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HOMOLOGIES OF THE FISSURAL PATTERNS OF THE HEMISPHERES OF DOG AND CAT

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The purpose of this study was to establish homologies in the patterns of sulci and gyri in the cortex of the dog and cat. The present aim is to solve this problem on the basis of the principles specified in a previous paper which is concerned with the cortical homologies of the dog and monkey (Kreiner 1961, 1966, 1968). The most important of these principles are as follows:

1. The adoption of the definition of the term "sulcus" as a cortical field characterized by the structure of fissural type (low and sparse radial fibres, thick layer I with the reduced thickness of the other layers, simplified cytoarchitectonic pattern) regardless of whether this field lies in a groove or on a smooth surface (cryptosulcus).

2. The adoption of the definition of the term "gyrus" as an area, or several areas, having the structure of gyral type and surrounded by areas of fissural type.

3. Basing the study on an analysis of section series and not on the external appearance of the fissures.

Seven series from dog brains and as many series from cat brains were used as material for study.

OBSERVATIONS

Fissura Sylvia

In the dog the sylvian fissure is a rather small furrow which extends obliquelly dorsocaudally. Its cleft is not perpendicular to the surface of the cortex but bent to the rear and thus forming a kind of pocket,

which opens towards the front. This fissure has a straight course and is generally devoid of ramifications.

The sylvian fissure of the cat has a similar position on the surface of the hemisphere only that it runs more dorsalwards. As in the dog, it sinks towards the rear, but unlike its namesake in the dog, in the cat it has fairly numerous branches, which run more or less horizontally. This may well be connected with the deficiency of the fissural cortex owing to the lack of the middle portion of the ectosylvian fissure.

Fissura Rhinalis Anterior and Fissura Presylvia

In both species the anterior rhinal fissure makes the boundary between the neo- and allocortex and extends, as a prolongation of the sylvian fissure, towards the front, up to the place where the olfactory peduncle branches off. Here it swings abruptly to the side and goes round the first portion of the olfactory peduncle as far as the ventral aspect.

The similarity of the course of the rhinal fissure proper in the dog and cat stands in opposition to the differences in the course of its branches. In the dog there are three such branches. One of them is the olfactory sulcus, which is a deep groove extending in a sagittal plane as far as the pole of the hemisphere in front. The olfactory sulcus branches off from the rhinal fissure where the latter runs round the olfactory peduncle. It is covered over the whole of its length by the olfactory peduncle and, farther to the front, by the olfactory bulb. The olfactory sulcus constitutes the ventral boundary of the orbital gyrus.

The second branch of the rhinal fissure ascends dorsal to the orbital gyrus, as does the presylvian fissure in the dog. It is hidden under a large opercle of the frontal cortex and forms the bottom of the perfissura presylvia, which contains several sulci and gyri. This system of sulci reaches upwards near the cruciate fissure.

The third branch in the dog is a small anonymous fissure situated laterally to the olfactory sulcus on the border of the areas PORV and ORB I″.

In the cat there is only one distinct branch of the anterior rhinal fissure. It is a deep furrow which branches off somewhat caudally to the bend of the rhinal fissure round the olfactory peduncle. It runs orad as far as the region of the cruciate fissure. In most of the studies this furrow is called the fissura presylvia, which name has been introduced by Winkler and Potter in their atlas (1914). This is, however, an improper name and for this reason in this paper the furrow will be referred to as the pseudopresylvian fissure. In this way it will be possible to avoid the false impression that it is homologous with the presylvian fissure of the dog.

The main argument for the introduction of the name "pseudopresylvian fissure" for this furrow in the cat is the completely different situation in the two species under study. In the dog the presylvian fissure runs dorsal to the orbital gyrus, whereas in the cat it is ventral to this gyrus. The place where it branches from the rhinal fissure is also different, occurring much farther to the rear in the dog. An accessory argument may be the fact that medioventrally to the pseudopresylvian fissure there is not enough cortex to admit it to be the homologue of the orbital gyrus. Besides, the situation of the orbital gyrus of the cat agrees quite well with that in the dog.

The foregoing argumentation may be completed by a discussion on the homologue of the pseudopresylvian fissure in the dog. The large olfactory sulcus cannot be regarded as such, because the pseudopresylvian fissure is situated laterally to the olfactory peduncle on the exposed surface of the hemisphere. In the dog this situation is rather appropriate to the inconspicuous anonymous sulcus or cryptosulcus on the boundary of the areas ORB I″ and PORV and, in my opinion, this sulcus is the homologue of the pseudopresylvian fissure of the cat, whereas in the cat the olfactory sulcus proper occurs in the form of a cryptosulcus hidden under the olfactory peduncle, and the area PORV can be seen as an anonymous gyrus concealed in the medial wall of the pseudopresylvian fissure.

I failed to find the homologue of the dog's presylvian fissure in the cat.

Gyrus Orbitalis

This is a classically developed gyrus on the lateroventral aspect of the hemisphere. On the ventral side it is bordered by the anterior rhinal fissure caudally and the olfactory sulcus orally. This boundary, however, embraces also the cryptogyrus of the ventral paraorbital area (PORV), separated from the orbital gyrus proper by a small sulcus, cryptosulcus or the border-line between the areas PORV and ORB I″. On the dorsal side the orbital gyrus is bounded by an anonymous sulcus partly hidden under the operculum of the lateral composite gyrus in the depth of the perfissura presylvia.

Typical of the posterior portion of the orbital gyrus is the occurrence of the lateral margin of the claustrum and extreme capsule. Another margin of the claustrum, the medial one, enters the region of the allocortex — the middle portion forms an arch which surrounds the anterior rhinal fissure.

The orbital gyrus of the cat stand out somewhat less distinctly,

owing to the poor and variable appearance of the anonymous sulcus which borders this gyrus on the dorsal side, and on account of the lack of the perfissura presylvia. As in the dog, the anterior rhinal fissure forms the caudal part of the ventral border of this gyrus, but, in contradistinction to the dog, its oral par is the pseudopresylvian fissure. As has been mentioned above, this fissure separates the gyrus of the area PORV from the orbital gyrus. The lateral margin of the claustrum is visible well inside the caudal portion of the orbital gyrus, this detail being of importance to the determination of the homology of the gyrus under discussion on a topographic basis.

The oralmost portion of the orbital gyrus of the cat has been identified as a motor area, using physiological methods, (Pinto, Bromiley and Woolsey 1956, Woolsey 1959) which prompts the supposition that this portion is not homologous with the orbital gyrus of the dog but corresponds with the precentral motor areas, shifted in the cat in connection with the compression of the frontal part of the hemispheres, characteristic of this species. This region occurs here close to the cruciate fissure.

Fissura Rhinalis Posterior

In both animals this fissure, a deep furrow at a right angle to the surface of the cortex on the ventral aspect of the hemisphere, is an extension of the anterior rhinal fissure. In the dog the posterior section of this fissure extends upwards and passes into the retrosplenial fissure. The boundary between these fissures occurs where the hippocampal cortex passes into the cingular cortex. Two, more or less horizontal, small branches arise from the terminal portion of the posterior rhinal fissure and run to the rear; they are the recurrent and pararecurrent fissures.

The posterior rhinal fissure of the cat resembles its namesake in the dog in its anterior and middle portions, whereas the terminal portion lacks the connection with the retrosplenial fissure. At the end the posterior rhinal fissure forks into two branches, of which the caudal one is the homologue of the pararecurrent fissure. The recurrent fissure does not occur in the cat.

Fissura Ectosylvia

The ectosylvian fissure of the dog surrounds the sylvian fissure on the oral, dorsal and caudal sides. Small accessory grooves separate from it, especially at the bends. The ectosylvian fissure of the cat divides into two parts, an anterior and a posterior, which are separated from

each other by a gyral region, known as the gyrus felinus. These fissures are fairly long and the configuration of the myeloarchitectonic areas indicates that their upper portions should rather be homologized with the branches of the ectosylvian fissure of the dog. This is, in particular, suggested by the branch of the area EM I, which extends a long way downwards along the posterior ectosylvian fissure. Another argument is the occurrence of a small transverse groove in the middle of the feline gyrus in some cats. In the main the ectosylvian fissure is characterized by its great variability; it may, above all, develop short branches, which run off in all directions.

Both in the dog and in the cat in the continuation of the posterior ectosylvian fissure some unstable sulci are observed in the posterior composite gyrus.

Fissura Suprasylvia

The suprasylvian fissure is large and deep in both animals and it describes a wide arch subparallel to the ectosylvian fissure. Three sections, an anterior, a middle and a posterior, can be distinguished in it. The middle and posterior parts run in a large arch in a very similar manner and only in some cats this arch is interrupted over a small distance. In the anterior part the regularity of the course is disturbed. The suprasylvian fissure dwindles in the vicinity of the dorsal end of the anterior ectosylvian fissure and forms very variable short branches, which differ in course. Its continuation can be found rather low in the extension of the dwindling portion as a fissure parallel to the anterior ectosylvian fissure. This fissure (fissura suprasylvia anterior ventralis), unlike that in the dog, extends up to the fissure which bounds the orbital gyrus dorsally. The difference is obviously caused by the lack of the anterior composite gyrus.

Fissura Lateralis, Ansata, Coronalis, Ectolateralis

In the dog these fissures make up a morphological whole. The lateral fissure runs in a parasagittal plane over a large part of the hemisphere and ends on its caudal aspect somewhat nearer than the suprasylvian fissure does. Anteriorly it forks into the ansate fissure (medial) and coronal fissure, which, like pliers, encompass the sensorimotor cortical field and the cruciate sulcus. The central sulcus is visible within the fork.

The cat's lateral fissure has a similar course only that it is often irregular at the boundary between the middle and posterior section; it is interrupted here and forms a small fork or bends describing an additional arch with a short radius. In some cats there also occur combinations with the ectolateral fissure (Otsuka and Hassler 1962).

In its course the ansate fissure of the cat resembles that in the dog.

In a vast majority of cats the coronal fissure consists of two sections. One of them branches directly from the lateral fissure approximately at a right angle. The other part is a ventral extension of the anterior section, separated from it by a wide gap where it is marked only by the boundary of myeloarchitectonic areas. This portion of the coronal fissure, like the terminal part of the suprasylvian fissure, runs as far as the furrow which borders the orbital gyrus.

Loosely arranged short sulci may occur orally to the ansate-coronal fork in some cats. It is, however, doubtful whether they are the homologue of the dog's central fissure.

Two parallel fissures (ecto- and anterolateral) are associated with the system of the lateral fissure in the dog, whereas in the cat they can be traced as areas of cryptosulcal type or boundaries between myeloarchitectonic areas. In this animal the ectolateral fissure is only sometimes present as a well-developed furrow parallel to the lateral fissure and connected with it.

Fissura Cruciata, Splenialis, Suprasplenialis

The cruciate, splenial and retrosplenial fissures of the dog make up a uniform whole, namely, a long furrow which extends far to the rear and joins the posterior rhinal fissure (through the retrosplenial fissure). Small side grooves run off upwards from this fissure, one of them on the border-line between the parietal cortex and the occipital. Caudally the suprasplenial fissure runs parallel to the splenial.

In the cat this system breaks up into three disconnected fissures. The first of them is the cruciate-splenial fissure, a direct continuation of the cruciate fissure on the medial side of the hemisphere. It stretches for about a third of the length of the hemisphere. The second fissure of this group is the splenial fissure, the anterior end of which lies somewhat farther to the front than the posterior end of the cruciate-splenial fissure. This end section is considered to be the homologue of the dorsal branch of the splenial fissure in the dog. Posteriorly the splenial fissure runs a long way along the cingulate gyrus, which in the cat reaches far beyond the splenium of the callosal commissure.

The terminal section of this fissure, extending still farther than the cingulate gyrus, on to the lateral aspect of the hemisphere, is regarded as the homologue of the pararecurrent fissure of the dog. The retrosplenial fissure is wanting in the cat, neither is there any connection with the posterior rhinal fissure.

The suprasplenial fissure resembles its namesake in the dog only

that its terminal portion may assume the form of a cryptosulcus or even that of the boundary between areas. Its anterior end can be seen somewhat caudal to the anterior end of the splenial fissure and is often bent upwards. This situation suggests the homology of the anterior end of the splenial fissure of the cat with the dorsal branch encountered in the dog.

A fissure called the fissura genualis occurs ventrally to the genu corporis callosi on the medial aspect of the hemisphere in some cats, but in cannot be homologized with the genual fissure of the dog.

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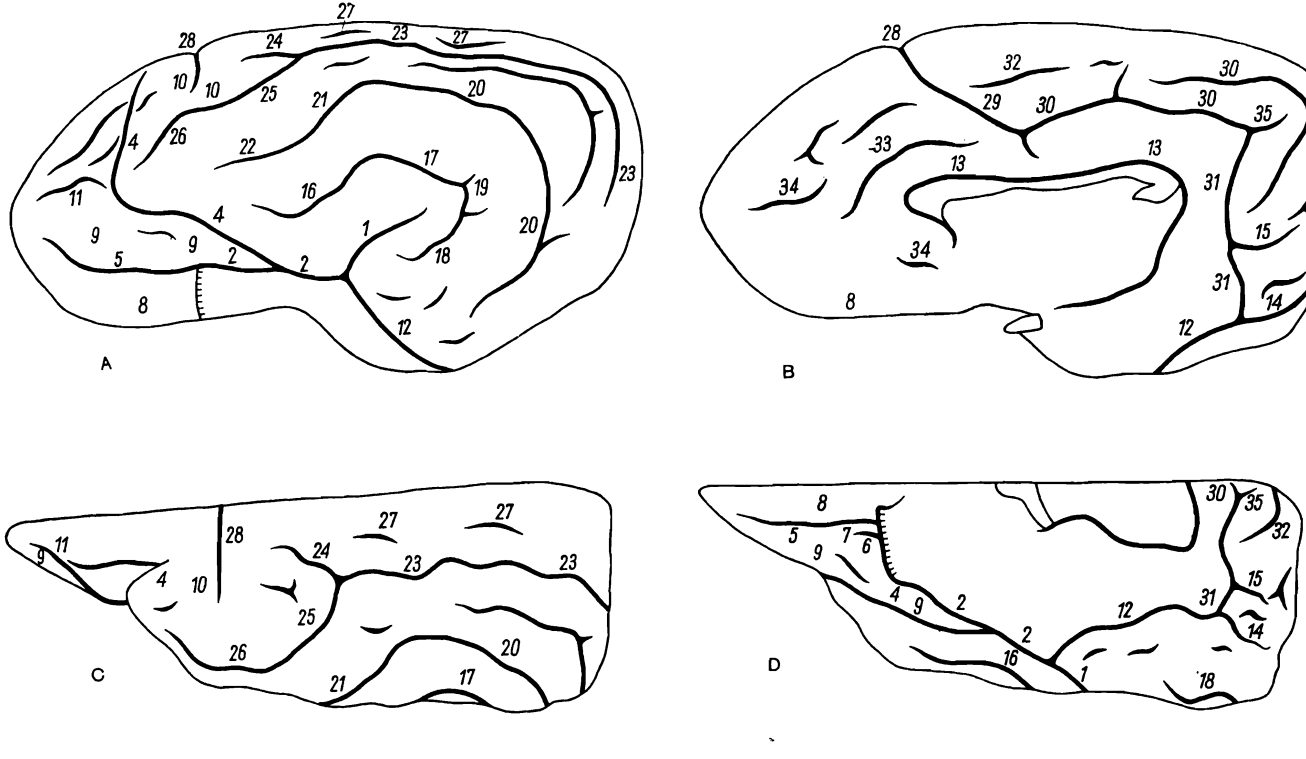

Fig. 1A–D. Lateral, medial, dorsal and ventral aspect of the brain of dog. Symbols explained in the table of homologies.

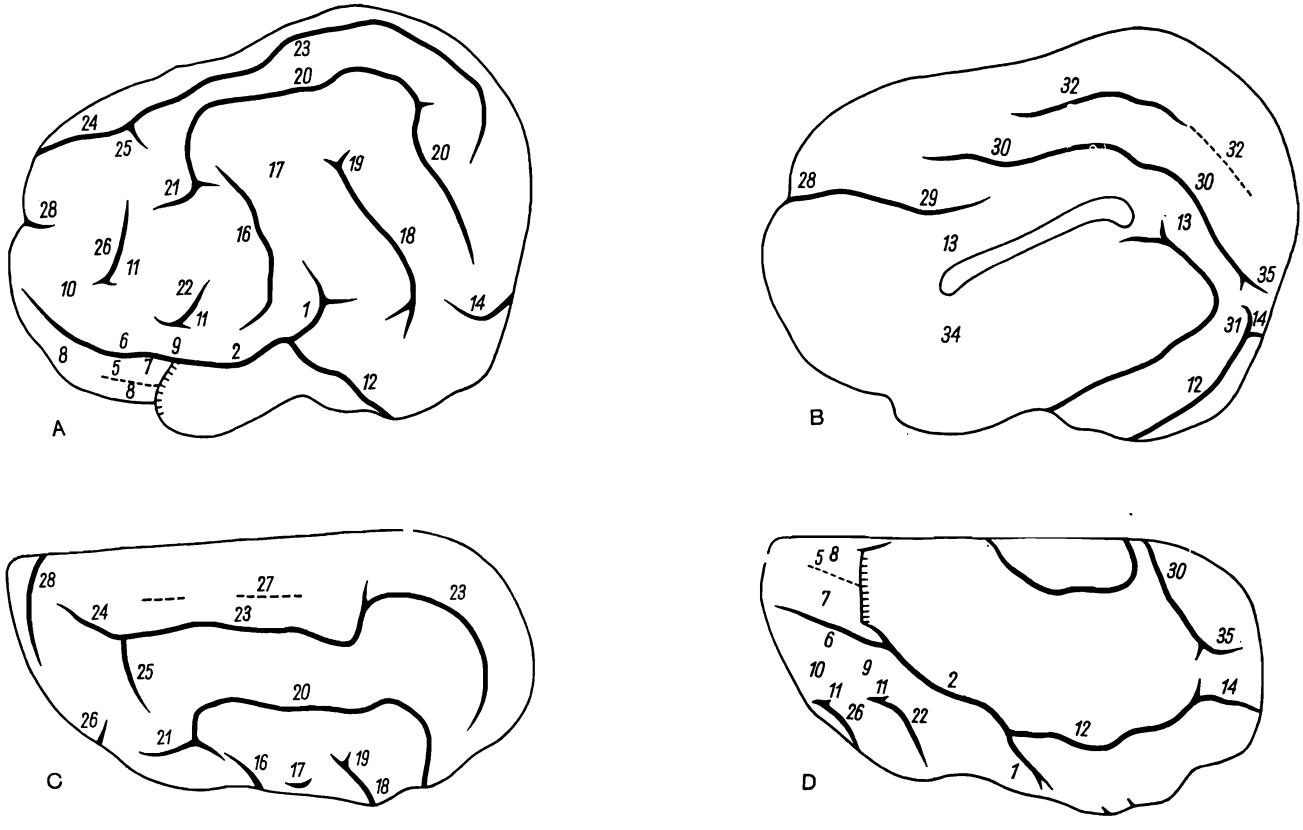

Fig. 2A–D. Lateral, medial, dorsal and ventral aspect of the brain of cat. Symbols explained in the table of homologies.

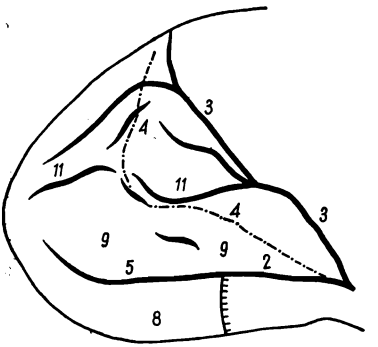

Fig. 3. Lateral aspect of the frontal cortex of the dog. Gyrus compositus anterior removed. Symbols explained in the table of homologies.

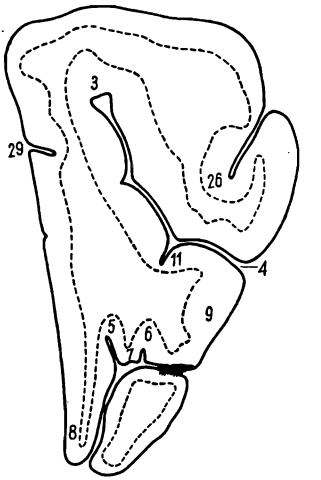

Fig. 4. Schematic section through the brain of the dog. Symbols explained in the table of homologies.

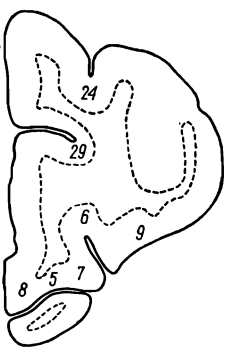

Fig. 5. Schematic section through the brain of the cat. Symbols explained in the table of homologies.

THE TABLE OF HOMOLOGIES

Symbol	Dog	Cat
1	Fissura sylvia	Fissura sylvia
2	Fissura rhinalis anterior	Fissura rhinalis anterior
3	Fissura presylvia	—
4	Perfissura presylvia	—
5	Sulcus olfactorius	(Crypto-)sulcus olfactorius
6	Cryptosulcus between gyrus areae paraorbitalis ventralis and gyrus orbitalis	Fissura pseudopresylvia
7	Gyrus areae paraorbitalis ventralis	Gyrus areae paraorbitalis ventralis
8	Gyrus subproreus	Gyrus subproreus
9	Gyrus orbitalis	Gyrus orbitalis, caudal portion
10	Neocortex accompanying fissura cruciata	Gyrus orbitalis, oral portion
11	Anonymous fissure bounding gyrus orbitalis dorsally	Anonymous fissure bounding gyrus orbitalis dorsally
12	Fissura rhinalis posterior	Fissura rhinalis posterior
13	Gyrus cinguli	Gyrus cinguli
14	Fissura recurrens	—
15	Fissura pararecurrens	Fissura recurrens
16	Fissura ectosylvia anterior	Fissura ectosylvia anterior
17	Fissura ectosylvia media	A dimple in gyrus felinus
18	Fissura ectosylvia posterior	Fissura ectosylvia posterior pars ventralis
19	Ramus fissurae ectosylviae	Fissura ectosylvia posterior pars dorsalis
20	Fissura suprasylvia media et posterior	Fissura suprasylvia media et posterior
21	Fissura suprasylvia anterior pars dorsalis	Fissura suprasylvia anterior
22	Fissura suprasylvia anterior pars ventralis	Fissura suprasylvia anterior ventralis
23	Fissura lateralis	Fissura lateralis
24	Fissura ansata	Fissura ansata
25	Fissura coronalis pars dorsalis	Fissura coronalis pars dorsalis
26	Fissura coronalis pars ventralis	Fissura coronalis pars ventralis
27	Fissura entolateralis	Fissura entolateralis (mostly in the form of a cryptosulcus)
28	Fissura cruciata	Fissura cruciata
29	Fissura splenialis pars anterior	Fissura cruciato-splenialis
30	Ramus dorsalis fissurae splenialis	Fissura splenialis pars anterior
31	Fissura retrosplenialis	—
32	Fissura suprasplenialis	Fissura suprasplenialis
33	Fissura genualis	—
34	Sulcus rostralis (?)	Fissura genualis
35	Ramus fissurae splenialis	Fissura splenialis pars posterior