XXX.—Scottish National Antarctic Expedition: Observations on the Anatomy of the Weddell Seal (Leptonychotes Weddelli). Part IV.: The Brain. By David Hepburn, M.D., C.M., Professor of Anatomy, University College, Cardiff (University of Wales). (With One Plate.)

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The material placed at my disposal for the purposes of this paper comprised the brains of four adult specimens of the Weddell seal, in addition to the brain of the young animal which has formed the subject of my former contributions.* The four adult brains having been removed at the time the animals were killed, and preserved in a solution composed of spirit (90 per cent.) 6 pints and formal (2 per cent.) 4 pints, were, with one exception, in a firm and satisfactory condition for detailed anatomical examination. The body of the young seal had been preserved with a view to ordinary dissection, and therefore its brain was not in the firm state of the adult specimens; but as I had the opportunity of removing this brain from the skull, I was able to observe the disposition of the dura mater to the hemispheres of the cerebrum and cerebellum. While the dura mater presented, as a whole, its usual arrangements, it was noteworthy that the falx cerebri did not act as a septum between the two hemispheres of the cerebrum except to a very slight extent, and certainly for not more than one-third of the distance between the vertex of the cerebrum and the dorsal surface of the corpus callosum. As a result, in the region referred to the opposing mesial surfaces of the two hemispheres lay not only in close apposition with each other, but their convolutions were intimately adapted to each other. Similarly, the tentorium cerebelli only extended a short distance between the cerebrum and the cerebellum, and, as the occipital ends of the cerebral hemispheres fell considerably apart from each other, there was space for the accommodation of the well-developed vermis of the cerebellum as well as for the bulbous pineal body, which occupied a position upon its dorsal aspect. As I removed the brain from the skull the stalk of the pineal body gave way, and probably the same thing had occurred during the removal of the adult brains, for, while different lengths of the stalks had been preserved, there was only one complete specimen of its bulbous extremity. Looked at from the vertex, the general outline of the whole brain was that of a four-sided figure with rounded angles, and the cerebral hemispheres concealed the cerebellum except where the vermis was exposed between them at their occipital ends. The frontal ends of the hemispheres were not rounded into frontal poles; but, on the contrary, they almost formed flat frontal surfaces. Similarly, the occipital ends were rounded and not pointed to form occipital poles. There was a small amount of difference in the absolute size of the adult brains, and the largest specimen measured 120 mm.

* Part I., *Trans. Roy. Soc. Edin.*, vol. xlvii. p. 57, 1909. Part II., *Trans. Roy. Soc. Edin.*, vol. xlviii. p. 191, 1912. Part III., *Trans. Roy. Soc. Edin.*, vol. xlviii. p. 321, 1912.

in its fronto-occipital diameter; 115 mm. in its greatest transverse diameter at a point well forward on the temporo-sphenoidal lobes; and 71 mm. in vertical height, measured from the pons varolii to the vertex of the cerebrum. Thus, apart from the peculiarity of its general outline in total size, it was only slightly less than an average human brain. Throughout the anterior two-thirds of their extent the cerebral hemispheres were, as already indicated, in very close apposition, and the falx cerebri only dipped into the pallial or superior longitudinal fissure to a slight extent; but in its posterior third this cleft opened to form a wide interval, measuring 65 mm. in the transverse direction at its hinder end and narrowing as it ran forwards towards the posterior end of the corpus callosum. In the deep level of this interval the pineal body and the upper surface of the vermis were visible, as well as part of the upper surface of the cerebellar hemispheres. It should be stated that the backward extension of the occipital lobes of the cerebrum carried them 2 mm. beyond the cerebellar hemispheres.

In its essential features the basal aspect of the brain conformed to current descriptions of the mammalian brain; but it presented many special points of interest, to which reference will be made in the course of my survey.

I. Cerebral Convolutions and Fissures.

Regarded as a whole, the cerebral convolutions (gyri) were large and well defined from each other by deep, well-marked fissures (sulci), and yet many furrows not deep enough to be regarded as sulci were seen crossing the surfaces of convolutions. Invariably these shallow furrows were in the position of blood-vessels ramifying in the pia mater, and it was clearly demonstrable that the furrows were produced by the blood-vessels. In appearance they resembled the arterial grooves upon bony surfaces, and their presence upon the surface of the brain suggested either arterial pulsation or resistance to brain growth as their determining cause. Indeed, from the distinct character of many of them it would not be difficult to credit these vessels with the possibility of determining the position of new fissures in a rapidly expanding hemisphere. In their chief and outstanding characters the two hemispheres corresponded with each other; but in the matter of intimate detail they presented a considerable amount of asymmetry, although neither hemisphere could be said to be more elaborately convoluted than the other.

The general plan of the convolutions and fissures was not simple or easy to determine. In fact, the whole arrangement bore very little if any resemblance to that presented by the brain of a typical member of the carnivora, *e.g.* the dog; and this is somewhat remarkable and unexpected when we remember that the seals are themselves carnivores notwithstanding their numerous adaptations to an aquatic habitat. Partly for this reason, and partly because my observations do not altogether harmonise with those of Murie * in his description of another seal (*Otaria jubata*, the sea-lion), nor with those

* Murie, *Trans. Zool. Soc. Lond.*, vol. viii., 1874.

of Sir Wm. Turner * in his account of the brain of the elephant seal, I propose to deal at some length with the arrangement of the convolutions and fissures and the possibility of dividing the cerebral surface into subordinate lobes, after the manner adopted in describing the human brain.

The complexity of the convolution pattern of the brain of seals has led observers to devise such an elaborate terminology for the description of the separate convolutions and fissures that it is a matter of considerable difficulty to correlate the different terms. Consequently, bearing in mind the variations which specimens of these brains present among themselves, as well as their divergence from the ordinary type of carnivore brain, I have preferred to restrict the use of terms as much as possible, and to limit the attempt to establish homologies to such characters as were fairly comparable to those presented by the human brain.

1. *The Lateral Surface of the Hemisphere.* (Fig. 1.)

On this aspect the convolutions and fissures were well developed both as regards their size and their numbers, and yet any underlying "pattern" resulting from the disposition of the primary fissures was most elusive and difficult to decide. Fortunately, there was no uncertainty with regard to the *fissure of Sylvius* (sulcus Sylvii). Its commencement in relation to the locus perforatus anticus on the basal surface of the brain, and its position between the orbital and temporo-sphenoidal parts of the hemisphere on the same surface, fixed the position of its main stem without any doubt, and so by its outer end it provided one fixed point from which to unravel the complexity of the lateral surface. Turner found this fissure traceable on the lateral aspect of the hemisphere "upwards and backwards for 32 mm. on the side of the right hemisphere, but not so far on the left." Nevertheless, for some time I found great difficulty in deciding which, and how many, of the fissures upon the lateral surface were entitled to be accepted as its direct continuations, although, as the dissection proceeded, the decision arrived at in the first instance was verified as correct. My initial difficulty was increased by the fact that in the lateral view of the hemisphere of the brain of the dog, as may be seen in the figure given by Wiedersheim and Parker,† the fissure of Sylvius is represented as a "closed" fissure, *i.e.* one provided with "opercula," forming an "arcuate gyrus" which surrounds the fissure on all aspects except the basal segment of the fissure. Further, in the brain of the dog, this "arcuate gyrus" is repeated twice, so that altogether on the lateral aspect of its hemisphere, to quote Wiedersheim and Parker, "In carnivores, cetaceans, and ungulates, three gyri arch over the Sylvian fissure, one above the other, and are separated by the so-called *arcuate* fissures."‡ Certainly this was not the manner in which the convolutions and fissures were disposed on the lateral aspect of the hemisphere of the Weddell seal in relation to the fissure of

* Turner, *Challenger Reports*, vol. xxvi., *Zoology: Report on Seals.*

† Wiedersheim and Parker, *Comparative Anatomy of Vertebrates*, 3rd ed., 1907, p. 224.

‡ *Ibid.*, p. 228.

Sylvius. On the other hand, in MURIE'S* paper already referred to, there is a fairly close resemblance shown in pl. lxxviii. fig. 40, between the brain of the sea-lion and that of the Weddell seal under consideration (fig. 1), so far as the general position of gyri and sulci is concerned; although, having verified my interpretation of the surface appearances by dissection of the interior of the hemisphere, my conclusions differ considerably from those arrived at by MURIE, and so far as carnivora in general are concerned I am of opinion that at least the Weddell seal presents a very novel arrangement of the fissure of Sylvius, but still one which is quite compatible with, and readily explainable by, reference to the mode of its development from the embryonic to the adult condition. As is well known, the Sylvian fissure, in the course of its embryonic development, results from the more or less close apposition of those portions of the cerebral cortex which, as derivatives from the orbital, frontal, fronto-parietal, and temporal portions of the cortex of the hemisphere, and under the term "opercula," extend beyond so as to overshadow and gradually conceal from lateral observation that portion of the cortex called the central lobe or island of Reil, and thus ultimately the surface of the island of Reil may become completely hidden by convolutions which are no longer upon the same superficial plane as those of the insula. Further, until these "opercula" practically come into contact with each other, not only does the insula remain more or less visible, but the lateral segment of the fissure of Sylvius is represented by a gap or interval of varying width. Again, if the growth of the insula kept pace with the growth of the surrounding "opercula," then the insular convolutions would continue to present themselves upon the same superficial plane as that of the "opercula," and thus instead of a fissure of Sylvius we should find in its place the sulcus which limits and marks off the island of Reil from the surrounding cortex, viz. the limiting sulcus (sulcus insulæ). In other words, we should find the island of Reil presenting or protruding between the "opercula" by whose apposition the fissure of Sylvius derives its lateral characteristics.

In my opinion, that is the interpretation of the condition which is presented by the brain of the Weddell seal. As a result there appear to be two sulci extending from the basal stem of the fissure of Sylvius, and between them the greater part of the island of Reil not only presents itself, but is to a large extent upon the same superficial plane as that of the surrounding gyri.

The convolutions upon the surface of the insula were irregular, and neither upon different brains nor upon the two sides of the same brain were they closely repeated; but I have given in fig. 1 a drawing of the brain in which they showed a tendency to radiate from the basal end of the fissure of Sylvius, and I have done so because in the human brain a radiating arrangement is their normal characteristic. From all this it will be evident that the fissure of Sylvius as such is not represented on the lateral surface of the brain of the Weddell seal; but that in its place there is a vallecula, wide anteriorly and narrower posteriorly, which is occupied by the convoluted surface of the island of

* MURIE, *loc. cit.*, pl. lxxviii., fig. 40.

Reil, whose boundaries are indicated by the limiting sulcus which almost completely separates the insula from the surrounding cortex.

In my opinion, this interpretation of the appearances is in conformity with the facts elucidated by a dissection of the corpus striatum, as well as with the facts of development, although I am not aware that it has hitherto been advanced by any of the observers who have described the brain of the seal. Indeed, in his description of the brain of the elephant seal, TURNER says: "I can make no definite statement as to the presence of the island of Reil, unless the concealed part of the anterior limb of the Sylvian fissure be regarded as representing it." Again, in reference to the brain of the walrus, the same observer says: "I could not speak with any precision of the island of Reil, unless the concealed part of the anterior limb of the sylvian convolution passed deeply into the fissure and was concealed by the anterior limb of the supra-Sylvian convolution, which for some distance therefore formed the anterior lip of the fissure of Sylvius." (In the first of these quotations the reference is to the concealed part of the Sylvian fissure, and in the second to the concealed part of the Sylvian convolution, but probably this is by inadvertence.)

The Plates which illustrate the papers of MURIE and TURNER, if compared with fig. 1 of the present communication, will show how much minor variation the brains of this group of marine mammals may present, while to my own mind they emphasise the interpretation which I have ventured to put forward. It is difficult to conceive a brain of the dimensions of those under consideration *without* an island of Reil; and as this part of the convoluted surface of the hemisphere corresponds more or less exactly to the surface aspect of the corpus striatum, the presence of the latter practically compels us to account for the former.

My next endeavour was to determine which of the sulci could be accepted as the fissure homologous to the fissure of Rolando (sulcus centralis), because of its importance as a guide to the position of the sensory-motor area and its value as a dividing line between the frontal and parietal lobes of the cerebrum. Reference may again be made to the brain of the dog, in which the *sulcus cruciatus* is an outstanding feature, and to WIEDERSHEIM and PARKER'S* description of the fissure, where the following occurs: "Along the lateral surface of the hemisphere, the *cruciate* sulcus (the homologue of the central sulcus or *fissure of Rolando* of primates) extends upwards to the pallial fissure." Now, in the Weddell seal the cruciate sulcus is well marked; but, as may be seen by reference to figs. 1 and 2, it is situated so far forwards that, if it be accepted as the homologue of the fissure of Rolando, practically not only is there no frontal lobe remaining, but the parietal lobe is carried forwards to a position *in front of* the basal limb of the fissure of Sylvius, both of which contingencies are so serious as to compel us to doubt whether the homology be correct in the case of this seal, in view of the importance of the Rolandic area as a sensory-motor centre. For these reasons, therefore, so far as the Weddell seal is concerned, I am driven to accept as the fissure of Rolando that fissure

* WIEDERSHEIM and PARKER, *loc. cit.*, p. 228.

whose lower end will be seen resting upon the fronto-parietal operculum of the insula, and I have marked it by this name in fig. 1. In this respect my drawing and its interpretation are more in agreement with MURIE'S * account of the sea-lion, although in his drawing the fissure of Rolando is represented as much more extensive than it appears to be in the Weddell seal.

TURNER describes the cruciate fissure of the elephant seal as seen from the front and not from the norma verticalis, and states that "a large sigmoid gyrus was bent around its outer end." To some extent this description would apply to the Weddell seal, although in the latter the cruciate fissure was visible from the norma verticalis, but it was much more effectively seen from the norma frontalis, while its outer end was blocked by an arched gyrus (fig. 1).

I could not find any satisfactory evidence of a homologue for the external parieto-occipital fissure, and therefore no fixed indication of a limit between the parietal and occipital lobes of the cerebrum on its lateral aspect, or between the occipital and tempero-sphenoidal lobes on the same aspect, for the reason that these areas were freely connected with each other by *annectant* gyri.

The Convolutions on the Lateral Surface.

The frontal lobe having been delimited in the manner described, its convolutions resolved themselves into a pre-central (ascending frontal); the frontal contribution to the opercula of the insula; and two or three short convolutions running forwards from the pre-central convolutions towards the sulcus cruciatus.

The elongation of these short convolutions in a forward, *i.e.* frontal, direction would have the effect of forcing the sulcus cruciatus forwards and downwards towards the roof of the orbit, and would thus bring the cruciate fissure into position as a kind of boundary line between the frontal and orbital aspects of the frontal lobe. It appears to me that the blunt frontal end of the brain of the Weddell seal is due in some measure to the presence of convolutions, which in the human brain would be found in relation to the roof of the orbit. Further, in the human brain there may sometimes be seen a fissure which runs transversely from the pallial fissure across the frontal lobe and close above the orbital margin of the hemisphere. In my opinion this is a fissure which may fairly be regarded as corresponding with the sulcus cruciatus.

In the figure given by MURIE, and already referred to several times, there is, on the *frontal* side of the fissure which is marked "Rolando," a convolution named in three places as the antero-parietal convolution (AP); and I cannot but think that this was an unfortunate term to introduce at such a place so long as the fissure of Rolando is accepted as a boundary line *between* the frontal and parietal lobes of the highly elaborated brain of man.

From the fissure of Rolando (fig. 1), and beginning at a point about its middle, a well-marked fissure ran backwards towards the occipital end of the hemisphere. This

* MURIE, *loc. cit.*, pl. lxxviii., fig. 40.

fissure, which was deepest at its ends and shallowest about half way between them, divided the parietal region of the brain into an upper and a lower lobule, and it might quite fairly be termed the *intra-parietal sulcus*. Each of the lobules above and below the intra-parietal sulcus presented in its turn a short and less defined fissure whose course was roughly parallel to that of the intra-parietal sulcus, but neither of these short fissures opened into the fissure of Rolando. Thus the frontal ends of the convolutions both above and below the intra-parietal sulcus were united together, with the result that the arrangement suggested an interrupted post-central (ascending parietal) gyrus.

It has already been stated that there was no definite guide which could be selected as a demarcation between the parietal and occipital lobes, and therefore I can only say that, as a whole, the convolutions in the occipital region ran from behind forwards, and more or less parallel to each other, to make connections with the parietal and temporo-sphenoidal convolutions. One of these connections seems worthy of special notice. It joined the hinder end of the island of Reil and the hinder end of the temporo-sphenoidal operculum to one of the occipital convolutions. In this relation it should be remembered that the Sylvian fossa (which ultimately becomes the posterior limb of the Sylvian fissure in the primate brain) is shallowest in this region during the process of its development.

The lateral aspect of the temporo-sphenoidal lobe, which provided one of the opercula of the island of Reil, was situated below and behind the Sylvian fossa. It presented two fairly well defined convolutions, an upper and a lower, separated by a definite sulcus, with irregular sulci of smaller dimensions, suggesting the possibility of further subdivision.

2. *The Mesial Surface of the Hemisphere.* (Fig. 2.)

This aspect of the hemisphere presented considerable elaboration and complexity as regards the structures belonging to the pallium, but in the basal region it was simpler and more easy of interpretation. As on the lateral surface, the convolutions and fissures were large and well defined, although the determination of their homologies was a matter of considerable difficulty.

The *corpus callosum* measured 5 cms. in length and 4 mm. in vertical depth over the greater part of its length. The *genu* was 10 mm. long and 9 mm. in vertical depth, while the vertical depth of the *splenium* was 5 mm. From the anterior end of the genu to the frontal end of the hemisphere the distance was 2 cms., and from the posterior margin of the splenium to the occipital end of the hemisphere the distance was 4 cms. Therefore, as a whole, the corpus callosum was situated nearer to the frontal end of the brain. The *rostrum* of the corpus callosum was very short, but the *lamina terminalis* (lamina cinerea), extending from the rostrum to the optic chiasma, was a well-defined object.

The *callosal sulcus*, which separated the dorsal surface of the corpus callosum and the anterior aspect of the genu from the surrounding convoluted surface, commenced at the *locus perforatus anticus,* which to a considerable extent encroached upon the mesial aspect of the hemisphere and presented itself in front of the lamina terminalis below the genu of the corpus callosum. Several shallow extensions of the callosal sulcus, in relation to the anterior half of the corpus callosum, ran forwards and upwards into the superincumbent convolution, thereby complicating the appearance of that gyrus.

The *sulcus cruciatus* was visible upon this aspect of the frontal lobe, and here it divided into several branches, of which the hindermost was the longest.

There also appeared on this surface the fissure which I have accepted as the *fissure of Rolando,* and it extended from the superior margin of the hemisphere downwards and backwards to a point almost half way to the dorsal surface of the corpus callosum.

The *calloso-marginal sulcus* was much interrupted by the invasion of other fissures, so that it was composed of not only the fissure on the dorsal aspect of the callosal gyrus, but also of a branch from the cruciate sulcus anteriorly, and a branch from a fissure situated posterior to the callosal gyrus (fig. 2).

The mesial aspect of the occipital lobe was reduced to comparatively small dimensions in comparison with the size of the hemisphere, a condition which resulted from the fact that occipital structures, which in a human brain of corresponding magnitude would have been visible on its mesial face, were in this seal's brain turned to the inferior or cerebellar aspect of the occipital lobe. For this reason there was very considerable difficulty in selecting a fissure which could be regarded as homologous with the *internal parieto-occipital* sulcus. As the result of a later dissection, which determined the position of the calcarine fissure, I concluded that the fissure which is immediately posterior to the callosal gyrus, and whose course is upwards and forwards towards the supero-mesial border of the hemisphere (fig. 2), should be regarded as the internal parieto-occipital sulcus. Apparently this is the splenial fissure of some authors.

The *callosal gyrus* started by rising gradually from the locus perforatus anticus immediately below the genu of the corpus callosum. It ran forwards, and growing larger as it proceeded it wound round the anterior end of the genu, forming several well-marked folds situated between the callosal and cruciate sulci. Thereafter it passed backwards in a straighter or less elaborate form above the posterior two-thirds of the corpus callosum and between the callosal and calloso-marginal sulci. Posterior to the splenium it turned abruptly towards the basal aspect of the hemisphere, constituting what is known in human anatomy as the *isthmus* of the limbic lobe. Subsequently (fig. 3) it curved along the infero-lateral aspect as the hippocampal gyrus, which steadily expanded as it proceeded forwards to terminate in a wide flattened extremity situated close behind the locus perforatus anticus, but separated from it by the basal segment of the Sylvian fissure. In a later stage of the dissection the *uncus* was found in connection with the hippocampal gyrus.

So far, therefore, as the essential elements which enter into its formation are concerned, the *limbic lobe* in all its parts was fully represented; and only at its frontal end, where several definite sinuosities appeared, and at the widely expanded end of the hippocampal gyrus were there any marked deviations from the much simpler appearances presented by the limbic lobe of the human brain.

3. *The Inferior or Basal Aspect of the Hemisphere.*

As may be seen by reference to fig. 3, the general appearance and the interpretation of this surface were relatively simple in comparison with the other surfaces, except in the occipital region, where again there was considerable complexity due to the fact that so much more of the convoluted surface of the occipital lobe was directed towards the tentorium cerebelli than towards the falx cerebri, with the result that objects which appear on the mesial aspect in the primate brain were found upon the tentorial aspect in that of the seal.

In the mesial plane the two hemispheres were divided from each other in the frontal region by the pallial fissure as far back as the lamina terminalis, below and behind which the *optic chiasma* was situated. The *inter-peduncular space* presented the usual boundaries, viz.: anteriorly, the optic chiasma; antero-laterally, the optic tracts; postero-laterally, the crura cerebri; posteriorly, the pons Varolii. The structures forming the floor of the space were the tuber cinereum, provided with a short infundibulum to which the hypophysis cerebri was attached, this latter being a large object in proportion to the size of other structures; the corpora mammillaria; and the locus perforatus posticus. The occulo-motor nerves emerged from the mesial aspect of the crura cerebri.

The basal surface of the frontal lobe was clearly defined posteriorly by the fissure of Sylvius and the locus perforatus anticus. This surface presented the following fissures:—the *olfactory sulcus*, which was occupied by the olfactory tract (fig. 3), pursued a straight course from the locus perforatus anticus forwards towards, but not quite up to, the orbital margin; the *rhinal sulcus* commenced a short distance in front of the Sylvian fissure and ran forwards in a curved manner, following the lateral contour of the orbital surface, but separated from the margin by a convolution, then, winding round the anterior end of the olfactory sulcus, it turned backwards between the olfactory and pallial sulci, and terminated as a shallow groove upon the gyrus rectus.

The convolutions on the orbital surface were the following:—the *gyrus rectus*, situated between the olfactory sulcus and the mesial orbital border; the *posterior orbital gyrus*, forming the anterior boundary of the Sylvian fissure and the orbital operculum of the island of Reil; a *triangular gyrus*, occupying the space between the olfactory and rhinal sulci; and a long *curved gyrus*, situated between the rhinal sulcus and the lateral margin of the orbital surface. The triangular and curved gyri were both connected with the posterior orbital gyrus behind and with the gyrus rectus in front, but otherwise they were separated throughout their length by the rhinal sulcus. The general arrangement of their surface suggested the possibility of the rhinal fissure being the foundation for the more elaborate fissures which characterise the orbital surface of the higher brains.

The *olfactory tract* presented two distinct roots, separated from each other by a large area of the locus perforatus anticus. Of these, the mesial root came into view from the mesial surface in relation to the anterior end of the callosal gyrus of the limbic lobe. The lateral root emerged from under cover of the expanded end of the hippocampal gyrus. Closely adhering to the locus perforatus anticus, these roots converged and fused to form the olfactory tract, which occupied and moulded itself to the olfactory sulcus.

In all my adult specimens the *olfactory bulb* had been broken off, so that I am not able to state its size, frontal relations, etc.; but it was present in the young specimen as an ovoid enlargement 17 mm. in length and 6 mm. in breadth. It turned upwards upon the frontal surface of the hemisphere, to which it was closely applied.

Behind the fissure of Sylvius, the basal surfaces of the occipito-temporal lobes were much more expanded in the lateral direction than is the case in the primate brain; and, as a consequence, convolutions and sulci which are not found on this aspect in the human brain were visible in the brain under consideration. At the same time, it presented sulci which do not occur in a human brain, and therefore it is not easy to suggest a nomenclature for some of these sulci, nor to be quite certain that they should be accepted as providing boundaries between the occipital and temporal sections of the surface.

The *dentate* and *collateral sulci*, situated respectively on the mesial and lateral aspects of the hippocampal gyrus, were distinctly indicated. Towards the hinder end the collateral sulcus was interrupted by a bridging gyrus, behind which the sulcus corresponded to the general position of the *eminĕntia collateralis* in the lateral ventricle, as was afterwards revealed by dissection. Further, with the same part of the sulcus, *i.e.* posterior to the annectant gyrus, just mentioned, other two well-marked sulci communicated. Of these, one was directed backwards towards the occipital end of the hemisphere, and the other diverged backwards and outwards towards the infero-lateral margin of the hemisphere in its occipital area. Thus a large segment of the occipito-temporal surface, situated between the collateral sulcus and the infero-lateral margin of the hemisphere, was divided into three wedge-shaped gyri whose bases were directed towards the infero-lateral margin and whose apices converged towards the annectant gyrus above referred to. Indeed, this annectant gyrus connected the anterior and the middle of the three wedge-shaped gyri with the middle portion of the hippocampal gyrus. The posterior one of these three wedges presented a free apex, but the surfaces of each of the three showed indications of further subdivision by additional sulci.

The callosal and hippocampal gyri were united to each other by a narrow gyrus which curved round behind the splenium of the corpus callosum and the crura cerebri.

In the human brain this gyrus is named the *isthmus* of the limbic lobe, and I have used the same term for its description in this account of the brain of the Weddell seal.

Posterior to the isthmus, a distinct deep fissure entered this region, *i.e.* the basal aspect of the occipital end, as the continuation of a fissure well defined upon the mesial aspect of the hemisphere. Upon the basal aspect it was cut off from junction with the hinder end of the collateral sulcus by an annectant gyrus, whereupon it turned abruptly backwards towards the occipital end of the hemisphere (fig. 3). It appears to me that that part of the fissure immediately behind the isthmus should be regarded as the continuation of the internal parieto-occipital sulcus (fig. 2), and that its extension towards the occipital end of the hemisphere is the *calcarine sulcus* (by some observers called the post-horizontal fissure). My reasons for this view will be further elaborated in connection with the description of the posterior cornu of the lateral ventricle, but meantime I may state that the *calcar avis* or *hippocampus minor* was closely related to the position of the deep anterior end of what I have named the calcarine sulcus. Resulting from appearances verified by dissection as well as by transverse section of the posterior cornu of the lateral ventricle (fig. 4), I feel warranted in concluding that the narrow gyrus which is situated on the *lateral* aspect of the calcarine fissure and connected with the hippocampal gyrus must be regarded as the *lingual gyrus*, while the larger gyrus situated on the *mesial* aspect of the calcarine fissure and posterior to the internal parieto-occipital fissure (fig. 3) must be regarded as the foundation for the *cuneate* lobule, which is found in a corresponding position on the mesial surface of the human cerebrum.

Although the foregoing account shows that there was great deviation from the convolution pattern characteristic of a typical carnivore brain on the one hand, and by the human cerebrum on the other, yet the internal appearances exposed by dissection underwent an entire change and became simplified to a remarkable degree. So much was this the case that, in consideration of its size and with certain points of exception as to the details, the various objects were as readily recognised as they are in a human brain.

II. Dissection of the Cerebrum.

The method of procedure followed was that adopted in the dissection of the human brain.

In the first place, the hemisphere was divided by a horizontal transverse section at about 4 mm. distance above the mesial free surface of the corpus callosum, in order to expose the white core or *centrum ovale minus*, which, considering the total size of the hemisphere, was smaller than one expected. The reduction in the size of the central white core could be explained by the depth of the sulci. Many of the sulci at the frontal end were 2 cms. in depth, and at the occipital end some were 2·3 cms. deep. As, of course, all the sulci were bounded by a zone of grey matter, the general effect was a reduction in the apparent size of the central white core.

Another unexpected result was, that at the level mentioned, viz. about 4 mm. above the corpus callosum, the section opened into the cavity of the lateral ventricle, which therefore rose to a higher level than the mesial surface of the corpus callosum, and consequently there must be a corresponding deviation from the horizontal direction of those fibres of the corpus callosum which form the roof structures in relation to the body of the cavity of the lateral ventricle. This upward extension of the ventricle, taken in conjunction with the large size of the convolutions as indicated by the depth of the fissures, shows that notwithstanding its superficial dimensions the brain of the seal falls considerably short of a human brain of similar size as regards the amount of grey and white matter.

In addition to what has already been stated with regard to the corpus callosum, the following additional facts may be noted. The mesial faces of the two hemispheres were so closely in apposition that opposing gyri practically interlocked with each other, and therefore the dorsal surface of corpus callosum was entirely concealed. When this surface was exposed it showed feeble *striæ longitudinales mediales* and still feebler *laterales*. The *cingulum* was present, but much smaller than the size of the surrounding gyri led me to anticipate. The *forceps major* and *forceps minor* were easily dissected and were of characteristic appearance.

On removing the roof of the lateral ventricle and of its cornua I was impressed by the apparent simplicity of the basal ganglia, which were large, and at the first glance suggested strongly such appearances as one is familiar with in the human brain. Taking into consideration the somewhat elaborate and intricate condition of the convolutions of the pallium, the simple nature of basal objects was remarkable. The *anterior* or *frontal cornu* of the lateral ventricle was very shallow. Its course was outwards and forwards into the substance of the frontal lobe, where it terminated in a blind recess. Its relations to the *septum lucidum* and to the *caput* of the *nucleus caudatus* were similar to the arrangements seen in the human brain.

The *middle* or *descending cornu* likewise followed the human plan in its chief features and direction. On its floor there were the *choroid plexus*, the *fimbria hippocampi*, and the *hippocampus major* terminating in the *pes hippocampi*. The choroid plexus was continuous with the pia mater of the dentate sulcus, and thus, as in man, the termination of this cornu was situated on the lateral aspect of the crus cerebri and closed by the ependyma ventriculorum. The choroid plexus, however, was wider than in man, and spread itself out so as to form a vascular sheet which separated the objects in the roof of this cornu from the other structures on its floor. Further, the hippocampus major and the fimbria, with the overlying choroid plexus, were pressed upwards against the roof of the cornu, where they adapted themselves to a deep furrow which was bounded mesially by the optic tract and laterally by the tail of the caudate nucleus. Again, on its *convex* margin the hippocampus major was separated from the *floor* of the cornu by a deep fissure which almost completely detached this object from the floor of the cornu. Indeed, the connection between the hippocampus major and the floor of the cornu was reduced to a narrow band in close relation to the concave margin of the hippocampus. Consequently, in the brain of this seal the hippocampus major could not be described as the *reverse* or ventricular surface of the sulcus hippocampi.

Again, the *pes hippocampi* terminated as a rounded end, only slightly wider than the general body of the object and not expanded or notched as in man.

The *fimbria hippocampi* occupied the concavity of the hippocampus major, but it only spread over the surface of the hippocampus major for about a fourth of the width of the latter. Both the concave and convex margins of the fimbria were free, so that it only adhered to the surface of the hippocampus to a slight extent. So far as could be seen, the fimbria became continuous with the lower end of the gyrus dentatus and the adjacent part of the gyrus hippocampi close to the uncus.

The *posterior cornu* was not narrow and pointed towards its occipital end as in man. Indeed, it appeared more like a wide backward extension of the middle cornu, for at its commencement it was 2 cms. wide, and at this place the *eminentia collateralis* appeared as a large well-defined elevation indented anteriorly by the convex face of the hippocampus major, but these two objects were separated from each other by the upward extension of the fissure already referred to on the floor of the middle cornu. On the mesial aspect of the cornu, and above the eminentia collateralis, there were two strongly defined convex ridges, the one above the other. Both of these ridges appeared from under cover of the hinder end of the corpus callosum, with which they were continuous. The *lower* of the two was directed outwards and backwards. It descended to the floor of the cornu, and ceased to be an elevated object immediately behind the eminentia collateralis. As already indicated in an earlier part of my description, this elevation corresponded to the general position of the calcarine fissure on the inferior aspect of the occipital lobe of the cerebrum, and for that reason I have regarded the elevation just described as the *calcar avis* or hippocampus minor. The *upper* of the two elevated ridges seen in the posterior cornu was the larger at its commencement, but it narrowed down rapidly, and disappeared on the floor of the cornu behind the calcar avis. This object may be taken as the *bulb* of the posterior cornu. Fig. 4 shows these two structures in relation to the calcarine fissure, and it will be observed that the bulb of the cornu has a more direct relation to the calcarine fissure than the calcar avis has. The posterior cornu extended backwards for a distance of 2 cms., and terminated in a blind rounded extremity which, from the size of the eminentia collateralis, appeared to dip downwards. Certainly it showed no tendency to bend towards the mesial surface of the occipital lobe.

The *body* of the lateral ventricle was roofed over, as already stated, by the tapetal fibres of the corpus callosum. On its floor the following structures were noted:—

Anteriorly the *nucleus caudatus*, which was particularly well shaped; to the mesial side of its tailed part, there was the choroid plexus of the velum interpositum, and this choroid plexus was spread out sufficiently to entirely conceal the tænia semicircularis; behind the choroid plexus there lay the widely expanded lateral half of the body of the fornix, which, although attached to the under side of the corpus callosum in the mesial plane, nevertheless was spread outwards as far as the tænia semicircularis, thus forming a complete layer above the velum interpositum and the optic thalamus, of which, indeed, no part was visible until the fornix was removed.

At the hinder and outer end of the optic thalamus, the fornix was raised from below by a subjacent object so that it appeared as if the fornix itself contained a rounded mass of material in the position just stated. However, this underlying rounded projection was the corpus geniculatum externum of the optic thalamus, which would have been visible in the floor of the lateral ventricle but for its concealment by the expanded overlying base of the triangular fornix. The *foramen of Monro* was clearly defined and occupied its customary position.

The *fornix* was remarkably well developed and of large size as compared with that of man; but, as in man, its body or central portion was triangular in shape and flattened from above downwards. By its upper or callosal surface it was attached to the under surface of the corpus callosum along a narrow mesial line which extended from Verga's ventricle posteriorly to the septum lucidum in front. Elsewhere the cavity of the lateral ventricle on each side extended between the corpus callosum and the fornix. The lateral margins of the fornix were sharply defined and free. The deep surface of the fornix rested upon the velum interpositum, but no vessels could be seen passing between the two structures. The two anterior pillars of the fornix followed their usual course towards the base of the brain, curving round in front of the foramen of Monro. The two posterior pillars were wide like the body from which they started. Each entered the descending horn of a lateral ventricle having its anterior margin closely adapted to the concave margin of the hippocampus major, so as to form the fimbria hippocampi in the manner already described. A closer examination of its disposition now revealed a somewhat remarkable fact which had so far escaped observation—viz. the surface of the hippocampus major, although rounded and solid in appearance, was now found to consist for the most part of the fibres of the posterior pillar of the fornix arranged somewhat like an incomplete hollow tube, within which there lay concealed a much smaller ridge of grey substance representing the grey matter of the hippocampus major, which became continuous with the isthmus of the limbic lobe at a point below the splenium of the corpus callosum.

It is probable, therefore, that the longitudinal fibres of the posterior pillars of the fornix are distributed to the hippocampus major; to the hippocampal gyrus with its uncus, as well as to the gyrus dentatus. Further, such an increase of the amount of grey matter in the hippocampus major as would deepen the sulcus dentatus would also probably lead to the obliteration of the fissure on the floor of the descending horn and to a thinning out of the fibres of the posterior pillar of the fornix, and thus produce appearances which are characteristic of the brain of man without materially increasing the total size of such a hippocampus major as is presented by the brain of the seal.

The *velum interpositum* was chiefly notable on account of its large choroid fringes and for its extreme thinness under the body of the fornix, where it covered the optic thalami and formed one of the roof structures in relation to the mesial or 3rd ventricle, for which it likewise provided the usual choroid plexuses. It transmitted numerous vessels into the upper or dorsal surface of the optic thalamus, to which it was closely adherent, but especially so at the hinder part.

The third ventricle was situated as usual between the optic thalami, and its most noteworthy character was the large size of the middle commissure (fig. 2). The position of its anterior and posterior commissures did not call for special comment, and the structural arrangements and composition of its boundaries were not in any way peculiar.

The *optic thalami* formed large well-developed masses, and, as already described, no part of their upper surfaces was visible within the lateral ventricles until the fornix and velum interpositum were removed. When the upper surface of the optic thalamus was fully displayed, it presented certain very interesting features. At its postero-lateral end—that is, close to the entrance to the descending horn of the lateral ventricle, but upon the upper surface of the optic thalamus—the *corpus geniculatum externum* constituted a well-marked elevation which was related to the fornix as previously explained. Along the mesial margin of its upper surface, a flattened ridge—the *tænia thalami* or stalk of the pineal body—ran backwards towards the anterior end of the mesencephalon above the posterior commissure of the 3rd ventricle and the entrance to the aqueduct of Sylvius, where it was joined by its fellow from the opposite thalamus, and thus formed the peduncle of the pineal body.

The *pulvinar* was situated between the corpus geniculatum externum and the tænia thalami. It formed a flattened area which did not project backwards with an overhanging border as in man. The *habenula* was situated partly to the lateral side and partly to the mesial side of the tænia thalami. In other words, the tænia thalami ran across the surface of the habenula. Considered as a whole, the habenula formed a narrow pyriform projection whose wider end was directed backwards and presented itself on the lateral wall of the 3rd ventricle high up in the interval between the middle and posterior commissures.

The *corpus striatum* was displayed by making horizontal transverse sections from the surface of the insula towards the mesial plane so as to include the caudate nucleus, but it was not until the lower levels of the island of Reil were reached that definite evidence of striation was observed. The grey substance of the surface convolutions and that of the caudate nucleus were always distinctly seen, but it was only after the sections had been subjected to the staining influence of a saturated solution of bichromate of potash for forty-eight hours that the other grey masses were clearly visible.

The *lenticular nucleus* occupied its usual position on the postero-lateral aspect of the head of the caudate nucleus. Its mesial border was convex and separated from the caudate nucleus and the optic thalamus by the *internal capsule.* This band was quite definite, but very narrow; and it presented the characteristic anterior and posterior limbs with an intermediate genu. The lateral margin of the lenticular nucleus in its higher levels presented the ridges and depressions which are the characteristic of the claustrum, and it was only after the sections had passed below the level of the general mass of the lenticular nucleus that the claustrum was seen as a separate structure, with a definite external capsule between it and the more deeply placed grey mass. Indeed, the appearance of striation, which was directed forwards and outwards, was more definite below the level at which the lenticular nucleus still retained its biconvex outline and while the striated substance intervened between the claustrum and the head of the caudate nucleus. The effect of this disposition of the grey and white masses of the corpus striatum was to suggest that the differentiation of the *external capsule* was incomplete and had not advanced to the stage of separating the claustrum from the lenticular nucleus.

A band of white substance intervened between the cortical grey matter and wavy margin of the claustrum, and, since the claustrum is usually regarded as a detached and submerged portion of the grey cortex of the insula, it would appear the white fibres which separate the grey cortex from the claustrum are developed earlier than those which, in the higher brains, separate the claustrum from the caudate nucleus and are known as the external capsule. In TURNER's account of the elephant seal, it does not appear that he submitted his specimen to this dissection. The grey nature of the tail of the caudate nucleus was always distinct, and an extension of the sections through the optic thalamus revealed quite plainly its grey substance, bounded laterally by the posterior limb of the internal capsule. The grey matter, however, did not resolve itself into the subordinate nuclei (anterior, mesial, and lateral) which characterises the human brain.

The Pineal Body.—I was able to examine three specimens of this interesting object, and in each case it presented widely different characters. Indeed, the differences were so pronounced that they were not easy to reconcile and certainly not easy to explain.

In the brain which I removed from the skull of the seal which was two days old at the time of its death, the pineal body was a large prismatic object resting upon the vermis of the cerebellum and wedged into the interval between the occipital ends of the cerebral hemispheres. It projected about 27 mm. behind the splenium of the corpus callosum. The peduncle broke in the process of removal, but it was very short and apparently just sufficiently long to permit the expanded part to clear the splenium. The dimensions of the expanded, prismatic part were as follows:—greatest length, 27 mm.; width, 18 mm.; vertical depth, 12 mm.

In a second specimen, belonging to one of the adult brains, the peduncle was again broken, but the expanded part still occupied its natural position. In this case the peduncle was cylindrical and the expanded end was pyriform in shape, its measurements being:—length, 20 mm.; width, 15 mm.; vertical depth, 9 mm. It showed no signs of faceting by pressure from surrounding structures, as might have been expected, supposing the reduction in its size as compared with the young specimen to have resulted from the effects of preservative solutions. In the third specimen, also that of an adult brain, the complete object was in an undisturbed position. The peduncle was very thin, flattened from above downwards, and measured 6 mm. in the transverse direction. It was closely enveloped in the pia mater, and extended backwards on the vermis of the cerebellum to terminate in a disc-like expansion 12 mm. in width. The discoid part was flattened upon its cerebellar surface, while it was slightly conical on the opposite side. From the commencement of the peduncle to the extreme edge of the disc it measured 25 mm., of which the peduncle represented 15 mm. and the disc 10 mm. Numerous vessels travelled between the pineal body and the pia mater. These two adult brains had been preserved in precisely the same way, and therefore it would appear as if the pineal body of the Weddell seal underwent a gradual reduction in size subsequent to birth, but that the shrinkage is not accompanied by any marked shortening in the total length of the object. Similar facts have been recorded by TURNER in connection with the pineal body of the elephant seal, in which the measurements were:—length, 16 mm.; greatest breadth, 8 mm.; greatest vertical diameter, 6 mm. In two specimens taken from the walrus the dimensions were, in one case, 30 mm. long and 18 mm. wide; in the other case, 29 mm. long and 13 mm. wide. There is thus satisfactory evidence that, so far as the seals are concerned, the pineal body attains an unusual size as compared with other mammals; although in the case of *Otaria jubata*, described by MURIE, the size of this structure may not have been so noteworthy as in the specimens above detailed, otherwise such a competent observer could scarcely have confined his account of its size to the statement that it was "relatively large."

The *optic tract* followed the usual course from the optic chiasma backwards and outwards to wind round the lateral aspect of the crus cerebri. Thereafter—owing to its relations to the hippocampus major, as already described—it became compressed into a somewhat triangular band upon the under side of the thalamus, and sweeping past the *corpus geniculatum internum*, with which it became closely associated, it continued its course, spreading out certain of its fibres towards the *pulvinar*, but reserving a bundle of considerable bulk for the *corpus geniculatum externum*. So far as the eye could judge, some of the fibres also reached the *superior* of the *quadrigeminal* bodies, but it did not divide into the *brachia* which characterise its human arrangement.

III. THE MESENCEPHALON.

The mesencephalon presented the *corpora quadrigemina* on its dorsal aspect, and each one of these was quite distinctly defined from the other by longitudinal and transverse furrows. On its ventral surface the *crura cerebri* were also well marked. Latterly, the *corpus geniculatum internum* constituted a large oval elevation, larger than either of the corpora quadrigemina and separated from them by a deep furrow through which many vessels entered the brain substance. The *aqueduct of Sylvius* (fig. 2) was a fairly wide canal, and was not reduced to a T-shaped chink as in man.

IV. The Hind Brain.

(*a*) *The Cerebellum.*—As is usual among carnivores, the cerebellum possessed a relatively large *vermis* in proportion to the size of the *hemispheres.* When examined in longitudinal section (fig. 2), the relation of the vermis to the 4th ventricle and the other constituents of the hind brain presented a great similarity to the corresponding appearances seen in the human brain.*

The *central lobe* rested upon the *superior medullary velum* and possessed a *lingula.* The *culmen* and *declive* were similarly recognisable, as were also the *nodule* and the *tonsil* upon the inferior or ventricular aspect of the vermis. The *pyramid*, the *tuber valvulæ*, and the *folium cacuminis* were not so easily determined in the brain of the seal as they are in the brain of man, because, whereas in the latter these structures are turned towards the floor of the skull, in the former they were turned more towards the hinder end of the vermis.

The *hemispheres* were small and practically impossible of the detailed subdivision which is customary in the descriptions of the human cerebellum, and any attempt to do so would introduce unnecessary risks of error. In a measure, the points of entrance of the *middle cerebellar peduncles* from the pons Varolii provided a guide to what might be regarded as the dorsal and ventral portions of the cerebellum. On this assumption, the *biventral lobe* and the *tonsil* projected laterally some distance beyond any other part of the hemisphere, while the *flocculus* formed a mass of considerable size which overlapped the middle peduncle from behind. If we accept the position of the middle cerebellar peduncle as a sufficiently reliable guide from which to continue the great horizontal fissure by means of which the upper and lower aspects of the human hemisphere are located, then in the brain of this seal all that remained of each hemisphere, in addition to the objects already mentioned, occupied the same aspect and was directed towards the tantorium. Nevertheless, it was divided into two clearly defined areas by a fissure which commenced at the point where the middle peduncle entered from the pons Varolii. If, now, we name these lobes respectively *superior-anterior* and *superior-posterior*, then all the parts of the cerebellum of the seal have been accounted for. It may be noted that the part which I have just named the superior-anterior lobe is reduced to a single folium in relation to the vermis, and it is this folium which is named the folium cacuminis (fig. 2).

Compared with the human cerebellum, it would appear that whereas in the seal the vermis and its subordinate parts are well developed, and the flocculus, biventral lobe, and tonsil are produced on a large scale, the remainder of the hemisphere is much reduced in proportion. On the other hand, in man the hemisphere proper has become much expanded and thickened, with corresponding reduction in the size of the flocculus, the biventral lobe, and the tonsil. In fact, a theoretical enlargement of the superior-anterior and superior-posterior lobes of the hemisphere of the seal, accompanied by their

* *Text-Book of Anatomy*, edited by CUNNINGHAM, 3rd ed., p. 512.

expansion backwards as well as laterally, and a reduction in the size of the flocculus, biventral lobe, and the tonsil, would be capable of producing a cerebellum with practically the same superficial characters as that of man.

The *pons Varolii* was well developed, and measured 25 mm. from its anterior to its posterior border in the line of its very definite basilar groove. The anterior and posterior borders converged upon each other so rapidly, as they travelled outwards to form the middle cerebellar peduncles, that the outline of the posterior border was interrupted by the emergence of the large root of the 5th cranial nerve. As a result of this arrangement, the greater part of this nerve-root made its appearance from the side of the medulla oblongata between the olivary eminence and the pons, but of course close up to the latter. In the elephant seal TURNER notes that the 5th cranial nerve arose from the pons Varolii and not from the bulb, whereas, in describing the same nerve in the walrus, he remarks that some fibres of the sensory root "passed backwards between the facial and auditory nerves to the anterior and outer part of the medulla oblongata."

The *medulla oblongata* was wide at its upper end, where it measured 40 mm.; but it narrowed rapidly towards the lower end, and instead of being conical it was markedly flattened in the dorso-ventral direction. Its upper or "open" part was associated with the 4th ventricle, while the "closed" or lower part contained the central canal in its unexpanded condition. Its bilateral character was indicated by the anterior and posterior medium fissures, the former shallow and terminating in relation to the posterior border of the pons Varolii at the foramen of Vicq d'Azyr. On each side of the anterior median fissure or groove the *pyramid* formed quite a distinct tract. The point of emergence of the 6th cranial nerve was not between the pyramid and the pons as in man, but from a flattened area situated external to the pyramid, so that the nerve-stem made its appearance close to the mesial side of the large medullary root of the 5th nerve and without any fibres of the pons intervening between them. The 7th and 8th cranial nerves emerged from the side of the medulla oblongata close behind the 5th and 6th nerves, but slightly nearer the dorsal or ventricular aspect of the bulb.

The *olivary eminence* was small and not so prominent as in man, but it distinctly separated the 9th and 10th cranial nerves from the 12th or hypoglossal nerve.

The closed part of the medulla oblongata presented the general appearances and proportions of the adjacent part of the spinal cord as regards its fissures and main columns. Posteriorly, the *funiculus gracilis* with the *clava* at its upper end, the *funiculus cuneatus* with its upper expansion, the *cuneate tubercle*, and also the *tubercle of Rolando* were all definitely recognisable. They turned outwards in a common bundle from a point immediately below the *obex*, and skirting the infero-lateral margin of the 4th ventricle they entered the cerebellum as the restiform body or *inferior cerebellar peduncle.* The visible *decussation of the pyramids* began at a point 32 mm. from the hinder margin of the pons Varolii, so that we may consider the total length of the bulb to be distinctly less than its width at its upper end.

The *rhomboid* or *4th ventricle* was distinctly lozenge-shaped, but neither in regard to its size nor in regard to the detailed modelling of its floor was it so well marked as in man. The floor presented a median furrow, as well as an inferior and a superior *fovea* in relation to each quarter of the lozenge. Associated with the *fovea inferior*, the *trigonum hypoglossi* and the *trigonum vagi* formed quite recognisable elevations. The *area acusticæ* was likewise a well-marked elevation on the floor, but its surface was smoother than in man because of the absence of visible striæ on its free surface. The *eminentia teres* was placed to the mesial side of the *superior fovea*, but it was prolonged upwards as well as downwards by a longitudinal ridge which ran upwards along the floor of the aqueduct of Sylvius in the one direction, and downwards to join the trigonum hypoglossi in the other.

The *obex* was a distinct object in the roof of the ventricle in relation to its inferior angle, and the *ligula* could be seen extending from it on each side.

Summary.

In making a general summary of the naked-eye anatomy of the brain of the Weddell seal, the features which have impressed me most and seem most deserving of special reference are the following:—

1. Its angular appearances in association with its large size, suggesting that the general fish-like outline of the entire animal has to a certain extent influenced the shape of its skull, and thereby the shape of the brain within the cranium.

2. The size and elaborate ramification of the cerebral convolutions, together with the considerable amount of asymmetry in the details of the arrangement of the convolutions of the one hemisphere as compared with the other.

3. The width of the interval between the two hemispheres posterior to the hinder end of the corpus callosum.

4. The marked departure from the arrangement of the cerebral convolutions in such a typical carnivore as the dog.

5. The presence of those convolutions belonging to the island of Reil upon the same superficial plane as that of the surrounding convolutions which form the opercula.

6. The definite and complete character of the limbic lobe.

7. The position of the calcarine fissure, and thereby of the visual area upon the inferior aspect of the occipital end of the hemisphere.

8. The large size of the fornix, and particularly of its posterior pillars, in association with a well-marked hippocampus major, of which the greater part is composed of fornix fibres and only a small part of grey substance.

9. The long stalk and the large size of the pineal body and its position upon the vermis of the cerebellum, in the open interval between the cerebral hemispheres.

10. The well-developed but, on the whole, simpler characters of the basal structures as compared with the elaboration of the pallium.

11. The relatively simple character of the mesencephalon.

12. The small size of those parts of the cerebellar hemispheres which in man would constitute their main bulk; and the large size of those objects in relation to the vallecula, which in man would be relatively small.

13. The reduction in the posterior margin of the pons Varolii, which thereby permits the bulbar root of the 5th cranial nerve to emerge directly from the side of the medulla oblongata.

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DESCRIPTION OF PLATE.

Fig. 1. The left cerebral hemisphere, natural size.

F. Sy. Fissure of Sylvius.
F. Ro. Fissure of Rolando.
S. P-c. Pre-central sulcus.
S. Cr. Sulcus cruciatus.
S. I-p. Intra-parietal sulcus.
I. R. Island of Reil.

Fig. 2. Mesial surface of the right cerebral hemisphere.

S. Cr. Sulcus cruciatus.
F. Ro. Fissure of Rolando.
I. P-o. Internal parieto-occipital fissure.
Op. C. Optic commissure.
C. C. Corpus callosum.
Hy. C. Pituitary body.
P. Var. Pons Varolii.
Pin. Pineal body.

Fig. 3. Basal surface of cerebral hemisphere.

Rh. f. Rhinal fissure.
F. Sy. Fissure of Sylvius.
S. Col. Sulcus colateralis.
C. f. Calcarine fissure.
P. o. Parieto-occipital fissure.
S. D. Sulcus dentatus.
O. T. Olfactory tract.
Op. N. Optic nerve.
Hy. C. Pituitary body.
Cr. C. Crus cerebri.
Is. Isthmus.
Cun. Cuneus.
G. L. Gyrus lingualis.

Fig. 4. Vertical transverse section through the posterior horn of the lateral ventricle of the right hemisphere, viewed from behind.

C. f. Calcarine fissure.
V. Lateral ventricle.

HEPBURN: BRAIN OF WEDDELL SEAL.

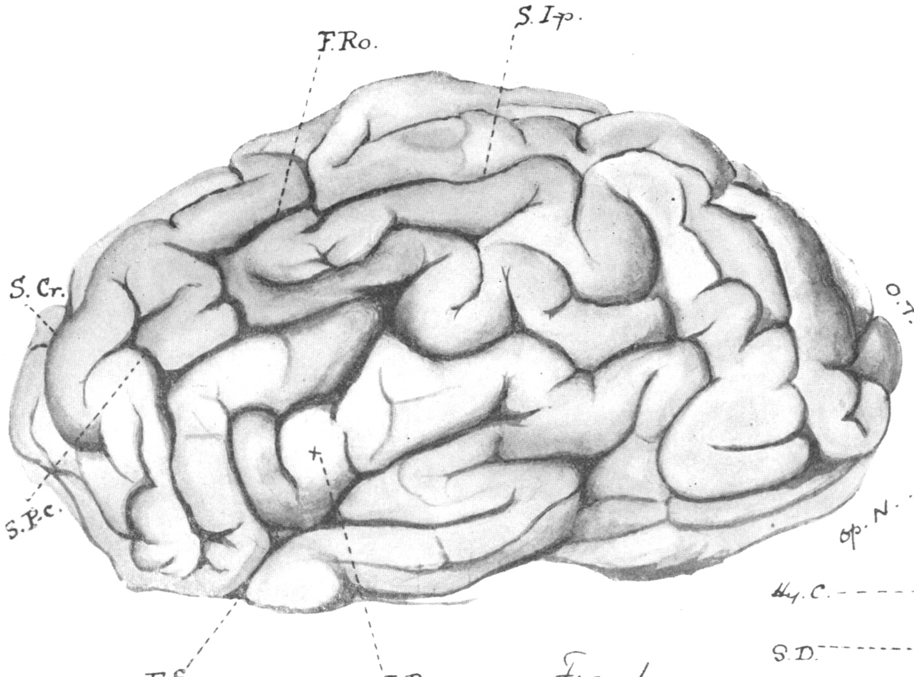
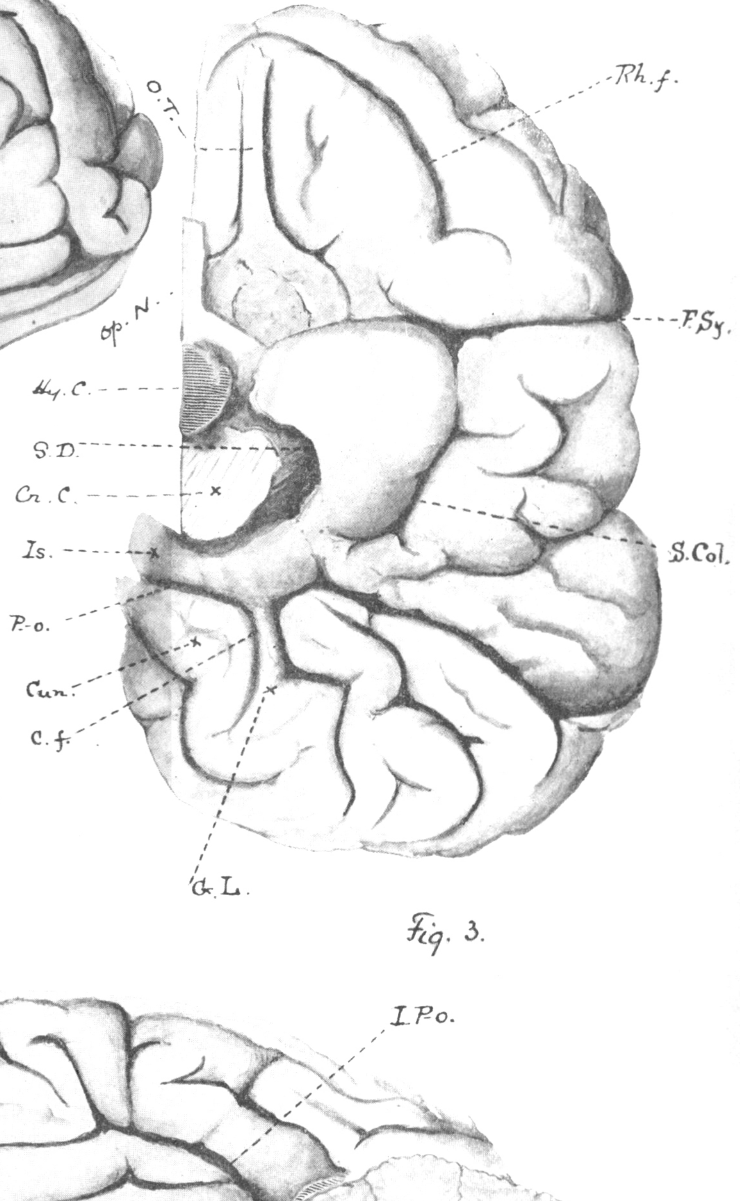


Fig. 1.



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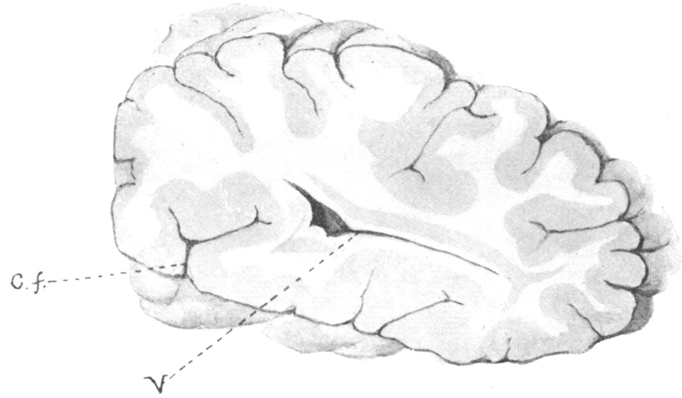

Fig. 4

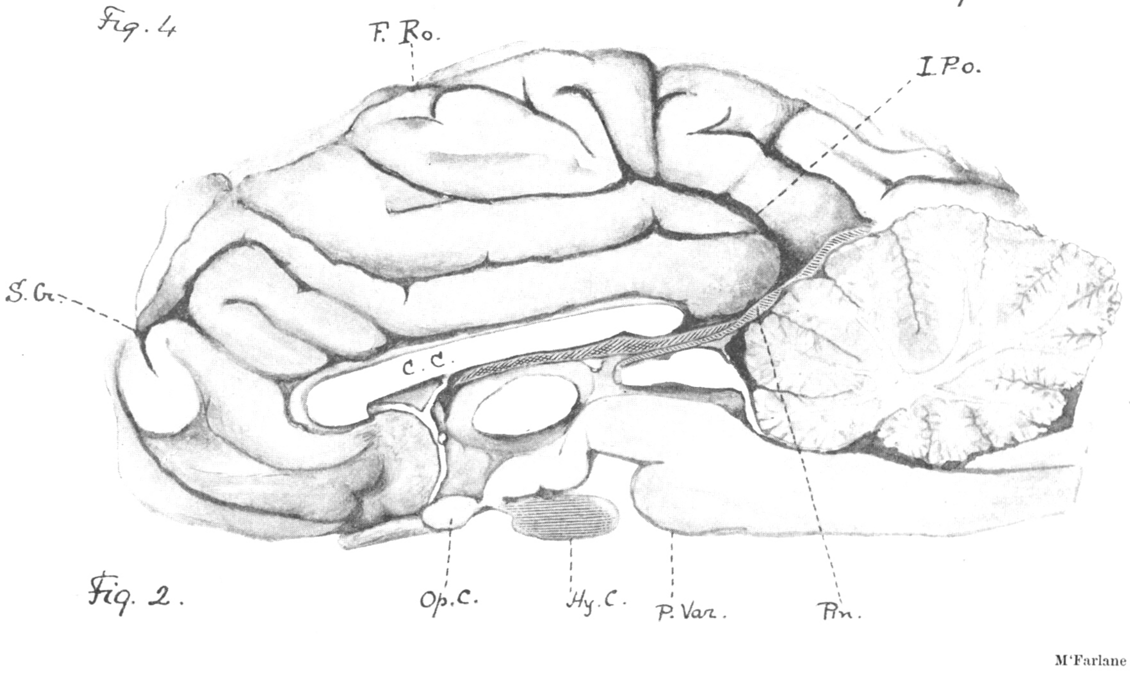

Fig. 2.

D. Hepburn, del.

M'Farlane & Erskine, Edin.