatrie.* Bd. VII. Hf. 3, p. 293, 1877.

[2] Tartuferi. "Studio comparativo del tratto ottico e. dei corpi genicolati." *Memorie della Reale Accad. scienze di Torino.* Ser. II. T. 34, 4.

indicates the distance from the surface to the bottom of the olfactory fissure which is here hidden by the olfactory tract. In the description of Figs. 1 to 9 the chief only of the variations from the typical fissures of the dog's brain are mentioned.

Fig. 1. *cor* does not join *l*; the position of *an* is different on the two sides; *an'* joins *l*, the position of *an'* being different on the two sides; on the left side *e. l* is shorter than on the right and it joins *l*; *p. l* is transversely placed and joins *e. l* on the right side.

Fig. 2. There are many shallow fissures and depressions; *p. e. sy* is absent.

Fig. 3. There are many shallow fissures and depressions; *p. e. sy* is absent; *sy* joins *a. e. sy*; *a. s. sy* joins *a. e. sy*; there is a nearly vertical fissure in P. E. SY.

Fig. 4. There is a fissure running into COR. from the posterior part of *cor*, it is placed farther back on the left side than on the right; *pr. cr* absent on the left side unless it be supposed to be joined to *cr*; *e. l* runs farther forward on the left side than on the right; *l* and *p. l* differ on the two sides; there is a fissure in front of *an'* from *a. e. sy*. The apparent anterior end of the splenial fissure is a small isolated fissure; the splenial fissure in this case did not reach the dorsal surface of the brain.

Fig. 5. *a. s. sy* joins *a. e. sy*, on the right side; which in several points was more 'normal' than the left, this was not the case; *a. e. sy* and *p. e. sy* are not united, from the latter run several short fissures; there are several shallow fissures in the 1st and 2nd convolutions. (A small portion of the island of Reil shows here in consequence of the Sylvian fissure being slightly dragged open.) Fissure running from *s. or* (apparently posterior end of it) is very marked, cf. Fig. 2, 3, 16.

Fig. 6. *s. or* has different positions on the two sides; there is a fissure (? *pr. cr*) running from *cor* into P. S. G.; *cor* is not joined to *l* on the left side; *l* is interrupted on the left side, nearly interrupted but in a different place on the right side; on the right side it is somewhat doubtful which fissure represents *an'*; *e. l* joins *l* on the left side; on the right side *p. l* is apparently broken and its anterior part joined to *e. l*.

Figs. 7 and 8 are copied from Pansch (18) (his Figs. 20 and 6 respectively). In this and in the following figure the fissures are named according to the system adopted in this paper.

Fig. 7. *cor* is isolated on the left side; *an'* joins *l*.

Fig. 8. *s. or* is isolated; *cor* is isolated; *a. e. sy* does not join *p. e. sy*; the relative positions of *l* and *p. l* is unusual, but cf. Fig. 4 left side; there is a nearly vertical fissure in P. E. SY.

Fig. 9. (Copied from Wilder (7), his Fig. 12); *p. e. sy* absent or joins top of *sy*; *cor* isolated; *an'* joins *l*.

Fig. 10. Semi-diagrammatic sketch of part of the right side of the brain of a dog to show the connection which occasionally occurs between the anterior supra-sylvian and anterior ecto-sylvian fissures.

Fig. 11. Outline sketch of part of the anterior mesial surface of the brain of a dog to show the fissure which sometimes runs from the summit of the crucial towards the genual fissure.

Figs. 12 and 13. Diagrams to illustrate the connections of the convolutions of the brain of the dog—according to the views of Leuret and Gratiolet (Fig. 12) and according to the views of Meynert (Fig. 13). The names given are those adopted in this paper; in addition to the symbols given in the index are used (INT) = internal convolution of Leuret and Gratiolet; (G. F) = gyrus fornicatus of Meynert; br = a spot where the fissure is sometimes broken.

Figs. 14 and 15. Copied from Krueg to show fissures seen when the Sylvian fissure is opened (*a. e. sy*; *p. e. sy* and *s. or.* are differently named by Krueg, cf. p. 266).

Fig. 16. Right side of brain of dog; the Sylvian convolution has been cut away to expose the island of Reil. The *e. l* fissure is here unusually short, on the right side it consisted of two small separate fissures; *p. l* is here isolated on the right side although having much the same course it joined *l*.

Plate VIII.

Figs. 17 to 21 inclusive are figures of the right side of the brain of a mongrel terrier. Figs. 17, 18, 19 are respectively lateral, dorsal and mesial views; Fig. 20 is a ventral and somewhat lateral view; Fig. 21 represents the posterior surface of the hemisphere. This brain was cut into slices, the plane of the cuts being roughly at right angles to the median longitudinal fissure, the actual direction of the cuts is indicated by the lines marked I. to X. The convolutions and fissures are not marked in these figures, since they can at once be made out by reference to the Figs. 1, 2, 3 in the text.

Figs. I. to X. represent the anterior surfaces exposed by the cuts I. to X. respectively.

Fig. 22. Section of the right hemisphere of a dog to show the projection of the anterior parts of the external convolutions over the sub-orbital lobe.

Figs. 23 and 24. Dorsal and ventral views respectively of the brain of a dog to show the position of the corpora geniculata, and the connection of the external corpus geniculatum with the optic tract. The dorsal surface of both hemispheres has been cut away, the cut being deeper on the right side (passing through the nucleus caudatus, optic thalamus and descending cornu of the lateral ventricle). On the left side the cortex has been further removed to an extent sufficient to show the optic tract, external corpus geniculatum and optic thalamus.

INDEX OF SYMBOLS.

CONVOLUTIONS.

A. C. Anterior composite convolution, i.e. the convolution formed by the anterior united ends of the four external convolutions, this with the anterior Sylvian convolution forms the operculum of Lussana and Lemoigne and of Meynert.

A. E. SY. Anterior ecto-sylvian convolution.

A. SY. Anterior Sylvian convolution.

A. S. G. Anterior limb sigmoid gyrus.

COR. Coronal or anterior supra-sylvian convolution.

D. Dentate convolution.

E. L. Ecto-lateral convolution = that part of second convolution which lies medially of ecto-lateral fissure and of its continuation to the ansate minor fissure.

EN. L. Ento-lateral convolution = that part of first convolution which lies between the ento-lateral fissure (with its continuation to the ansate) and the lateral fissure.

G. Genual convolution.

I. Inferior convolution = second external convolution.

I. R. Island of Reil.

M. Median convolution = third external convolution.

M. E. SY. Median ecto-sylvian.

O. L. Olfactory lobe.

OR. Orbital lobe = part of sub-orbital lobe of Leuret and Gratiolet.

O. T. Olfactory tract.

P. C. Posterior composite convolution = the convolution formed posteriorly by the united ends of the four external convolutions.

P. E. SY. Posterior ecto-sylvian convolution.

PR. Prorean convolution.

PR. SP. Pre-splenial convolution.

P. S. SY. Posterior supra-sylvian convolution.

P. S. G. Posterior limb sigmoid gyrus.

P. SP. Post-splenial convolution.

P. SY. Posterior sylvian.

S. Superior convolution = fourth external convolution.

S. C. Supra-callosal convolution.

SY. Sylvian convolution = first external convolution.

S. PR. Sub-prorean convolution.

SP. Splenial convolution.
S. SP. Supra-splenial convolution.
U. Uncinate convolution.

1.	First external convolution			= Sylvian.
2.	Second	,,	,,	= Ecto-sylvian or Inferior.
3.	Third	,,	,,	= Supra-sylvian or Median.
4.	Fourth	,,	,,	= Superior.

FISSURES.

a. e. sy. Anterior ecto-sylvian.
a. s. sy. Anterior supra-sylvian.
an. Ansate.
an′. Ansate minor.
ca. Callosal.
cor. Coronal.
cr. Crucial.
de. Dentate.
e. l. Ecto-lateral.
en. l. Ento-lateral.
e. sy. Ecto-sylvian.
g. Genual.
i. ol. Intra-olfactory.
i. or. Intra-orbital.
i. r. Inferior recurrent.
l. Lateral.
ol. Olfactory (Krueg).
p. cr. Post-crucial.
p. e. sy. Posterior ecto-sylvian.
p. l. Post-lateral.
p. rh. Post-rhinal.
pr. Prorean.
pr. cr. Pre-crucial.
pr. sp. Pre-splenial.
p. sp. Post-splenial.
p. s. sy. Posterior supra-sylvian
r. Rostral.
rh. Rhinal.
s. or. Supra-orbital.
s. r. Superior recurrent.
sp. Splenial.
s. sp. Supra-splenial.

s. sy. Supra-sylvian.
sy. a. Sylvii anterior (Krueg).
sy. ac. Sylvii acuminis (Krueg).
sy. p. Sylvii posterior (Krueg).
sy. Sylvian.

PARTS OF THE BRAIN OTHER THAN CONVOLUTIONS AND FISSURES.

a. c. Anterior commissure and its bundles which run forward in the olfactory lobe.
a. p. f. Anterior pillar of the fornix on its way to the corpus mammillare.
c. c. Corpus callosum.
c. g. e. Corpus geniculatum externum.
c. g. i. Corpus geniculatum internum.
cl. Claustrum.
c. m. Corpus mammilare (in Fig. 20 anterior end).
c. r. Corona radiata.
c. q. a. Corpus quadrigeminum anterior.
c. q. p. Corpus quadrigeminum posterior.
cr. c. Crusta of crus cerebri.
cr. c. q. p. Crus (brachium) of corpus quadrigeminum posterior.
cr. p. Crus (peduncle) of pineal gland.
d. l. v. Descending cornu of lateral ventricle.
e. c. External capsule.
f. Fornix.
i. c. Inner capsule.
inf. Passage from third ventricle to infundibulum.
l. v. Lateral ventricle.
m. c. Middle or soft commissure.
n. c. Nucleus caudatus.
n. l. Nucleus lenticularis.
o. ch. Optic chiasma.
o. t. Optic tract.
o. th. Optic thalamus.
tr. Bundle of longitudinal fibres above anterior and external part of corpus callosum.
V. d'. A. Bundle of Vicq d'Azyr running from corpus mammillare to the anterior nucleus of the optic thalamus.
3 v. Third ventricle.

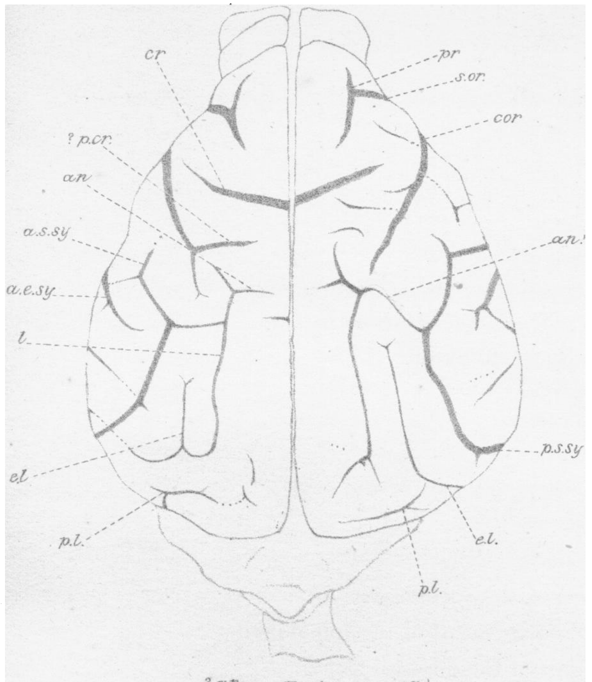

Fig.1.

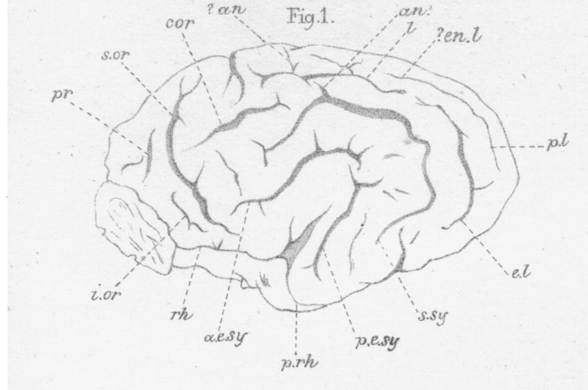

Fig.8.

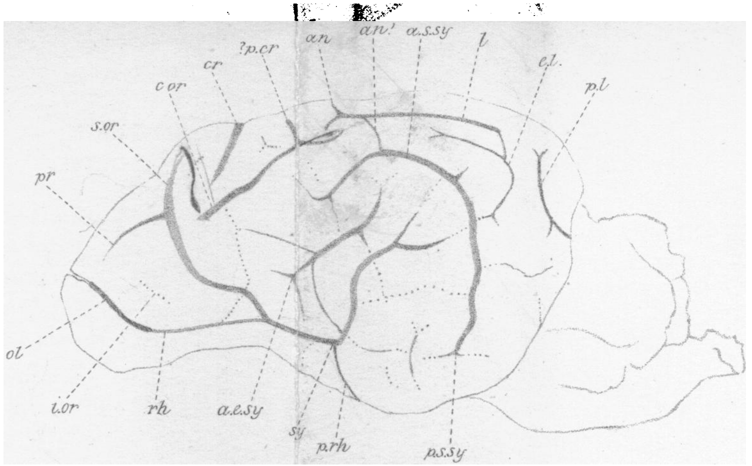

Fig.2.

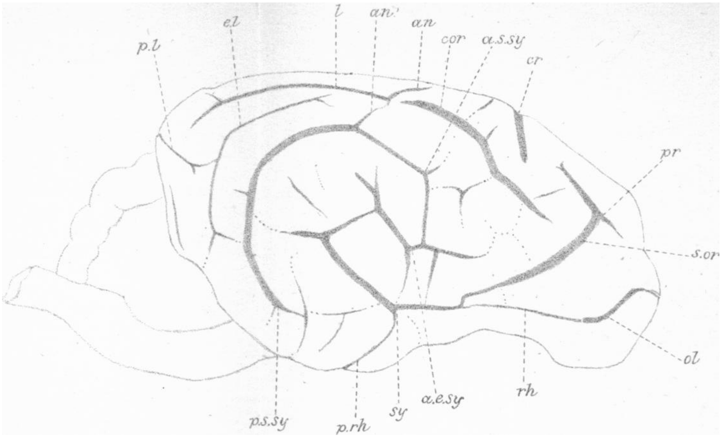

Fig.3.

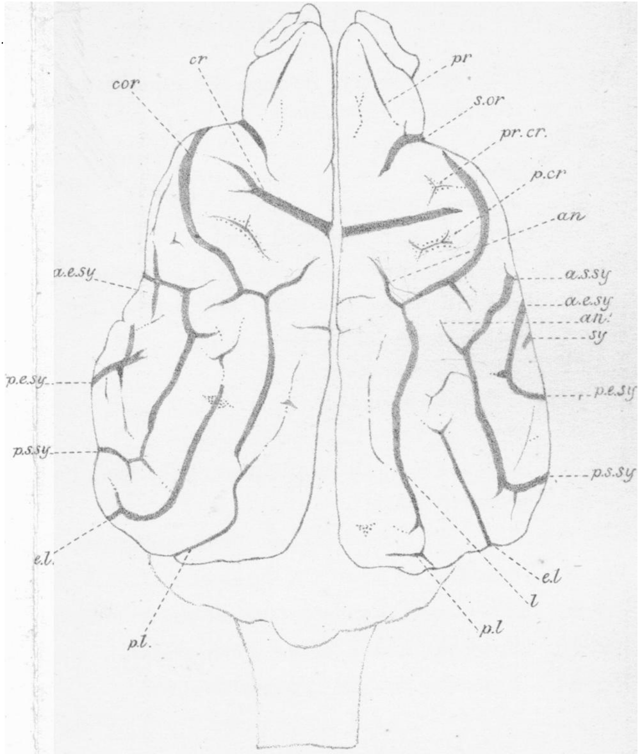

Fig.4.

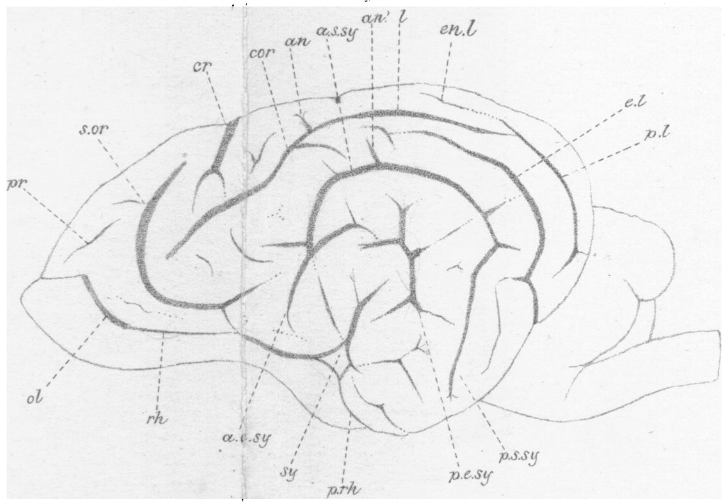

Fig.5.

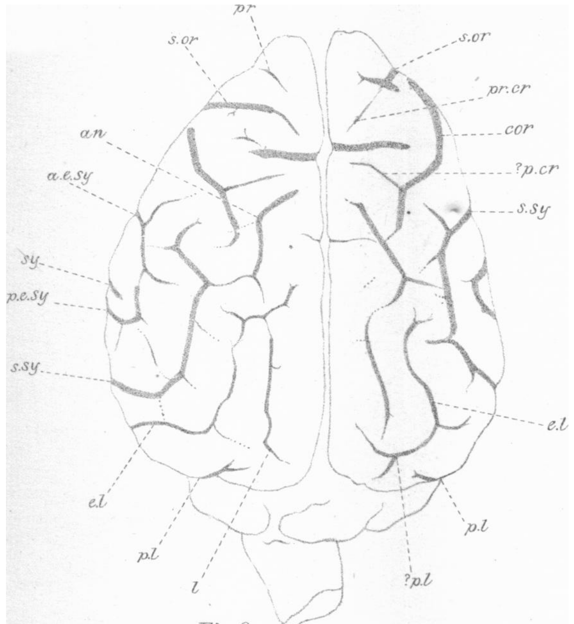

Fig.6.

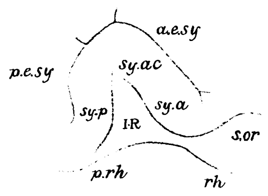

Fig.14.

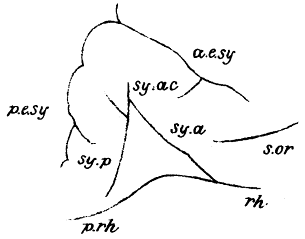

Fig.15.

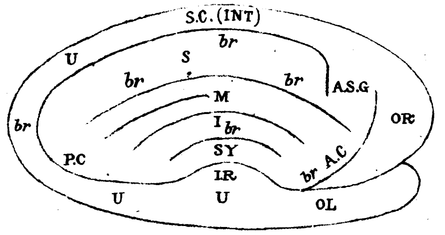

Fig.12.

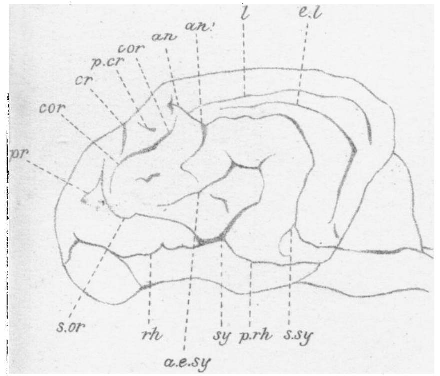

Fig.9.

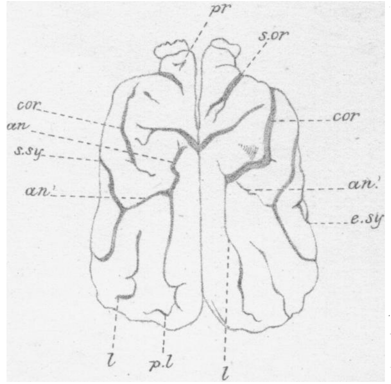

Fig.7.

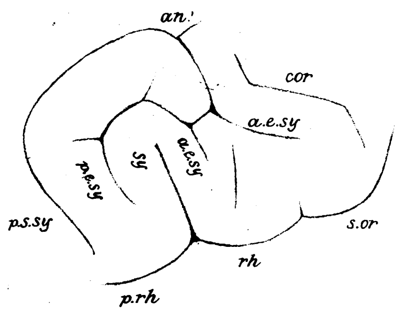

Fig.10.

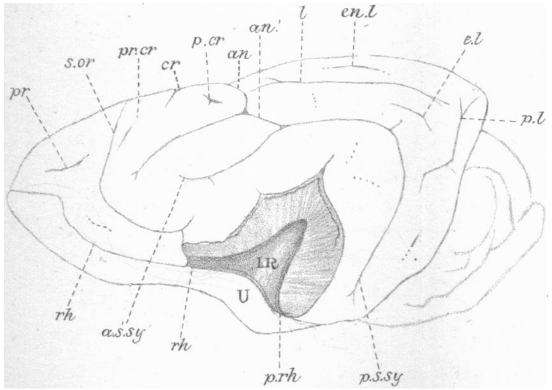

Fig.16.

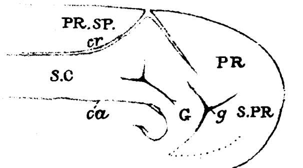

Fig.11.

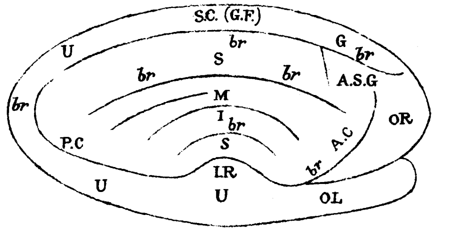

Fig.13.

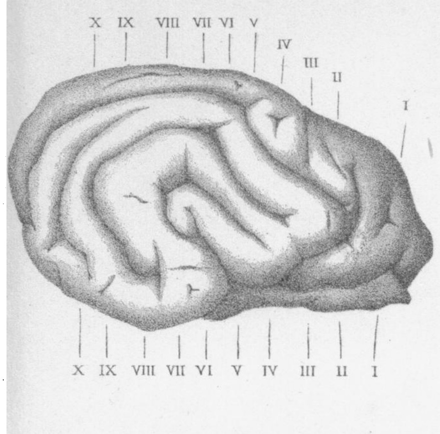
Fig. 17.

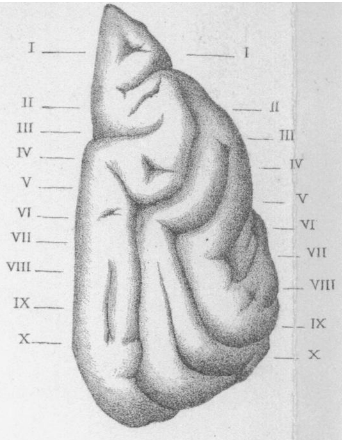
Fig. 18.

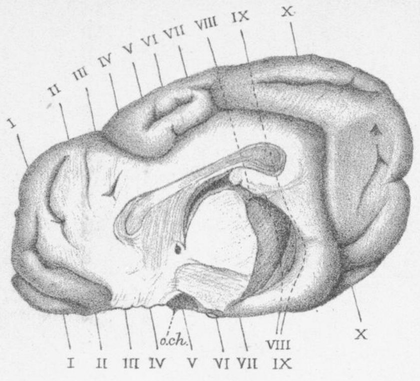
Fig. 19.

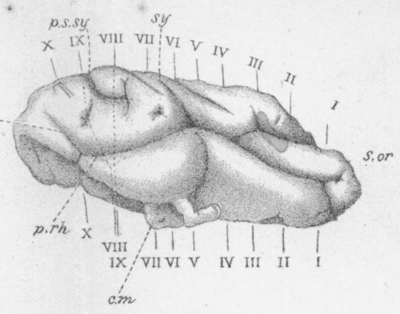
Fig. 20.

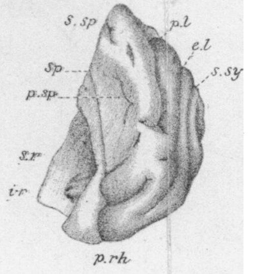
Fig. 21.

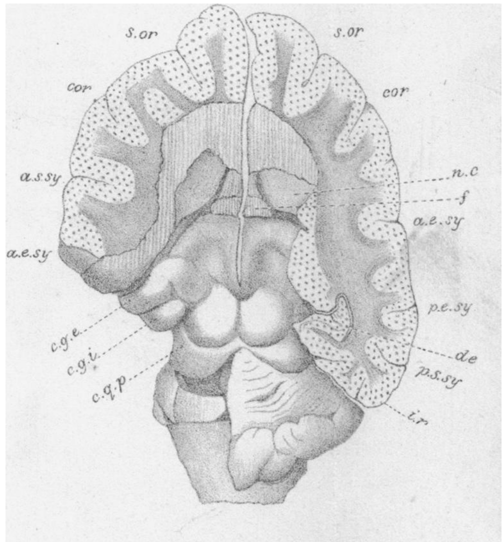
Fig. 23.

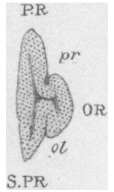
Fig. I.

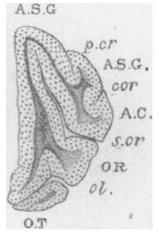
Fig. II.

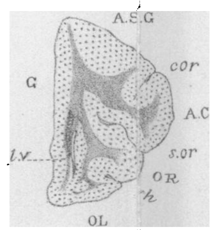
Fig. III.

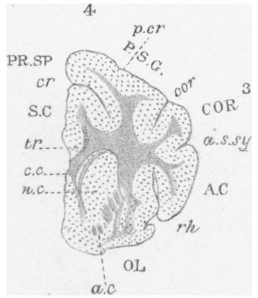
Fig. IV.

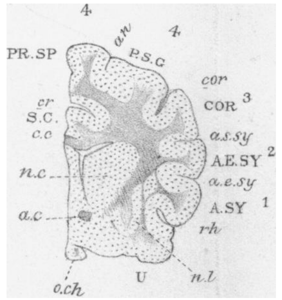
Fig. V.

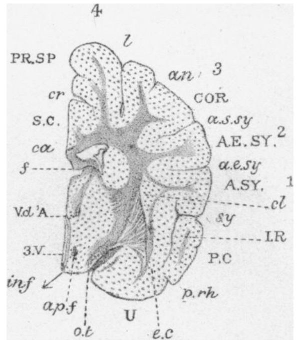
Fig. VI.

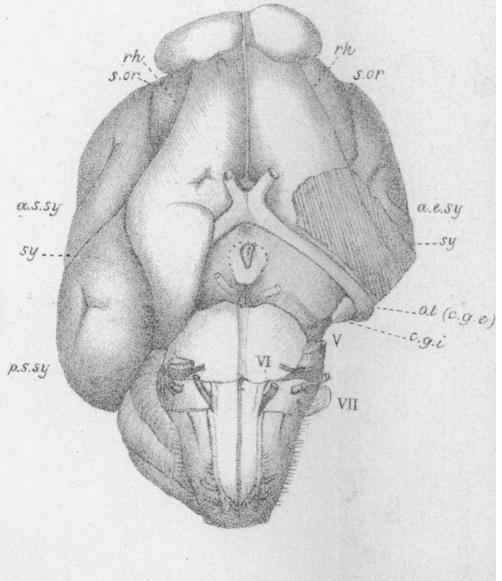
Fig. 24.

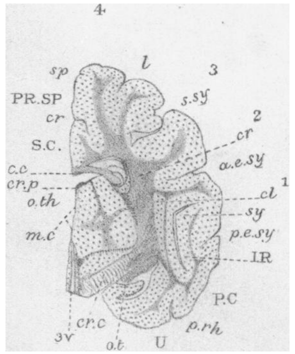
Fig. VII.

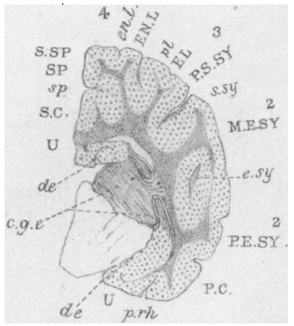
Fig. VIII.

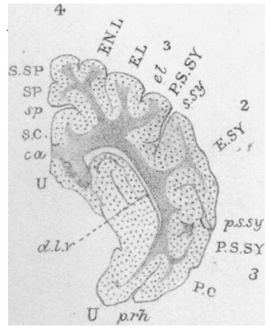
Fig. IX.

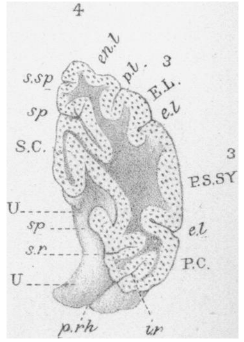
Fig. X.

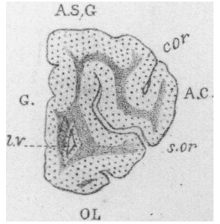
Fig. 22.

J.N.L. del. Edwin Wilson Lith.