V—The Brain of the Aboriginal Australian
A Study in Cerebral Morphology

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[Plates 15–37]

Introduction

The problem of the interpretation of the brain in terms of intellectual capacity and racial difference has been one of profound interest since the time when Gall first put forward his conceptions of cerebral localization. The relationship of the anatomical pattern, both macroscopic and microscopic, to functional localization is naturally in the final analysis the end of all morphological studies. Our knowledge of these relations has greatly increased since the time when Cunningham, Retzius, and others wrote their descriptive accounts of the cerebral hemispheres ; but it cannot yet be said that studies in morphology have reached that level of perfection which warrants the study of anatomy being subordinated to the background of physiology. Thanks to the labours of Turner, Cunningham, Elliot Smith, Campbell, Brodmann, and many others, morphological and, to a certain extent, functional significance can be given to many of the sulci. Further, the arrangement of the sulci can be to some extent used as an index to the relative amount of the expansion of the newly acquired areas in the human brain. Despite this, the views of Keith are substantially true :—

> " Unfortunately our knowledge of the areas, convolutions, and furrows of the frontal region of the human brain has not yet reached that stage which permits us to say that this or that marking has such and such a meaning ; we cannot yet read the functional capacities of any given brain by a study of its external appearances. We have every right to believe that our knowledge will increase, and that some day experts will be able to determine the functional significance of the appearance seen on such endocranial casts as that obtained from the Galilean frontal bone ".

This may be said to be almost equally true of other regions of the brain ; and so, whilst the question of functional localization naturally attracts one's attention throughout such a study as the series of primitive brains which forms the subject matter of this enquiry, it is as apparent to-day as it was to Elliot Smith in 1904, that the problem cannot be usefully pursued until a vast amount of work has been done on pure brain morphology.

One of the most difficult problems in such a study as this is that of the institution of exact homology. Even were our knowledge of cerebral function adequate, before any interpretation of a particular brain, or series of brains, could be made, the exact relationship between the sulcal pattern and the histologically defined areas must be determined for each pattern. A mere description of the sulci in terms of their accepted nomenclature very often presumes exact homology. The determination of homologies in which exact criteria are employed has been one of the most difficult aspects of the description of the series of brains under consideration. It is easy to fall into the error of appearing exact by conforming the material to classificatory patterns—a danger so aptly put by HEAD in his discussion on Aphasia :

> " The tendency to appear exact by disregarding the complexity of the factors is an old failing in medical history. Each patient with a speech defect of cerebral origin is stretched on the procrustean bed of some theoretical scheme ; something is lopped away at one part, something at another, until the phenomena are said to correspond to some diagrammatic conception, which never has and never could have existed. And yet neurologists continue to cling to these schemes, modifying them to suit each case, conscious that they do not correspond in any way to the facts they are supposed to explain ".

Despite these dangers, tentative classificatory schemes in science are to a large extent unavoidable. Throughout this work on the Australian brain, classifications of the sulci and of whole areas are employed, and the classifications are summed up in tables of percentage occurrence. Realizing the dangers, these classifications have been used as a means to an end ; they are arbitrary in their choice and consequently open to alteration without hesitation. Furthermore, the summing up in terms of percentage grouping is merely a matter of convenience ; for the essential racial and functional features of any particular brain can never be submerged under a mass of figures dealing with other brains. Percentage figures and endless columns of figures are not morphological features and frequently tend to obscure the fundamental features of structure.

In arriving at the homologies of the different sulci, the works of CUNNINGHAM, BRODMANN, CAMPBELL, BOLTON (1900), ELLIOT SMITH, RETZIUS, and others have been freely consulted. It is not always necessary or convenient to refer to particular authors in the course of such a discussion as this. It seems to be sufficient in the introduction to emphasize that advances in knowledge are collective and not the work of the individual concerned ; therefore references will be sparingly used in the text.

For the most part the state of preservation of the material did not warrant the taking of any measurements for the determination of weight, volume, or shape.

In previous accounts of the brain of the aboriginal Australian certain features have been emphasized as indicative of primitiveness and lowly estate, and have been used to suggest differences from the brains of other races. Whilst such may be the case, much has since been written on the brains of other races by KOOY, GENNA, and others ; and in these races, features which were emphasized as significant in the Australian have also been found. At the outset, therefore, it is essential to state that the retention of a primitive feature does not necessarily imply lowliness. It is apparent that many of the ideas permeating these works were the direct result of the previous publication of ELLIOT SMITH's work on the brain of the Egyptian (1904, *c*) ; and so it is desirable to give his own view on the matter to avoid any misunderstanding as to the meaning of the retention of certain individual primitive features shown in the series under consideration.

> " Those anthropologists who use the retention of primitive features in the Nordic European as an argument to exalt the Negro to equality with him are neglecting the clear teaching of comparative anatomy, that the persistence of primitive traits is often a sign of strength rather than weakness ".

It is not on the presence of individual features, but on the whole composition of the pattern that our final conclusions must ultimately be founded.

The problem of arrangement of such a large series of brains has been a difficult one. Whether to arrange the figures of the occipital region, of the lateral surfaces, and of other aspects together, or whether to put the pictures of each brain by itself has been difficult to decide. It seems to be most convenient to place the figures of each brain together. The Sydney brains are numbered one to thirteen, Plates 15–27. The four Queensland brains are shown on Plates 28–31, and then there follow the three brains from Cambridge, Plates 32–34, one from the Royal College of Surgeons, Plate 35, and one from Amsterdam, Plates 36–37. The hemispheres are referred to by a capital letter, a number, and then right or left. For example, the left hemisphere of brain No. 1 of the Sydney collection is referred to as S.1.L. and so on.

In the drawings illustrating this paper the sulci are drawn as being separate where the meeting sulcus only just overlaps the edge of the sulcus met ; where the meeting sulcus passes into the wall of the sulcus met, but its termination is clearly seen, the condition is indicated by two dots ; and where two sulci are separated by a deeply buried gyrus they are drawn as being continuous.

Where the extent of the area striata could be determined this is indicated by stippling or by a dotted line where the line of Gennari was seen.

The different aspects of the brain are described separately. The features of these aspects are classified together in groups where each hemisphere is described separately. At the end of each section dealing with the respective areas there is a general summing up, and an attempt is made to put the information in tabular form for the sake of reference.

MATERIAL

The material consists of forty-four hemispheres of the aboriginal Australian. All the Sydney and Queensland material is definitely recorded as belonging to full-blooded aboriginals. DUCKWORTH (1908), who has previously described the

Cambridge series, states in the introduction to his paper that they are the brains of Australian natives. It is presumed that the brain in the Institute of Brain Research at Amsterdam is that of a full-blooded Australian.

The Sydney series consists of twenty-six hemispheres. This material was practically all collected by the late Dr. J. F. FLASHMAN many years ago. He compiled a brief catalogue of the brains including their source of origin and the statement with each that it is the brain of a pure aboriginal. Some of the material was collected as long ago as 1880 ; and naturally the brains are in various states of distortion. Apart from their age, the difficulty of proper fixation where they were obtained means that they are to some extent distorted and contracted, so that the taking of any measurements is useless. Although they are distorted to a varying extent the sulcal pattern is clear in almost every hemisphere.

The catalogue compiled by FLASHMAN is of interest in giving the names of many of those who were directly responsible for collecting the material and there are also comments on the aboriginals themselves ; thus brain No. 1 is described.

" Brain 1. (Joey Governor.)

This is the brain of a full-blooded aboriginal. It was obtained by Dr. BOWMAN of Singleton : he sent it to Professor WILSON, who handed it to me. The man was a bushranger who was shot when being captured. I found a piece of the bullet in his brain. This specimen is quite authentic and is preserved in a jar labelled . . . etc. . . . "

" Brain 6. Full-blooded aboriginal.

Billy King. Presented by Dr. JAMES HOGG, Queensland. It is the brain of a male about 37 years. He was a ' stockman in North Queensland '. In May, 1898, he was sentenced to death for murder at Townsville, but the sentence was commuted ".

Beyond these extracts it is unnecessary to publish the catalogue compiled by FLASHMAN.

The material from the Queensland Museum at Brisbane consists of four brains which are in an excellent state of preservation with the exception of the frontal lobe of one hemisphere. In four of these hemispheres the arteries were intact. The arterial pattern of these was determined and the findings used in many places for the establishment of homologies. The figures on Plates 28, 29, and 30, showing the cortical areas of arterial supply, are not described in detail and are inserted for the purpose of reference. The reader is referred to my paper on the arterial supply of the brain of the Chimpanzee for the morphological interpretation of the arterial supply (1930).

The Cambridge material consists of three brains in which the majority of the features of the sulcal pattern can be made out. These three brains were described by DUCKWORTH in 1908. I have to acknowledge that on my visit to Cambridge Dr. DUCKWORTH very kindly placed these three brains at my disposal, and welcomed a review of his previous description in the light of advances in knowledge since the time when he wrote his account.

The Amsterdam brain is in the Institute of Brain Research at Amsterdam. It has been referred to by KAPPERS in different writings. Dr. ARIËNS KAPPERS very kindly permitted me to examine and describe it.

The brain in the Royal College of Surgeons is that of an aboriginal woman and has been referred to by ELLIOT SMITH in his description of a Tasmanian brain (1911).

THE LATERAL SURFACE OF THE OCCIPITAL REGION

The foundation of this description rests on the work of ELLIOT SMITH, and frequent reference will be made to his interpretation of the occipital region in his "Studies in the Morphology of the Human Brain" (1904). ELLIOT SMITH has laid down the criteria for homology in these studies, and was the first to distinguish clearly the intimate relationship between the sulcal and cortical patterns. The description given here is founded on a large series of Chinese and Australian cerebra, and it has been found possible to classify the occipital region on the postero-lateral aspect into six groups. These groups are arranged so that they run from those cases in which a large sulcus lunatus is present to those in which it has broken down and become difficult to recognize. Whilst the order of arrangement is roughly in the order of the breaking down of the sulcus lunatus, and whilst it suggests an evolutionary series, this must not be taken to imply that they are arranged in order of primitiveness. The classification takes into account all the features of the occipital lobe and, as far as possible, an attempt has been made to give expression to the whole appearance of the region. The features which have been employed in arriving at the grouping are

1. the direction of the folding and displacement of the striate cortex,
2. the form and dimensions of the sulcus lunatus,
3. the association of the sulcus occipitalis transversus with the sulcus lunatus,
4. the appearance of the sulci on the dorso-lateral and ventro-lateral borders of the hemisphere,
5. the extent to which the striate cortex extends on to the lateral surface, its disposition, and other features.

The classification is not to be regarded as a fixed one. It may be that, in larger series, subdivisions of the main groupings may be desirable ; and even in other series further groups may conveniently be added. The whole object of the grouping is to attempt a reasonable basis for racial classifications founded on the whole general appearance of the brain and the relative extent of its foldings and expansions in different regions. The presence or absence of such sulci as the sulcus lunatus and the sulcus paracalcarinus cannot reasonably be used as bases for racial differences.

Group 1

A well-marked occipital operculum extends from the medial to the lateral border of the hemisphere. The extent of the operculum is greater than that usually seen in the human brain when a sulcus lunatus can be defined. The area striata extends far on to the lateral surface of the hemisphere. The sulcus occipitalis transversus is buried, either wholly or in part, under the operculum ; or this sulcus may actually take part in the formation of the opercular sulcus.

The type occurs in two hemispheres, Q.1905.R. and Q.1487.R.

These two hemispheres show a greater extent of operculation than I have seen recorded. I have examined a very large series of Chinese, Australian, and other brains and have never seen any hemisphere which I would place in group 1 ; the nearest approach to the condition is figured in MARSHALL's photograph of the occipital region of the brain of a Bushwoman which I have published elsewhere (1933). But, apart from the mere question of size, the hemispheres are of great value and interest in not only throwing light upon, but also practically in solving, many difficulties of homology. They clearly indicate where past divergence of opinion was justified with the material available. These points will become apparent as the description proceeds ; it will suffice here to mention the names of sulci which have been the subject of dispute and to refer to certain passages in the literature where they have been discussed. The sulcus occipitalis transversus is such a sulcus ; by some it has been homologized with the "Affenspalte" and by others has been regarded as an exclusively human feature (*see* ELLIOT SMITH, 1904 *c*, p. 165 and CUNNINGHAM, 1892, pp. 218–234). Other sulci which may be mentioned are the sulcus lunatus, the superior polar sulcus, the paramedial sulcus and the paracalcarine sulcus. We shall see that the varying methods of packing the area striata so affects the sulcal pattern that sulci having the same topographical relations may be morphologically different. The importance of the two hemispheres is such that a detailed description of each is necessary.

Q.1905.R. (Plate 28)—The occipital operculum (18) is seen as a crescentic folding of the cortex extending from the medial to the lateral border of the hemisphere. It separates the occipital region from the parietal region except for a narrow strip of cortex lying between the lower end of the opercular sulcus and the sulcus occipitalis inferior. The sulcus lying under the operculum is deep and complex. Superiorly it lies immediately posterior to the fissura parieto-occipitalis (21) ; inferiorly it ends in a backwardly curved sulcus lying anterior to, and partly surrounding, a typical Y-shaped sulcus calcarinus externus (19). The latter sulcus is accompanied by accessory external calcarine sulci. The calcarine group of sulci is folded horizontally. Many features go to establish the fact that this large opercular sulcus is homologous with the "Affenspalte"—the clear definition of the sulcus calcarinus externus, the identification in its correct topographical relations of the sulcus praelunatus (18*p*), the upward extension of the operculum, almost covering the fissura parieto-occipitalis, and finally, the submergence of the sulcus occipitalis transversus under the operculum. The operculum belongs to the type frequently seen in the brain of the Chimpanzee and is homologous with the sulcus described by some writers as the fissura perpendicularis externa. I am unable to find any reference to so extensive an operculum in the human brain.

Plate 28, fig. 3, shows the arrangement of the sulci after turning back the operculum. The sulcus lunatus (18), the sulcus occipitalis transversus (17), and the sulcus medial to the inner end of the sulcus occipitalis transversus are all clearly defined. The sulcus lunatus stands out as a subordinate part of the occipital operculum : that part of it lying above the sulcus praelunatus is buried under the operculum, together with the outer limb of the sulcus occipitalis transversus ; the part below the sulcus praelunatus is coincident with the outer and inferior extremity of the major operculum and corresponds with that portion of the sulcus lunatus named by ELLIOT SMITH the pars ventralis sulci lunati. The sulcus occipitalis transversus at its outer end is deeply buried under the occipital operculum and almost continuous with the upper end of the sulcus lunatus : medially its inner end is buried with a sulcus on the dorso-medial border.

Although the limits of the stria of Gennari could not be determined in the Queensland brains, the distribution of the arteries gives a fairly clear indication of its extent. The area supplied by the branches of the posterior cerebral artery, ascertained by dissection, extended as far forward as the opercular lip in its lower part, and included within its area both the sulcus calcarinus externus (19) and its attendant accessory sulci. The line of demarcation between the posterior and middle cerebral arteries coincides with the line of the lower half of the opercular sulcus as far superiorly as the point at which the sulcus praelunatus arises ; the line of demarcation then crosses over on to the surface of the operculum to follow the upper accessory sulcus for a short distance, and finally turns forward to cross the opercular sulcus again immediately above the point where this sulcus is joined by the sulcus paroccipitalis. The supply of the more medial part of the operculum is from branches of the posterior cerebral artery coming from the medial surface.

The close relationship in other brains between the area supplied by the calcarine artery and the extent of the area striata would indicate in this specimen that the area striata is limited by the posterior lip of the opercular sulcus in its lower part, and that above this the anterior part of the operculum is occupied by parastriate cortex. The distribution of the arteries is very similar to that which I have described in the brain of the Chimpanzee : and furthermore, the distribution of the cortical areas is what one would be entitled to assume from the arrangement of the sulci, emphasizing the primitive type of sulcus calcarinus externus. Further confirmation of the extremely primitive nature of the lateral occipital region in this brain is obtained by making a comparison of the areas assumed above with those determined by BRODMANN (1909) in the Orang-utan (fig. 122), by CAMPBELL (1905) in the Chimpanzee (plate 11) and depicted by ARIËNS KAPPERS (1921, Tafel IX).

Q.1487.R. (Plate 29)—On the right side of Q.1487 the occipital operculum (18) is a crescentic folding of cortex extending from a point on the medial surface of the hemisphere immediately posterior to the fossa parieto-occipitalis almost to the lateral border of the hemisphere. Its postero-lateral extremity has the same form and relations as in Q.1905.R. On the surface of the operculum there are several sulci produced apparently by the folding of the area striata. When the operculum is raised the sulci lying under it can be analysed. As in Q.1905.R. the outer part consists of a clearly defined sulcus lunatus. The upper end of the sulcus lunatus cuts the border of the operculum and lies on its surface. The sulcus praelunatus (18*p*) arises from the anterior part of the sulcus lunatus. The intermediate sulcus lying under the operculum—actually forming the bottom of the opercular sulcus—is a simple and deep sulcus entirely free from any interlocking gyri. This is the sulcus occipitalis transversus (17), presenting the unusual condition in the human brain of being completely separated from the sulcus paroccipitalis. The medial part of the occipital operculum is a deeply operculated sulcus cutting the dorso-medial border and extending well on to the medial surface. At its outer part it is separated from the inner arm of the sulcus occipitalis transversus by a narrow gyrus which is only slightly submerged by the main operculum. The outer arm of the sulcus occipitalis transversus, on the other hand, is placed very deeply in the angle between the sulcus lunatus and the sulcus praelunatus. At first sight this occipital region appears to be very similar to Q.1905.R. This appearance is only superficial, however, for the method of folding of the striate cortex as determined by the form of the intrastriate sulci is fundamentally different. In Q.1905.R. the folding is essentially horizontal, whereas in Q.1487.R. the folding is mainly vertical. For reasons to be fully discussed later, the area striata is displaced both dorsally and ventrally. The two sulci within the concavity of the sulcus lunatus are intra-striate foldings and therefore homologous with the sulcus calcarinus externus ; but there is also the long vertical folding of the striate cortex producing the vertical sulcus (19*v*)* directed superiorly towards the concavity of the medial operculum. This specimen is very important in providing grounds for the classification of many of the Australian hemispheres into a group in which the essential feature is the vertical folding of the striate cortex. It is therefore essential at this point to discuss the interpretation put forward to explain the arrangement of the sulci in this specimen.

Elliot Smith, in his " Studies in the Morphology of the Human Brain " (1904), fully discusses the varieties in form which may be assumed by the sulcus retro-calcarinus as an expression of difference in folding of the area striata, and on p. 133 states that " in many cases its caudal element r3 is a large independent vertical furrow (sulcus retrocalcarinus verticalis), which may even in some cases become confluent with the sulcus occipitalis paramesialis ". (The difficult problem of the homology of the sulcus paramesialis is discussed elsewhere in this paper.) And on p. 168, having defined the sulcus lunatus as " a depression formed by the forward projection of the cortical area containing the stria of Gennari ", he states that in

* (19*v*). This is the correct number for the sulcus referred to, but unfortunately in Plate 29 this is wrongly labelled (20*v*).

the brain of a Roumanian he has seen the area striata cross on to the outer surface of the hemisphere in two places, each of which was bounded in front by a lunate sulcus, one dorso-caudal and the other ventro-caudal in position.

This interpretation has led to a considerable degree of confusion as to the exact identity of the sulcus lunatus. If any part of an occipital operculum is retained in the human brain and limits the stria of Gennari, in accord with this definition, it is right to regard it as a sulcus lunatus or "Affenspalte", and HULSHOFF POL is apparently justified in his statement that from the writings of ELLIOT SMITH any sulcus from the medial to the lateral border might be regarded as the sulcus lunatus. It seems to the writer that it is unfortunate that the term "Affenspalte" has been so freely used as an expression of a structure sufficiently fixed morphologically to be used as a basis for homology. So far as I have been able to ascertain, the "Affenspalte" may be represented by different sulci, and the sulcus lunatus, as defined in this paper, is only in part representative of it.

FLASHMAN (1908), taking ELLIOT SMITH's work as his basis for description, names in S.5.R. the sulcus retrocalcarinus verticalis the sulcus occipitalis superior (calcarinus externus); and, naturally, then named a medial operculum the sulcus lunatus, whereas it is in reality the superior polar sulcus. But, whereas ELLIOT SMITH in his earlier writings may have left the impression that the sulcus lunatus is variable in position to a considerable extent (in one case he states it was on the medial surface of the hemisphere), there can be no ambiguity about his later views on the matter: for in the Mott Memorial Volume he emphasizes the distinction between the sulcus lunatus and the superior polar sulcus: "Fig. 8 represents the medial and lateral aspects respectively of the right hemisphere (the occipital part) of a Bulgarian brain, in which at first sight there seemed to be two lunate sulci upon the lateral aspect of the brain. But comparison with the other diagrams reveals the fact that the upper lunate sulcus is really the superior polar sulcus which has been displaced on to the lateral surface while the inferior polar sulcus remains on the medial surface".

The presence of a medial operculation, probably indistinguishable from the superior polar sulcus, in so many of the Australian brains has made this digression necessary; and it will avoid needless repetition to define the viewpoint held by me on the identity of the various fissures. The so-called "Affenspalte" is the fissure bounding the posterior lip of the occipital operculum. The occipital operculum is, however, so variable in its extent that the cleft can hardly be said to be homologous with any other particular cleft unless the opercula in the compared specimens are of approximately equal size and form. In the two Australian hemispheres the type of operculum is almost comparable with that seen in the Cercopithecidae and the cleft must be taken to include the sulcus occipitalis transversus. This is entirely in keeping with ELLIOT SMITH's writings. He states: "In all the Cercopithecidae there is invariably a large occipital operculum, which springs not only from the posterior lip of the sulcus lunatus but also from the dorso-medial edge of the hemisphere: it always overlaps the sulcus occipitalis transversus, which may even in some cases become confluent with the sulcus lunatus or in other cases become aborted ". The sulcus lunatus is therefore a subordinate part of the fissure formed by the occipital operculation. His statement that " there can be no reasonable doubt in the mind of anyone acquainted with the structure of the Gorilla's brain that the furrow which I have called ' sulcus occipitalis lunatus ' represents the ' Affenspalte ' and that its overhanging posterior (ventral) lip is the occipital operculum ", is correct only if the term " Affenspalte " is applied to those hemispheres where the medial part of the occipital operculum has become separated from the lateral part—the sulcus lunatus. In such cases, seen in the Gorilla, the Gibbon, many Orangs and Chimpanzees, all that is left of the occipital operculum is the area of cortex bounded by a sulcus lunatus ; in the Orang, and more particularly in the Chimpanzee, however, an occipital operculum as extensive as that seen in the Cercopithecidae is often present.

The sulcus lunatus, then, is a crescentic sulcus, revealed after the unfolding of the occipital operculum, placed on the lateral aspect of the hemisphere. The medial part of the occipital operculum may be present on the dorso-medial border and separated from the sulcus lunatus. The interval is then occupied by a Y-shaped gyrus formed by the cortex connecting the occipital with the parietal area in this region and dividing anteriorly to pass on either side of the sulcus occipitalis transversus.

The two occipital regions, then, which have been included in group 1 present the very primitive state in which the occipital operculum is so large that it covers over an area more extensive than the limits of the sulcus lunatus.

Group 2

" *The Accessory Group* "

This group is characterized by a stereotyped pattern of the sulci on the lateral occipital region. The sulcus lunatus stands out as a prominent, fully curved sulcus almost exactly limiting the stria of Gennari ; the intrastriate sulci are horizontally arranged ; the sulcus calcarinus externus is Y-shaped, or is obviously derived from the Y-shaped type ; the sulcus calcarinus externus accessorius, after which the group is named, surrounds the outer end of the sulcus calcarinus externus as a curved U-shaped sulcus, concentric with the sulcus lunatus, and finally the sulcus paramedialis, as a sulcus limitans areae parastriatae, is frequently well defined on the dorso-medial border of the hemisphere.

This type is ideal for the purpose of demonstrating the morphological pattern of the sulci in relation to the histologically defined areas of the cerebral cortex. It has been depicted or described by writers in the brains of various races. Elliot Smith depicts it in the European (1925), in the Tasmanian (1911), and in the Egyptian (1904, *c*) ; Retzius in the European (1896, Taf. LXIV) ; Kooy (1921) in the Indonesian (fig. 13 and other figures) ; Genna (1924) in the native races of the

Cameroons (Taf. 3) ; WOOLLARD (1929) in the Australian aboriginal (fig. 3). It occurs in about 20% of Chinese brains.

There are eight examples in this series :—

Q.1487.L. ; S.1.R. ; S.5.L. ; S.10.L. ; S.10.R. ; S.12.R. ; Q.2788.L. ; and C.3.R.

Q.1487.L. (Plate 29)—Every feature characterizing this group is diagrammatically shown in this brain ; so that it might well be used as a standard for the purposes of comparison. The sulcus lunatus (18) is a fully curved operculated sulcus placed on the lateral aspect of the hemisphere. It extends for a distance of four centimetres from the occipital pole. The extent of the stria of Gennari could not be ascertained ; but, having examined a very large number of brains of the Chinese, it can safely be assumed that it should be found close to the posterior lip of the opercular sulcus. The sulcus calcarinus externus (19) presents the typical Y-shaped form, enclosing between the limbs of the Y the posterior end of the sulcus retrocalcarinus (20). The accessory external calcarine sulcus (19*a*) forms a U-shaped loop around the stem of the sulcus calcarinus externus and is concentric with the sulcus lunatus. In some of the hemispheres the accessory sulcus is equally deep throughout its extent ; in Q.1487.L. it is somewhat shallower at the highest point of the curve constituting a transition stage to the presence of two accessory sulci as seen in Q.1905.R. The sulcus occipitalis inferior extends from the tentorial surface to emerge on the lateral aspect just anterior to the lower end of the sulcus lunatus. It is confluent anteriorly with an occipito-temporal sulcus. The sulcus praelunatus (18*p*) arises at a somewhat high level and curves upwards into the postparietal lobule.

On the inner side the sulcus lunatus is separated from the sulcus paramedialis (22) and the sulcus occipitalis transversus (17) by a Y-shaped gyrus. The stem of the Y is placed posteriorly ; the arms are directed anteriorly into the first and second plis de passage of Gratiolet. The stem of the Y lies between the inner end of the sulcus lunatus and the sulcus paramedialis ; the arms of the Y diverge to pass on either side of the sulcus occipitalis transversus, thus connecting the occipital cortex with the arcus parieto-occipitalis above and with the postparietal lobule below. As I shall have occasion to make reference to this gyrus, I propose, for the convenience of description, to name it the gyrus occipito-parietalis superior.

The sulcus paramedialis (22) lies on the dorso-medial border of the hemisphere. It is a triradiate sulcus in which the posterior limb is separated from the remainder by a submerged gyrus. This triradiate form is common in the brain of the Chinese and is often seen with this type of occipital lobe.

The remaining seven members of group 2 need not be described in detail but certain individual features may be pointed out. In all of them there is a fully curved sulcus lunatus and lying concentrically within it an accessory external calcarine sulcus. In S.1.R. there are two sulci praelunati and, on opening up the sulcus lunatus between their points of origin from it, there is seen a deep interlocking gyrus separating the sulcus lunatus into dorsal and ventral elements as described by ELLIOT SMITH in the brain of the Egyptian (1904, *c*). He named the gyrus the gyrus translunatus. Antero-medial to the inner end of the sulcus lunatus there is a transverse sulcus (22) continuous with the sulcus intraparietalis. At first sight this appears to be the sulcus occipitalis transversus. It is, however, separated from a transverse sulcus lying anterior to it—the true sulcus occipitalis transversus—by a submerged gyrus. This sulcus is possibly related to the type of medial operculation or superior polar sulcus discussed in the first group and resembles in many respects the sulcus paramedialis of Elliot Smith. It was not possible to determine the extent of the area striata, and so its identity must be left uncertain.

The lateral occipital region in S.5.L. was accurately described by Flashman (1908). He regarded the sulcus arising from the anterior border of the sulcus lunatus as the sulcus occipitalis transversus. This, however, I regard as the sulcus praelunatus (18*p*). The arcus parieto-occipitalis, so clearly defined in most human brains, cannot be defined in this brain. The sulci of the parietal region are so disconnected that it is difficult to compare them with sulci in other brains, and the identifications given to them in the section of this paper on the parietal region are purely hypothetical. The sulcus calcarinus externus is Y-shaped with a short anterior stem and short upper arm. Flashman regarded the longer inferior arm as the stem of the Y. This is not in keeping with the primitive form of the sulcus; and, furthermore, in this hemisphere the curved accessory external calcarine sulcus surrounds the short stem of the Y.

S.10.L. is a good example of the group. The lunate sulcus and the intrastriate sulci are all very clearly defined and require no description. The sulcus paramedialis (22) occupies its normal position along the dorso-medial border. It is confluent with the sulcus occipitalis transversus. The sulcus occipitalis inferior—a sulcus which shows so much variability in the human brain—presents a very primitive form. It is deeply operculated and forms an arcade lying under the lateral part of the sulcus lunatus. The medial surface, to be described later, presents a remarkable group of primitive features. The arcus intercuneatus is widely exposed, the gyrus cunei is superficial, and the sulci related to the parieto-occipital fossa are separate and distinct.

In Q.2788.L. the arrangement of the sulci constituting the group 2 type is diagrammatically shown. The sulcus lunatus appears from the figures to be somewhat inferiorly placed but this is due to antero-posterior distortion during fixation.

C.3.R., S.10.R., and S.12.R. all have the type of lunate sulcus and accessory external calcarine sulcus described above. They differ materially, however, from the other members of the group in the general arrangement of the intrastriate sulci. In S.12.R. there appear to be two lunate sulci, one on the infero-lateral region and one on the dorso-medial region of the occipital lobe. The lower one is clearly the sulcus lunatus (18), the upper the superior polar sulcus of Bolton (22*a*). Both of these sulci limit the stria of Gennari, whilst the gyrus separating them is non-striate cortex. The superior polar sulcus passes well on to the medial surface to end in the angle formed by the fissura parieto-occipitalis and the sulcus retrocalcarinus (20). On the dorso-lateral surface it is superficially confluent with the sulcus occipitalis transversus (17). Within the concavity of both the sulcus lunatus and the superior polar sulcus there are axial foldings of the striate cortex represented by two sulci which become confluent at the occipital pole. Here the folding is very deep, clearly indicating a large submerged area of buried cortex. From the arrangement of the sulci and the depth of this central area it is reasonable to suggest that the stem of the gyrus occipito-parietalis superior has pushed back the area striata in the centre, and that there has been, in consequence, a dorso-medial and a ventro-lateral displacement of the area striata. Comparing the medial surface in C.3.R., S.10.R., and S.12.R., it is apparent from the method of branching of the sulcus retrocalcarinus (20) that the striate cortex is vertically folded and that a larger extent of the cuneus than usual is occupied by the striate cortex ; in fact, in C.3.R. the whole of the cuneus is a striate area. In the other members of this group the area striata is folded in a horizontal direction ; but, although there is horizontal folding in the concavity of the sulcus lunatus in the three hemispheres just described, the main axis of folding of the area striata is vertical.

This vertical folding of the striate cortex is made use of to institute a separate group—group 5—to be described subsequently. Although these three hemispheres show the vertical arrangement of the intrastriate sulci they are included in group 2 because of the presence of those features which constitute that group.

The terms horizontal and vertical folding, used throughout this description, have reference solely to the main direction of the striate cortex as determined by section of the cortex, or by the form of the intrastriate sulci where the cortex could not be examined. The terms have no reference to the form of the sulcus lunatus or other sulci on the lateral surface of the hemisphere such as the lateral occipital sulci and gyri of other writers.

Group 3

The Miscellaneous Lunate Group

This group is a heterogeneous one. The sulcus lunatus is always present ; but it is found in various forms, in some cases it is extensive, in other cases small. The general direction of the folding of the striate cortex is horizontal. The most marked cases are closely related to those placed in group 1 ; others show a definite similarity with group 2.

The comparisons which I am making with the Chinese brains in order to obtain some standard for morphological classification have made it necessary to subdivide this group in the brains of the Southern and Northern Chinese into three sub-groups. These sub-groups are arranged in accordance with the size of the sulcus lunatus. In the Chinese, although the percentage of group 3 cases is as great as in the Australian aboriginal, there is a definite preponderance of those specimens in which the sulcus lunatus, although well defined, is small. These facts are tabulated at the end of the description of the occipital region.

Within this group there is a great variety in the form of the sulcus lunatus, and therefore it is necessary to describe many of the hemispheres in some detail. This is curtailed as much as possible and the figures are relied upon where the description fails.

The type occurs in eleven cases :—

Q.2640.L., Q.2640.R., Q.2788.R., Q.1905.L., S.9.R., S.2.R., S.4.L., S.3.R., C.2.R., C.2.L., C.3.L.

Q.2640.L. (Plate 31)—The arrangement of the sulci on the lateral aspect of the occipital region of this hemisphere presents many unusual features and is difficult to interpret. Passing from a point immediately posterior to the parieto-occipital fissure on the dorsal surface, a complicated, obliquely-placed sulcus (18) cuts off the occipital region behind from the parietal region in front. It ends in a backwardly curving sulcus almost on the lateral border. The lower end of this sulcus is clearly the inferior end of the sulcus lunatus. Tracing the sulcus from below upwards, the sulcus praelunatus (18*p*) is seen passing forward into the concavity of a small sulcus in the occipito-temporal region which is concentric with a sharply curved sulcus occipitalis anterior. Immediately above the sulcus praelunatus the floor of the sulcus lunatus is crossed by a deep gyrus translunatus ; so there is no doubt that the lower part corresponds with the pars ventralis sulci lunati. It is above the sulcus praelunatus that difficulties arise. Starting from the medial end of the sulcus, the sulcus paroccipitalis (16) ends in the inner third of the major sulcus so that the inner third corresponds with the sulcus occipitalis transversus (17). Immediately lateral to the point of junction of the sulcus paroccipitalis with the sulcus occipitalis transversus the outer limb of the sulcus occipitalis transversus is joined by what appears to be the upper end of the sulcus lunatus. This connexion is superficial, for the two sulci are separated by a submerged gyrus. This sulcus, lying anterior to the outer limb of the sulcus occipitalis transversus, can be traced without interruption as far as the gyrus translunatus and is equally deep throughout its extent. If we are to regard it as the pars dorsalis sulci lunati, the opercular sulcus lunatus lies anterior to the sulcus occipitalis transversus—a condition which I have not previously encountered in the examination of a large number of brains.

There is a sulcus immediately lateral to the outer end of the sulcus occipitalis transversus which passes backwards from the main sulcus. This might be regarded as the upper end of the pars dorsalis sulci lunati ; but this is rendered doubtful by the fact that is it a shallower sulcus than the main sulcus and does not cut it very deeply. Since the extent of the area striata could not be determined it seems desirable to leave the exact interpretation somewhat indefinite ; being satisfied with the fact that the pars ventralis is clearly defined. Posterior to the large obliquely placed sulcus five sulci are seen crossing the occipital region. The most inferior of them passes forwards under the lower end of the pars ventralis and is the sulcus occipitalis inferior. The innermost from its topographical relations is the sulcus paramedialis (22), the remainder are presumably intrastriate, although the extent of the area striata was not determined.

Q.2640.R. (Plate 31)—The sulcus lunatus (18) is an extensive operculated sulcus placed far out on the lateral surface. It has features in common with the two hemispheres placed in group 1, but the occipital operculum being entirely lunate in nature it is placed in group 3. In its inner part the lunate operculum covers the outer arm of the sulcus occipitalis transversus (17) which is on the anterior wall and is not deeply placed. Apart from the size of the sulcus lunatus the most interesting feature of the occipital region is the anterior angle of the sulcus lunatus where the sulcus praelunatus (18*p*) arises. The lower part of the sulcus lunatus and the sulcus praelunatus are in alignment so that the sulcus praelunatus appears to arise at a low level. This type of junction between the sulcus lunatus and the sulcus praelunatus is not uncommon in the higher Apes ; I have observed it in the Orang-utan, MINGAZZINI (1928) depicts it in the Chimpanzee, and ELLIOT SMITH in the Gorilla.

The intrastriate sulci are arranged horizontally. The sulcus retrocalcarinus passes round the occipital pole and extends for a short distance on to the lateral surface. The sulcus calcarinus externus (19) is typically Y-shaped, the limbs of the Y tending to approximate one to another and lie on either side of the posterior end of the sulcus retrocalcarinus. The sulcus occipitalis inferior is an operculated sulcus lying along the tentorial border. It arises close to and inferior to the point of branching of the sulcus calcarinus externus and ends in the occipito-temporal region where it is separated from the lower end of the sulcus occipitalis anterior by a narrow gyrus. The sulcus occipitalis anterior (26) is in two parts : the upper part is confluent with the parallel sulcus, whilst the lower part is continuous with a fragmentary sulcus temporalis medius. The general form of the sulcus occipitalis anterior, as in other brains of the series, closely parallels the sulcus lunatus.

S.9.R. (Plate 23)—The features of the occipital region of this brain present many points of interest and certain difficulties of interpretation. The sulcus lunatus is fully curved and laterally placed ; above, it ends in a slightly curved sulcus directed towards the concavity of the sulcus occipitalis transversus. It is labelled '*y*' in the figures illustrating it. The stria of Gennari just falls short of the posterior lip of the sulcus lunatus anteriorly. The sulcus calcarinus externus is of the typical Y-shaped form and the sulcus occipitalis transversus is clearly defined. On the dorso-medial edge of the hemisphere a branched sulcus, whose stem passes well on to the medial surface, forms a prominent feature. The part on the dorso-medial border is from its topographical position the sulcus paramedialis, whereas the stem lying on the medial surface has affinities with the sulcus paracalcarinus. This will be dealt with when the medial surface is considered. Between the sulcus lunatus and the sulcus paramedialis a wide gyrus occipito-parietalis superior, containing two sulci, is to be noted.

The most interesting feature of this brain, in the light of ELLIOT SMITH's description of a Tasmanian brain, is the upward continuation of the sulcus lunatus—the sulcus '*y*'.

In order to explain the arrangement of the sulci in the Tasmanian brain, ELLIOT SMITH (1911) called to his aid two brains, one an Australian brain in the Museum of the Royal College of Surgeons and one an Egyptian brain. His description has such an important bearing on the interpretation of the group of hemispheres placed in group 5 in this paper that it seems desirable to quote him *in extenso.* Concerning the sulcus '*y*' he says :—

"J'ai eu beaucoup de difficultés à interpreter le sillon *y*. Tout d'abord j'inclinais à croire que ce sillon (aussi bien chez le Tasmanian fig. 1 que chez l'Australien fig. 7) pouvait représenter le sulcus paramesialis. Ce dernier est la limite dorsale de l'area parastriata mihi (*voy. op. cit.*, 'Journal of Anatomy and Physiology,' vol. 41, pp. 200 et 201). L'area striata s'étend si loin dans la direction dorsale (fig. 6) que le bord latéral (dorsal) de l'area parastriata (et le sulcus paramesialis qui marque la place de ce bord) devait être transporté très loin en dehors sur la face dorsale de l'hémisphère. Mais la comparaison d'une importante série de cerveaux m'empêche de m'arrêter à cette manière de voir. En effet il n'est pas rare de rencontrer la portion latérale du sulcus transversus occipitalis (*voyez* le cerveau Egyptien, fig. 8 *y*) déviée au point de devenir sagittale et de reproduire ainsi le type des cerveaux de Tasmanien et d'Australien ainsi que le montrent respectivement les figures 1 et 7.

"A cette interprétation on pourriat objecter la disjonction en deux parties sillon '*y*' dans les cerveaux Australiens.

"Le fait intéressant qui ressort de cette comparaison c'est qu'après avoir cherché dans une nombreuse série de cerveau de toute races celui fut le mieux de nature à jeter quelque lumière sur ce cerveau de Tasmanien, je suis tombé sur les proches alliés des Tasmaniens qui habitent de l'autre côté du détroit de Bass".

It is a striking fact that this sulcus '*y*' should occur in many of these brains; and not only that but also that the figure of the Australian brain which is depicted by ELLIOT SMITH should be a perfect example of the type of occipital region showing vertical folding of the area striata which occurs in a large number of these brains (*see* group 5). S.2.R., in which I have also labelled the sulcus '*y*', is almost an exact copy of the right side of the Egyptian brain depicted by him. In Q.2640.L. (Plate 31) there is the difficult sulcus bearing some resemblance to the sulcus '*y*', but it ends anterior to the sulcus occipitalis transversus instead of posterior to it. ELLIOT SMITH is inclined to the opinion that the sulcus '*y*' is related to the sulcus occipitalis transversus, but there are difficulties presented by S.9.R. in accepting this interpretation. It is perhaps an expression of the fact that in these cases the unfolding of the occipital operculum has not progressed as far as it does in more highly developed brains. It is the difficulty of giving exact definition to the term "Affenspalte" suitable for all cases. The difficulty is lessened by realizing that names cannot imply all that is involved in the changes which are taking place in this region, or, in fact, in any region of the brain. (*See* KOOY, 1921, fig. 22.)

In S.2.R. the sulcus '*y*' is confluent with the sulcus occipitalis transversus (17).

Q.2788.R. (Plate 30)—The sulcus lunatus is a slightly curved sulcus lying obliquely across the occipital lobe. The lateral extremity does not recurve to the same extent as in most of the other brains. The crescent-shaped sulcus is very similar in form to the type depicted by Kooy in some of the Indonesian brains (his figs. 22, 23, and 31). Its most anterior point lies about four centimetres from the occipital pole. The sulcus praelunatus extends forwards from the midpoint of the sulcus lunatus and is confluent with the lower element of the sulcus occipitalis anterior, and through this with the parallel sulcus. There is thus a continuous sulcus from the temporal pole to the sulcus lunatus. The intrastriate sulci are irregularly arranged and fragmentary.

The arterial supply was determined in this brain. The sulcus lunatus forms the line of demarcation between the areas of the middle and posterior cerebral arteries above the level of the sulcus praelunatus ; below this level the line of demarcation follows the line of the sulcus praelunatus for a short distance and then follows its usual course along the inferior temporal gyrus. The area striata is supplied by calcarine branches of the posterior cerebral artery which reach the lateral surface by passing over the inferolateral margin of the hemisphere after emerging from the sulcus retrocalcarinus.

This brain was somewhat flattened antero-posteriorly in fixation, so that the position of the sulci are probably somewhat displaced.

Q.1905.L. (Plate 28)—The clear definition of the sulcus calcarinus externus, of the sulcus occipitalis transversus, and of the sulcus lunatus would lead to the impression at first sight that the interpretation of the occipital region is simple and straightforward.

The sulcus occipitalis transversus lies transversely across the dorso-medial region ; its inner arm bears a normal relation to the fissura parieto-occipitalis ; and its outer arm is normally related to the sulcus occipitalis anterior and the sulcus praelunatus. The sulcus calcarinus externus is typically Y-shaped ; it lies at a somewhat more posterior level than on the other side, and its anterior end lies in the concavity of the sulcus lunatus. The sulcus lunatus is placed well on the lateral surface and is shaped like the old-fashioned bow. The extent of the stria of Gennari was not determined.

The difficulty of complete interpretation lies in the wide expanse of cortex lying between the sulcus occipitalis transversus and the sulcus calcarinus externus and which is folded by deep sulci on the dorso-medial border. Both of the sulci lying medial to the inner end of the sulcus lunatus cut the dorso-medial border of the hemisphere, the posterior one being operculated. Although the arrangement is peculiar, one can assume with a fair degree of certainty that the posterior sulcus, from its relationship with the upper limb of the Y of the sulcus calcarinus externus, is a sulcus limitans areae striatae and therefore homologous with the sulcus polaris superior ; whereas the anterior sulcus is probably a sulcus limitans areae para-striatae and therefore homologous with the sulcus paramedialis. Usually, when the sulcus polaris superior is as well marked as this, there is no recognizable sulcus paramedialis. This arrangement of sulci lends weight to the argument, already stated, that the "Affenspalte", using the term to indicate its more fully developed types, may equally well be represented by sulci on the dorso-medial border of the hemisphere as by the sulcus lunatus on the lateral surface.

S.4.L. (Plate 18)—The sulcus lunatus is a sharply curved sulcus on the postero-lateral aspect of the hemisphere. It is somewhat smaller than any which have so far been described. Arising from it anteriorly is a typical sulcus praelunatus and within its concavity lies the stem of the Y-shaped sulcus calcarinus externus. The area striata fills the concavity of the sulcus lunatus.

The sulcus paroccipitalis ends immediately in front of the sulcus lunatus in a somewhat complicated branching involving, but probably more than, the sulcus occipitalis transversus. In this hemisphere the gyrus occipito-parietalis superior is very well shown. The anterior limbs become widely divergent around the sulcus occipitalis transversus, whilst the stem is clearly defined between the sulcus lunatus and a deep sulcus on the dorso-medial border. This sulcus would be named topographically the sulcus paramedialis : but morphologically it is not a sulcus limitans areae parastriatae, but a sulcus limitans areae striatae. On the medial surface the sulci limitans praecunei and paracalcarinus are divergent, exposing a triangular arcus intercuneatus. The upper end of the sulcus paracalcarinus is superficially confluent with the presumed sulcus paramedialis tending to form an extensive operculum fossae parieto-occipitalis posterioris.

The difficulty of always defining the sulci paramedialis and polaris superior strictly in accordance with the criteria laid down for their homology is so clearly shown in this brain that beyond pointing it out no further discussion is necessary.

The sulcus occipitalis inferior lies under the outer part of the sulcus lunatus and is operculated.

S.3.R. (Plate 17)—The sulcus lunatus is a curved sulcus placed well out on the lateral surface. Superiorly it is superficially joined with the sulcus occipitalis transversus, resembling to some extent the condition of S.9.R. Sulci praelunatus et paramedialis are present. The general direction of the folding of the striate cortex is horizontal.

C.2.R. (Plate 32)—The lunate sulcus is a fully curved sulcus which extends well on to the lateral aspect of the hemisphere. The drawings give the appearance of the sulcus extending to the medial border and actually passing on to the medial surface. This extensive sulcus is, however, composed of three different parts. Although their points of separation are quite definite, some facts, such as the extent to which the sulcus occipitalis transversus is buried, are difficult to determine because the hemisphere is somewhat cracked from handling. Although it is necessary to state this, there is very little doubt concerning the arrangement. The sulcus lunatus at its lower end sweeps backwards towards the occipital pole and comes to lie under a typical sulcus calcarinus externus. At its upper and inner end it is confluent with what appears to be the outer limb of the sulcus occipitalis transversus, but it is possible that the whole of this sulcus may be buried, as the floor of the sulcus is somewhat injured and definition is not possible. Just medial to the point of contact with the sulcus occipitalis transversus the sulcus lunatus ends by turning slightly forwards.

The second part of the extensive sulcus is a small curved sulcus which turns upwards and forwards to overlap the superior polar sulcus—the third part of the sulcus. The overlap of the two is somewhat deep.

This hemisphere is placed in group 3. It is to be noted, however, that there is, as well as the horizontal folding of the striate cortex, a tendency to vertical folding.

C.2.L. (Plate 32)—The tip of the occipital pole has been damaged in this hemisphere, but the pattern is not very much affected thereby. The sulcus lunatus is a fully curved sulcus which has been displaced dorso-medially. Its lower extremity curves backwards and is situated at a little distance from the tentorial margin. Beneath it there is a well-marked sulcus occipitalis inferior. Medially the sulcus lunatus forms a full curve which passes well down the medial border of the hemisphere. The condition is clearly due to a confluence of the sulcus lunatus with the sulcus paramedialis and illustrates a type which I have described in the Chinese in which the medial part was described as a pars mesialis sulci lunati.

C.3.L. (Plate 33)—The sulcus lunatus is fully curved and extends well on to the lateral surface of the hemisphere. Within its concavity is a horizontally disposed sulcus calcarinus externus. At its medial end it is confluent with the sulcus occipitalis transversus and the sulcus paramedialis. Its characters are well shown in the figures and require no further description.

Group 4

The Translunate Group

The main characteristic of this group is the separation of the sulcus lunatus into a pars dorsalis sulci lunati and a pars ventralis sulci lunati by a superficial translunate gyrus (see Elliot Smith, 1904, *c*, p. 152).

This grouping is very important, forming a definite transition stage between those hemispheres which show a well-defined sulcus lunatus and those in which the forces of expansion of the parietal lobe have driven back the area striata towards the medial surface with consequent obscuring of the sulcal features on the lateral surface. The morphological features of the group have been fully confirmed on a large series of Chinese brains. The features of the grouping, once recognized, are very easy to pick out in working through a series of brains.

The condition can only be regarded as definitely established when the extent of the area striata is capable of determination, and fortunately, in the two brains of the

Sydney series where it occurs the area striata was determined. The line of Gennari extends to the posterior lip of both the pars dorsalis and the pars ventralis.

The fallacy of drawing conclusions from percentage occurrence in a small series is well shown here, for this grouping only occurs in two of the Sydney and Queensland series, and yet of the ten other hemispheres which I have examined it appears in four. There are thus six cases in the group, S.1.L., S.7.L., C.4.L., A.954.R., A.954.L., and R.C.S.703.5.L.

S.1.L. (Plate 15)—This is a very typical example of the translunate type. The pars dorsalis sulci lunati is a curved sulcus with its convexity directed towards the sulcus occipitalis transversus. It is continued anteriorly into the sulcus praelunatus, so that these two sulci form together a double curved sulcus passing forward into the parietal lobe. Such a condition, according to the older descriptions, would have been named a lateral occipital sulcus. The posterior part of the sulcus is a sulcus limitans areae striatae.

The pars ventralis is a sharply curved sulcus whose lower end is directed backwards towards the occipital pole ; it limits the stria of Gennari anteriorly. It is superficially confluent anteriorly with an occipito-temporal sulcus passing into the inferior temporal region.

The intrastriate sulci are horizontally arranged. The sulcus retrocalcarinus is superficially continued into the sulcus calcarinus externus which terminates within the area enclosed by the two parts of the sulcus lunatus. Anterior to it is an accessory sulcus.

The sulcus paroccipitalis ends posteriorly in a diminutive sulcus occipitalis transversus. The sulci paracalcarinus and paramedialis are confluent to form an operculum posterior fossae parieto-occipitalis very similar to that seen in S.4.L. The arrangement of the occipital gyri in this specimen is very instructive, and it is of interest to try to harmonize the description given here with the older purely topographical descriptions of Gratiolet and others.

Between the pars dorsalis and the sulcus paramedialis the Y-shaped gyrus occipito-parietalis superior is beautifully displayed as a wedge of cortex split by the sulcus paroccipitalis. The arms on either side of the sulcus occipitalis transversus agree with the first and second plis de passage of Gratiolet. The gyrus translunatus—a middle occipito-parietal gyrus—agrees in part with the third plis de passage ; whilst the fourth plis de passage would be placed between the pars ventralis and the sulcus occipitalis inferior if that sulcus were defined in this hemisphere.

Arising from the anterior curve of the pars dorsalis, but only superficially connected with it, is a sulcus within the gyrus occipito-parietalis which is very like that seen in S.5.L., and mistaken in that hemisphere by Flashman for the sulcus occipitalis transversus. It appears to be a compensatory folding of no special significance.

S.7.L. (Plate 21)—The arrangement of the sulci in this hemisphere is in essential details similar to S.1.L.

C.4.L. (Plate 34)—This brain has been considerably distorted and flattened so that it was not possible to draw the posterior and anterior aspects. The flattening, however, permits most of the features to be well seen from the lateral aspect. It is unfortunate that the left hemisphere has been broken in three pieces because of the very interesting collection of features which the brain shows. The occipital region is intact and it is easy of interpretation. The form of the lateral intrastriate sulci corresponds with the group 2 types ; this at once reveals the change which has taken place for the pars dorsalis and the pars ventralis are so formed that if the gyrus translunatus were hidden there would be a fully curved sulcus lunatus. The pars dorsalis is short and separate from any other sulci. It arches over the sulci calcarinus externus and calcarinus externus accessorius. The pars ventralis is more extensive and is prolonged forwards into the sulcus praelunatus.

A.954.R. (Plates 36, 37)—Here again the form of the intrastriate sulci provides evidence for the identification of the elements of the sulcus lunatus. The sulcus retrocalcarinus reaches the occipital pole and there divides into ascending and descending branches which are vertically disposed. These branches are capped by superior and inferior polar sulci, and in respect of this vertical folding the specimen belongs to group 5 to be described presently. The sulcus calcarinus externus is a somewhat small Y-shaped sulcus horizontally disposed and at its outer end points to the gyrus translunatus. Above and below the sulcus calcarinus externus the pars dorsalis and the pars ventralis are clearly shown. Each is continued forward into the parietal lobe by a sulcus. These forward continuations constitute a duplicated sulcus praelunatus. The sulcus occipitalis anterior forms a complete arcade anterior to the praelunate sulci.

A.954.L. (Plate 36)—As on the right side, the sulcus retrocalcarinus passes well backwards to the occipital pole and divides into ascending and descending branches. A very small sulcus polaris superior caps the ascending branch ; but a deeply operculated inferior polar sulcus surrounds the descending branch. The outer end of the inferior polar sulcus passes on to the lateral surface of the hemisphere. The sulcus calcarinus externus is represented by a simple sulcus lying immediately lateral to the descending limb of the sulcus retrocalcarinus. These sulci having been defined, the pars dorsalis and the pars ventralis sulci lunati are apparent. The pars dorsalis is a horizontally placed sulcus which is continued forwards into the sulcus praelunatus. It is superficially confluent with the sulcus occipitalis transversus. The pars ventralis is a simple straight sulcus lying immediately below the point of junction of the pars dorsalis with the sulcus praelunatus. The gyrus translunatus is narrow. Below the pars ventralis there is a sulcus occipitalis inferior which is continued into the occipito-temporal region. The sulcus occipitalis anterior forms a complete arcade lying around the anterior end of the sulcus praelunatus.

R.C.S.703.5.L. (Plate 35)—In this hemisphere the lateral intrastriate sulci are somewhat complicated. Consequently, in the absence of evidence of the extent of the area striata, the analysis of the specimen must be somewhat doubtful. At the posterior end of the sulcus paroccipitalis there is a curved sulcus reaching from a point close to the medial border of the hemisphere to a point well out on the lateral surface of the occipital region, but, on opening up this sulcus, this is not a simple union. The curved sulcus is operculated and covers the outer limb of the sulcus occipitalis transversus ; and so, from its general appearance and topographical relations, there can be little doubt that it is the pars dorsalis. The pars ventralis is superficially confluent posteriorly with a vertical intrastriate sulcus. From this point it curves downwards to end immediately anterior to the outer end of the pars dorsalis, where it is confluent with the sulcus praelunatus. The gyrus translunatus is narrow.

Group 5.

The Vertical Group

In this group the area striata is disposed in a characteristic manner ; it is vertically folded and may often extend as far forward as the posterior border of the fossa parieto-occipitalis. The displacement of the area striata results in a striking alteration in the disposition of the sulci, within the area and limiting it, so that exact comparison with other types is rendered difficult. There is a vertical disposition of the intrastriate sulci, and a tendency to the development of superior and inferior polar sulci limiting the striate cortex.

As a rule, the sulcus lunatus tends to be absent or fragmentary, although some of the most striking examples of vertical folding in this series occur in conjunction with horizontal folding and a well-marked sulcus lunatus (*see* S.10.R., S.12.R., and Q.1487.R.). These cases are grouped in accordance with the form of the sulcus lunatus.

In most of the cases included in the group there is a medial opercular, or superior, polar sulcus on the dorso-medial border of the hemisphere which limits the line of Gennari. There is as a rule no defined sulcus calcarinus externus, its place being taken by a lateral intrastriate sulcus vertically disposed whose upper end occupies the concavity of the medial opercular sulcus. To avoid confusion with the sulcus calcarinus externus this sulcus is named the sulcus retrocalcarinus verticalis. Elliot Smith first used this term in describing the displacement of the striate area in the brain of the Egyptian (Elliot Smith, 1904 *c*, " Studies in Morphology ", p. 137).

Nine hemispheres are placed in group 5 : S.5.R., S.6.R., S.6.L., S.4.R., S.2.L., S.13.R., S.8.R., S.11.L., and R.C.S.703.5.R. Besides these specimens there are seven showing vertical folding which have been included in other groups in accordance with the features of the sulcus lunatus. These specimens may be regarded as transition stages in the evolution of the occipital region. They are Q.1487.R. (group 1), C.3.R., S.10.R., S.12.R. (group 2), C.3.L. (group 3), and A.954.R. and A.954.L. (group 4).

This tendency to vertical folding in the aboriginal Australian, as determined by the form of the intrastriate sulci, constitutes a very interesting feature because it is much more marked than in the brain of the Chinese. In the Australian the medial occipital region is much less developed than in the Chinese brain. There is a much smaller cuneus and the arcus intercuneatus is much more frequently exposed. In the examination of some hundreds of Chinese hemispheres, although there are cases of vertical folding, I have not met with any specimens showing collections of primitive features such as the Australian brain does. These facts make one hopeful that a definite basis for racial classification may be obtained from the whole features of the brain, but it is certain that such a basis cannot be obtained with reference to individual features.

S.5.R. (Plate 19)—FLASHMAN's description of this hemisphere is very accurate and complete so far as the actual disposition of the sulci is concerned. His account of the occipital region is reproduced in full so that the difference in interpretation may be fully discussed.

> " *Right Occipital Region*—As has been said, the condition of the two occipital lobes differs considerably. If we look at the photograph of the mesial surface of the right occipital lobe we will see that the posterior end of the retrocalcarine fissure ends in a rectangular bifurcation. In the photograph of the mesial surface of the left hemisphere one can see an indication of a similar condition ; the bifurcation is not rectangular, but it is present, and its upper limb is the longer of the two. Lying behind and below this bifurcation there is an area of cortex, which is homologous with the area of cortex lying behind the rectangular bifurcation of the retrocalcarine fissure of the right hemisphere. Limiting this cortex behind, on both hemispheres, we have a portion of the Y-shaped superior occipital fissure. Owing to various causes, this fissure has a slightly different relation to the surface of the brain in the two hemispheres. On the left side it passes well round on to the lateral surface, where it bifurcates ; whereas on the right hemisphere it is confined almost entirely to the mesial surface. *Having located the superior occipital fissure on both sides, it follows that we can homologise the areas of the cortex in front of them. On the left side this area of cortex forms a beautifully distinct operculum over the sulcus lunatus. On the right side there is no obvious operculum, but we must regard the small area of cortex limiting the end of the superior occipital fissure just where it passes to the lateral surface, as representing the upper part of that structure, and the sulcus immediately in front of it as part of the sulcus lunatus* ". (Italics mine.)

On the medial surface of the hemisphere the sulcus retrocalcarinus ends before reaching the occipital pole in a rectangular bifurcation. Immediately posterior to this terminal bifurcation is a deep vertical sulcus extending upwards from the inferior margin of the hemisphere to emerge on the dorsal surface just posterior to the operculated medial sulcus. The examination of the medial surface makes it clear that the striate cortex has been displaced downwards and is limited by a large inferior polar sulcus—a sub-occipital operculum—which passes from the medial to the tentorial surface ; similarly, the striate cortex has been displaced upwards and is surmounted by the superior polar sulcus—a medial occipital operculum. The great extent of the striate cortex which finds accommodation within the area between the two polar sulci and in the depths of the terminal bifurcation of the sulcus retrocalcarinus and of the sulcus retrocalcarinus verticalis sufficiently accounts for the fact that the area striata does not occupy that area of the lateral surface usually occupied by the lunate operculum.

On the lateral surface the situation of the sulcus lunatus is occupied by a branched sulcus, which really consists of two separate sulci, for the upper and posterior branch is separated from a horizontally placed sulcus by a submerged gyrus. These sulci probably represent all that remains of the sulcus lunatus.

FLASHMAN's interpretation of the pattern of the sulci, which he so accurately described, depended entirely on identification of the sulcus retrocalcarinus verticalis as the sulcus occipitalis superior (external calcarine). It is true that from a morphological point of view the sulcus retrocalcarinus verticalis in this hemisphere is a lateral intrastriate sulcus in the same way as the external calcarine sulcus is a lateral intrastriate sulcus where it is horizontally situated. The typical sulcus calcarinus externus is a Y-shaped sulcus ; in the brains of the Chimpanzee and Orang (*see* MINGAZZINI, 1928) one frequently sees the limbs of the Y well developed and divergent, and in these cases the occipital operculum is well developed at the dorso-medial border of the hemisphere and is there related to the upper end of the upper arm of the Y. The sulcus lunatus proper is related to the stem of the Y. It seems to the writer that, so far as homology can be made, if the sulcus retrocalcarinus verticalis is homologous with the sulcus calcarinus externus it is with the arms of the Y and not with the stem. Thus the opercular sulcus on the dorso-medial border of the hemisphere, being related with the upper end of the upper arm of the Y, cannot be homologous with the sulcus lunatus. In S.5.R. there is a small posterior branch of the sulcus retrocalcarinus verticalis which is possibly homologous with the stem of the Y-shaped sulcus calcarinus externus.

In disagreeing with the opinion expressed by HULSHOFF POL that " the sulcus lunatus, described by ELLIOT SMITH, for the rest possesses no properties which characterize it as an ape fissure ", I (1926) did not fully appreciate the significance of his statement " that each sulcus on the occipital pole can be taken for a sulcus lunatus " ; and yet this interpretation is justified if the same name is given to a sulcus on the dorso-medial border as is given to a sulcus placed on the lateral aspect of the hemisphere and having definite relations with the sulcus praelunatus and the sulcus occipitalis anterior.

In S.5.R. one sees a small sulcus concentric with the dorso-medial operculum ; it is this sulcus which limits the stria of Gennari and not the larger opercular sulcus. FLASHMAN labelled the smaller sulcus the sulcus lunatus and also a smaller sulcus more laterally placed. He identified the medial opercular sulcus as the sulcus paroccipitalis. As on the left side, the sulci bounding the arcus parieto-occipitalis are impossible to define clearly. The operculum may include part of the sulcus occipitalis transversus, but it seems preferable in describing this specimen to comment on the open condition of the sulci of the parieto-occipital region and to leave their exact identity uncertain.

S.6.R. (Plate 20)—In order to describe adequately the features of group 5 it is necessary to make frequent reference to the condition of the medial surface although this is more fully discussed later. The medial surface of S.6.R. illustrates very clearly the effect of the vertical folding of the area striata. The area has been pushed back from the lateral surface and hardly extends for more than one centimetre from the middle line. The sulcus retrocalcarinus is relatively short and ends in a very obliquely placed terminal bifurcation. The upper arm is placed well forward in the cuneus and extends upwards and forwards to within a short distance of the upper end of the fissura parieto-occipitalis. It is immediately succeeded by a very deep sulcus retrocalcarinus verticalis. This sulcus is likewise obliquely situated and lies parallel with the terminal bifurcation of the sulcus retrocalcarinus. Both the sulcus retrocalcarinus and the sulcus retrocalcarinus verticalis are entirely intrastriate. Surrounding the upper end of these two sulci there is a curved operculated sulcus lying across the dorso-medial border of the hemisphere. The medial part of the operculated sulcus lies very close to the fissura parieto-occipitalis ; but I do not regard it as being in any way a sulcus paracalcarinus because the opercular sulcus limits the area striata throughout its whole length, so that almost the entire area of the cuneus in this specimen is intrastriate.

FLASHMAN examined this specimen with considerable care. He interpreted the sulcus retrocalcarinus verticalis as a Y-shaped sulcus occipitalis superior (calcarinus externus) with its stem detached and extending to the lateral surface. Having done so, he proceeded to name the medial operculum as the inner portion of the sulcus lunatus. He goes on to say :—

> " That this is really the upper portion of the sulcus lunatus is evidenced by the fact that the cortex immediately behind it is operculated, and shows a definite streak of Vicq' d'Azyr running nearly up to the edge of the fissure. The lower portion of it which normally lies in front of the sulcus occipitalis superior is apparently obliterated ".

It is to be noted that FLASHMAN says obliterated and does not suggest displacement dorso-medially. This would suggest that FLASHMAN regarded the sulcus lunatus as a structure which might in some circumstances extend from the medial surface to the lateral border of the hemisphere. If the sulcus lunatus represents the occipital operculum in the Cercopithecidae this interpretation is justified. It is preferable, however, in the light of these specimens, to confine the term sulcus lunatus to the outer part of the sulcus limiting the occipital operculum. The medial operculum practically corresponds with the sulcus polaris superior of BOLTON, and it is found commonly in the vertically folded group. As in S.10.R., S.12.R., and 1487R., a sulcus lunatus might also be present.

The postero-lateral region of the hemisphere is seen in Plate 20. The stria of Gennari only just passes the dorso-medial border. The paroccipital sulcus ends in a conglomeration of sulci from which it is difficult to sort out the sulcus occipitalis transversus. Below this conglomeration of sulci there are horizontal tiers of lateral occipital gyri separated by horizontal occipital sulci. Which of these sulci, and how much of them, represent the sulcus lunatus or the sulcus occipitalis inferior is difficult to say. FLASHMAN regarded the sulcus lunatus as being present. One can therefore see how impossible it is to make use of the expression " presence of the sulcus lunatus " as a means of racial classification.

S.6.L. (Plate 20)—This is a very interesting hemisphere. At first sight the breaking down of the occipital operculum is suggestive of the condition seen in higher types. On closer examination, a series of primitive features impress themselves—the exposed gyrus cunei, the presence of a sulcus paracalcarinus entirely separated from the sulcus limitans praecunei, having the form of a reversed L as is frequently seen in the brain of the Apes, and, finally, a medial operculation on the dorso-medial border.

The sulcus retrocalcarinus verticalis is a long sulcus running along the dorso-medial border of the hemisphere. It occupies the topographical position of the sulcus paramedialis, but it is an intrastriate sulcus morphologically. Surmounting the upper end of the sulcus retrocalcarinus verticalis is the superior polar sulcus. This is deep and operculated and is superficially confluent with the inner limb of the sulcus occipitalis transversus. The superior polar sulcus forms the anterior limit of the area striata. Inferiorly the lower ends of the sulci retrocalcarinus and retrocalcarinus verticalis are surrounded by a wide and operculated inferior polar sulcus.

The arrangement of sulci on the lateral surface is very similar to that on the right side. There are horizontal tiers of gyri separated by horizontal sulci. The most inferior of the horizontal sulci is the sulcus occipitalis inferior lying along the lower border of the hemisphere ; the remainder are difficult to identify.

The arrangement of the sulci on both sides of S.6 conforms very clearly to the type characteristic of group 5. I cannot agree, therefore, with FLASHMAN's description where he says :—

> " As is the case with several other aboriginal brains which I have examined, the operculum and sulcus lunatus are more marked on the left side than on the right side ".

S.4.R. (Plate 18)—The vertical folding of the striate cortex is clearly indicated by the form of the sulci on the medial surface. The terminal bifurcation of the sulcus retrocalcarinus lies obliquely across the cuneus ; it is followed by an obliquely situated and deep sulcus retrocalcarinus verticalis. Superficially the upper ends of the two sulci are directed towards the upper angle of the parieto-occipital fossa and are surmounted by a curved operculated sulcus of the same form as is seen in the other brains. It is placed so far forward as to form medially almost an operculum posterior fossae parieto-occipitalis. This medial operculum on the inner side has a very strong resemblance to the sulcus paracalcarinus whilst laterally it is a topographical sulcus paramedialis. It is unfortunate that the exact homology could not be determined from the extent of the stria of Gennari, which could not be seen on account of the state of preservation. It seems reasonable to assume, however, that both the sulcus retrocalcarinus and the sulcus retrocalcarinus verticalis are intrastriate and that therefore the medial operculum limits the area striata.

On the lateral surface the sulci are broken up and confused. The sulcus paroccipitalis ends in a conglomeration of sulci, from which it is difficult to define the sulcus occipitalis transversus and to say which part may represent the pars dorsalis sulci lunati. Lateral to this group of sulci at the posterior end of the sulcus paroccipitalis there is a highly branched and complex sulcus whose main direction is from before backwards. Topographically the anterior part corresponds with the sulcus praelunatus and the remainder probably represents the pars ventralis sulci lunati.

S.2.L. (Plate 16)—The sulcus retrocalcarinus ends on the medial surface in a short bifurcation ; posterior to it and placed vertically on the dorso-medial border is a well-marked sulcus retrocalcarinus verticalis. Surmounting the upper ends of the two retrocalcarine sulci is a prominent superior polar sulcus. The arrangement of the operculated superior polar sulcus is interesting. It is placed more posteriorly on the hemisphere than in many of the other specimens ; but on the medial surface, the arcus intercuneatus is exposed and bounded posteriorly by a sulcus paracalcarinus which is confluent with the superior polar sulcus. An inferior polar sulcus is also present confluent anteriorly with the sulcus occipitalis inferior.

On the lateral surface the sulcus paroccipitalis appears to end in the sulcus occipitalis transversus, but whether there is also included a part of the remains of the sulcus lunatus must be considered. Below the superior polar sulcus and the posterior end of the paroccipital group there is a horizontally placed sulcus branched anteriorly. This probably represents the sulcus praelunatus and the sulcus lunatus in part. Unfortunately, in the specimen the extent of the stria of Gennari could not be determined.

S.13.R. (Plate 27)—This hemisphere is of great interest in throwing light on the question whether or no in this series the " Affenspalte " is represented by the medial operculation only whilst the lateral part of the " Affenspalte "—the sulcus lunatus—is broken.

Immediately posterior to the fissura parieto-occipitalis, and separated from it by a narrow tongue of cortex, is a deep and extensive medial operculated sulcus. On the medial surface it indents the fissura parieto-occipitalis but does not enter into its constitution. Laterally it extends from some distance to terminate immediately above a deep horizontal sulcus passing forwards to become superficially confluent with the sulcus occipitalis anterior. The operculum is deep and on its anterior wall the sulcus occipitalis transversus is almost buried. Such an operculum, with these relations with the sulcus occipitalis transversus, must be so closely related to the medial part of the "Affenspalte" as to warrant it as being, if not completely homologous, at least representative of that part of the occipital operculum. It is placed too far dorsally to be homologous with the laterally placed sulcus lunatus of the other types of hemisphere. Associated with the dorso-medial operculated superior polar sulcus is a very extensive and deep sulcus retrocalcarinus verticalis which passes right across the medial surface of the hemisphere just anterior to the dorso-medial border.

On the lateral surface of the hemisphere is the horizontal sulcus passing forward to become superficially confluent with the sulcus occipitalis anterior, and through this running as a continuous sulcus to the temporal pole. Above and below the horizontal lateral occipital sulcus are fragmentary sulci. It is to be noted that in practically every member of this group there is an indication of this horizontal folding of the region normally occupied by the sulcus lunatus, and it occurs along the line usually occupied by the sulcus praelunatus.

I have refrained from naming it the sulcus occipitalis lateralis—as I should like to have done—because of the amount of confusion which has arisen in the literature from the use of this name.

S.8.R. (Plate 22)—This hemisphere is so essentially similar to those already described that it will be sufficient to refer to the figures and mention its salient features.

The salient features are the sulcus retrocalcarinus verticalis, the presence of superior and inferior polar sulci, the well-marked horizontal sulcus on the lateral surface of the hemisphere confluent with the sulcus occipitalis anterior and, finally, the termination of the sulcus paroccipitalis in a conglomeration of sulci from which it is difficult to separate the sulcus occipitalis transversus. The terminal T-piece of this group of sulci is separated from the remainder by a deep gyrus and probably represents the pars dorsalis sulci lunati.

S.11.L. (Plate 25)—The left hemisphere of this brain is very much flattened and distorted; but the features are quite clear. The general characters of the group—the form of the sulcus retrocalcarinus, the sulcus retrocalcarinus verticalis and the presence of superior and inferior polar sulci—are sufficiently shown in the figures.

R.C.S.703.5.R. (Plate 35)—The occipital region of this interesting hemisphere was described by ELLIOT SMITH in his paper "Le cerveau d'un Tasmanien," 1911. His description so clearly forms the foundation for the establishment of these group 5 cases that it is here quoted in full :—

> "La partie mésiale de l'area striata se dilate largement dans la direction dorso-ventrale et les sulci extremi de Schwalbe ou de Seitz très développés et verticaux qui semblent la continuer, s'étendent en haut et en bas comme les prolongements des deux fragments du sulcus calcarinus. Au dessus et en dessous de cette région largement exposée de l'area striata sont des sulci polares anormalement dévéloppés. J'ai essayé de représenter diagramaticallement

dans la fig. 2 de mon mémoire (' New Studies of the Folding of the Visual Cortex') l'association entre l'exageration des extrémités bifides du sulcus calcarinus posterior ou du sulcus calcarinus externus formant les sillons verticaux de Seitz d'une part et la formation des sulci polares d'autre part ".

Group 6

This group comprises those cases in which the sulcus lunatus cannot be identified as such, although fragmentary sulci on the lateral surface mav be suggested as representing it. On the lateral surface of the hemisphere there are often horizontal sulci corresponding with the sulcus occipitalis lateralis of Eberstaller, or the sulcus occipitalis inferior of Giacômini (not the sulcus occipitalis inferior of this paper). *The area striata is mainly confined to the medial surface of the hemisphere.* The grouping is somewhat heterogeneous. Some of the specimens bear resemblance to groups 4 and 5 and are probably transition forms.

Seven hemispheres are placed in the group :—S.13.L., S.8.L., S.7.R., S.12.L., S.3.L., S.11.R., and C.4.R.

S.13.L. (Plate 27)—Running horizontally across the lateral aspect of the occipital lobe so as almost to bisect it is a Y-shaped deep sulcus. The two arms of the Y are directed backwards towards the occipital pole ; the stem passes forwards almost as far as the sulcus occipitalis anterior and probably is homologous in part with the sulcus praelunatus. For the sake of convenience this will be named the sulcus occipitalis lateralis, with application only to this type of hemisphere. Posterior to the sulcus occipitalis lateralis there is a triradiate sulcus on the occipital pole which topographically is homologous with the sulcus calcarinus externus. Unfortunately, as the extent of the area striata could not be determined, homology must remain uncertain. A curved operculated sulcus occipitalis inferior runs along the tentorial margin of the hemisphere enclosing within its concavity the lower ends of the sulci occipitalis lateralis and calcarinus externus. The sulcus occipitalis transversus is well defined and lying medial to it, and superficially confluent with it, in a topographical sulcus paramedialis.

Elliot Smith (1903, fig. 6) depicts a similar type of hemisphere in the brain of the Egyptian.

S.8.L. (Plate 22)—This brain is so hard that the sulci cannot be opened up to determine their depth and other internal features. On the lateral surface of the hemisphere the lateral occipital sulcus extends from the occipital pole to a point just posterior to the sulcus occipitalis anterior. At its midpoint a curved branch is given off inferiorly. On the medial border a clearly defined sulcus paramedialis is seen. Between the lateral occipital sulcus and the sulcus paramedialis is the wide superior occipito-parietal gyrus which contains the posterior end of the sulcus paroccipitalis and a clearly defined sulcus occipitalis transversus. The picture of the medial surface shows the sulcus retrocalcarinus as a curved sulcus directed posteriorly, towards, and slightly below the occipital pole to emerge on the lateral surface just below the posterior end of the lateral occipital sulcus. Although the extent of the area striata could not be determined, the interpretation from its assumed position confirms the sulcus paramedialis as a sulcus limitans areae parastriatae, and thence it seems a justifiable assumption that the anterior end of the sulcus occipitalis lateralis, in front of the point of junction, is the sulcus praelunatus, and that the two posterior branches form a diminutive curve representing the sulcus lunatus.

S.7.R. (Plate 21)—This brain is badly distorted and its description is given with reserve. It was difficult to know in which class to put it as it bears resemblance to both groups 4 and 5. On the dorso-medial border of the hemisphere there is a sulcus which may be regarded either as a superior polar or as a sulcus paramedialis. The area striata, although the line of Gennari was not seen, is horizontally placed on the medial surface with a tendency to vertical displacement at the dorso-medial border. On the lateral surface the sulcus paroccipitalis ends in a complex folding, but as the lower part is only superficially confluent with it the sulcus occipitalis transversus is easily defined. Below this on the lateral surface are two triradiate sulci which may be interpreted as pars dorsalis and pars ventralis sulci lunati, but on account of the condition of the specimen it may be preferable to regard the sulcus lunatus as being absent.

S.12.L. (Plate 26)—This hemisphere is of particular interest in that it presents a primitive type of intrastriate sulci with a considerable extension of the area striata on to the lateral surface and yet there is no definable sulcus lunatus. The sulcus retrocalcarinus ends on the medial surface in a terminal bifurcation ; it is followed by a short horizontal sulcus and then by a well-marked T-shaped calcarinus externus. The arms of the T indicate a certain degree of vertical displacement of the area striata and the hemisphere has some right to inclusion in group 5, for the upper arm of the T is surmounted by a sulcus polaris superior. The stem of the T passes well on to the lateral surface and is entirely intrastriate. On the lateral surface there is no sulcus lunatus ; there is, on the other hand, a definite sulcus occipitalis lateralis which limits the stria of Gennari in its posterior part as shown in the figure. It is therefore reasonable to suggest that the sulcus occipitalis lateralis is a combined pars dorsalis sulci lunati and sulcus praelunatus. Below, and partly surrounding the outer end of the sulcus calcarinus externus, is a small curved sulcus which probably represents the pars ventralis sulci lunati. The sulcus occipitalis inferior is a curved sulcus passing from the occipital pole towards the tentorial surface to and under the pars ventralis.

S.3.L. and S.11.R. (Plates 17 and 25)—Both of these hemispheres have been damaged to some extent, but it was possible to make out the sulci sufficiently clearly to show that the sulcus lunatus was not present. Plates 17 and 25, showing the posterior view of these hemispheres, illustrate the appearance of the sulcal pattern sufficiently clearly to explain the arrangement in the light of the description of the other hemispheres in this series.

C.4.R. (Plate 34)—This hemisphere is very difficult to interpret. At first sight the sulcus lunatus appears to be a large angulated sulcus extending well on to the lateral surface and having associated with it a short and clearly defined sulcus praelunatus. This cannot be so, however, because the greater part of this sulcus lies anterior to the sulcus occipitalis transversus. The curved sulcus apparently consists of three parts confluent with one another. The upper part, from its relations with the sulcus paroccipitalis, is the upper element of the sulcus occipitalis anterior ; the short anterior branch is caused by the breaking off of the sulcus occipitalis anterior from the parallel sulcus and is the sulcus which I have named the sulcus annectans ; the lower part of the sulcus is composed of the lower part of the sulcus occipitalis anterior confluent with the sulcus occipitalis inferior. Behind the sulcus occipitalis transversus there is a small sulcus lying vertically on the hemisphere. This is interpreted as the sulcus lunatus and, from the arrangement of the intrastriate sulci on the medial surface, it must limit the stria of Gennari. The specimen is somewhat injured at the occipital pole and I am of the opinion that this sulcus was a more prominent feature when the brain was fresh. Although, therefore, this specimen may belong to group 3—a sulcus lunatus present with horizontal folding of the striate cortex—it is preferable to place it in group 6 and so avoid possible errors.

General Discussion

In Table I the occurrence and percentage of the different groups in the aboriginal Australian are compared with those of the Southern Chinese from Hong Kong and the Northern Chinese from the Pekin Union Medical College. I have included with the Australian series the two hemispheres which Karplus (1902) described, and those hemispheres whose grouping can be determined from the figures of Woollard's paper (1929).

The first point to which I wish to draw attention is the difference between the Sydney series and the remainder of the Australian Hemispheres. The Sydney series was examined before I had access to the remainder. It will be observed that, whereas every Queensland brain has a well-marked sulcus lunatus of some form or other, this sulcus does not form an unusually prominent feature in the Sydney series. In fact, the number of clearly defined sulci lunati is not greater than, if as great as, one would expect to find in the brains of the Southern Chinese. Before having seen the Queensland material I told Professor Elliot Smith of the results of my examination of the Sydney material. This is recorded in the Mott Memorial Volume. The Queensland material necessitates a modification of the views expressed at that time.

In grouping the hemispheres a false impression is given from a mere examination of the figures. The Southern Chinese show 57% of hemispheres in the first three groups where the Australian show 56·3%, making it appear at first sight that there

TABLE I—CLASSIFICATION OF THE LATERAL OCCIPITAL REGION

Fifty Australian Hemispheres

Group	1		2		3		4		5		6	
	R.	L.	R.	L.	R.	L.	R.	L.	R.	L.	R.	L.
Sydney (26)	0	0	3	2	3	1	1	2*	5	3	2	4
Queensland (8)	2	0	0	2	2	2	0	0	0	0	0	0
Cambridge (6)	0	0	1	0	1	2	0	1	0	0	1	0
Amsterdam (2)	0	0	0	0	0	0	1	1	0	0	0	0
R.C.S. London (2)	0	0	0	0	0	0	0	1	1	0	0	0
Karplus (2)	0	0	0	0	1	1	0	0	0	0	0	0
Adelaide (4)†	0	0	0	0	1	3	0	0	0	0	0	0
Totals	2	0	4	4	8	9	2	5	6	3	3	4
%	4	0	8	8	16	18	4	10	12	6	6	8

Southern Chinese from Hong Kong

One hundred Hemispheres

	1 R.	1 L.	2 R.	2 L.	3 R.	3 L.	4 R.	4 L.	5 R.	5 L.	6 R.	6 L.
	0	0	8	11	*a*3 *b*9 *c*5 17	*a*13 *b*3 *c*5 21	10	12	8	3	7	3

Northern Chinese from Pekin Union Medical College

Eighty-seven Hemispheres

	1 R.	1 L.	2 R.	2 L.	3 R.	3 L.	4 R.	4 L.	5 R.	5 L.	6 R.	6 L.
	0	0	1	3	*a*4 *b*6 *c*7	*a*5 *b*1 *c*4	6	8	9	7	11	13
%	0	0	1·2	3·5	20	12	7	9·4	10·6	8·2	13	15·2

* One of these hemispheres is that of Henry Bob of the Sydney Collection on which a cranio-cerebral survey was carried out. It is being published in another communication.

† Taken from the figures of WOOLLARD's paper (1929).

was little difference. On closer examination and analysis of the specimens, however, the difference in the size of the operculation of the sulcus lunatus becomes very striking. In the Australian there are two hemispheres in group 1, and, if we consider the cases in group 3, we find that there are many which are so extensive that it is debatable whether they should not be included in group 1. These debatable cases are S.5.L., S.9.R., Q.2640.R., Q.2640.L., C.2.R., C.2.L., and the two hemispheres depicted by KARPLUS. On the other hand, in only one hemisphere, S.4.L., is the sulcus lunatus in any way diminutive and therefore out of its class. If it may be so expressed there is a definite tendency towards group 1 and the majority of the cases are transitional. In the Southern Chinese, group 3 is subdivided into sub-groups *a*, *b*, and *c*, and of the thirty-eight hemispheres in group 3 there are only sixteen which compare with the group 3 Australian hemispheres, excluding S.4.L.

The difference between the Northern Chinese and the Australian is more marked than that between the Southern Chinese and the Australian. I had the opportunity of examining fifty Dutch brains at the Institute for Brain Research at Amsterdam. This examination was cursory, but it was clear that the Dutch brains differed markedly from those of the Australian.

It is not, however, in the presence or absence of any particular feature that the problem of racial cerebral anatomy will find its solution, it is in the consideration of the whole brain. And as a commencement to this task, how do the form and development of neighbouring sulci and gyri compare in the Australian and in the Southern Chinese? In the Australian brain there are 12 hemispheres showing the primitive Y-shaped form of the sulcus calcarinus externus (30%). In the Southern Chinese hemispheres this form is found in 11%, and in many of these it is not so well marked as in the Australian; in the Northern Chinese it is found in 4·7% of cases. The superior polar sulcus is found in 56% of the Australian brains and in only 30% of the Southern Chinese brains, and again is more prominent in the Australian than in the Chinese.

These percentage figures are merely given by way of examples of differences; but it must here be emphasized that percentage figures are not morphological features, they are not the solution of the problem. They are of use perhaps in pointing the way to the solution but can never be the final answer.

Our analysis has up to the moment been concentrated on the sulci around the occipital pole. When the medial surface is considered in the next section it will become patent that the problem becomes one of comparison between the amounts of expansion of whole areas of the brain. In the Chinese brain a well-developed sulcus lunatus is often found, better, practically always found, with well-expanded parietal, precuneal, frontal, and temporal regions. In the Australian the primitive pattern of the sulcus lunatus is accompanied by ill-developed parietal and precuneal regions. The problem must be deferred until the examination of these interesting brains is concluded.

The Asymmetry of the Occipital Region

In many of his writings Elliot Smith has called attention to the fact that the sulcus lunatus is a more prominent feature on the left hemisphere than on the right. The analysis of the figures for the aboriginal Australian shows that it does not hold for them. The largest forms have both been found on the right hemisphere and in the remainder there are approximately the same numbers for the right and left sides.

In the Chinese the figures show that there are slightly more lunate sulci on the left side ; but on closer analysis it is seen that, when the question of type is considered, the larger variety of lunate sulcus is found more commonly on the left side. The question of asymmetry will be considered more fully in dealing with the parietal region of the brain.

The Medial Surface of the Occipital Region

In the description of this region an attempt is again made to classify different types. The morphological interpretation on which the classification of the medial occipital region is founded is drawn almost exclusively from the work of Elliot Smith. The essential features of his interpretation of the parieto-occipital region are given in his own words as follows :—

> " in the vast majority of human brains the parieto-occipital fossa consists of a deep vertical cleft in which a large convolution, the arcus intercuneatus, is submerged, together with the incisura parieto-occipitalis and sulci limitans praecunei and paracalcarinus. But it often happens in the human brain and much more frequently in the brains of most genera of Apes that the arcus intercuneatus is exposed on the surface and the three furrows—incisura parieto-occipitalis, sulcus limitans praecunei and sulcus paracalcarinus—are widely separated the one from the other ; in such cases there is no fissure corresponding to that usually called ' parieto-occipitalis ' because none of the three independent furrows can be strictly so-called ", 1904, *c*, p. 145.

The pattern of the sulci in many of the aboriginal brains is so diagrammatic that not only is this morphological interpretation fully confirmed but also light is thrown to some extent on the changes which must have taken place in the development of the folded types. But, despite this diagrammatic representation, in many of these brains the exact homology between sulci having apparently the same characters cannot always be established.

Both Flashman (1908) and Duckworth (1908) recognized the importance of the parieto-occipital region in the brain of the Australian aboriginal. Duckworth recorded the presence of an open arcus intercuneatus in many of the cerebra in the Cambridge collection. Referring in particular to No. 4, he says :—

> " The occurrence of such marked simian affinity in one brain out of this small collection is indicative of the lowly status of the Australian aboriginal in respect of cerebral conformation ".

Woollard (1929), in a recent paper describing eight hemispheres from Adelaide, recorded the presence of an open arcus intercuneatus in all of them followed by a sulcus paracalcarinus. It is unfortunate that so few of these hemispheres were depicted by him and that they were destroyed in ascertaining the relative weight of the grey and white matter. In his summing up he states that " The fissural pattern of the aboriginal brain shows two features which distinguish it from European brains in general, (*a*) the retention of a paracalcarine fissure and a sulcus lunatus ; . . .". RETZIUS (1896) depicts many examples of a sulcus lunatus in the European ; and taking these pictures in which the fissura parieto-occipitalis is not fully closed, the sulcus paracalcarinus appears to be quite commonly present. In those in which it is closed I have no doubt that the sulcus paracalcarinus would be found under the operculum posterior fossae parieto-occipitalis.

It seems to the writer that, using cerebral anatomy as a basis for racial difference the problem cannot be advanced by the arbitrary selection of the presence or absence of any particular sulcus as a percentage feature. In this paper an attempt is made to deal with the whole grouping of the sulci rather than with them individually.

GROUP 1

Type figures for comparison are found in the following works :—

(*a*) ANTHONY (1917, fig. 50, p. 301).
(*b*) ELLIOT SMITH (1902, fig. 247).
(*c*) MINGAZZINI (1928, figs. 38 and 67).

In this group the sulcus paracalcarinus lying in the anterior part of the cuneus is entirely separated from the sulcus limitans praecunei. The posterior part of the arcus intercuneatus (sometimes spoken of as the anterior cuneal gyrus) communicates with the cuneus both above and below the sulcus paracalcarinus. The sulcus limitans praecunei fails to reach the dorsal border of the hemisphere, its upper end is turned somewhat forwards into the praecuneus and the angle formed by the sulcus limitans praecunei with the corpus callosum more nearly approaches a right angle than in more fully developed types.

This type is seen in two hemispheres, S.13.L. and S.10.L.

S.13.L. (Plate 27)—The morphological interpretation of this specimen depends upon the indentification of the sulcus paracalcarinus (21*p*). The hypothetical interpretation of the cortical area is dependent upon the identification of the right-angled L-shaped sulcus in the anterior part of the cuneus as the sulcus paracalcarinus. The sulcus calcarinus anterior is continuous with the sulcus retrocalcarinus (20) and together they form a horizontal folding within the striate area. The sulcus retrocalcarinus ends posteriorly in a bifurcation whose arms approximate to one another and lie within an area enclosed by the arms of a T-shaped sulcus calcarinus externus.

Above the sulcus retrocalcarinus an L-shaped sulcus paracalcarinus (21*p*) separates the arcus intercuneatus from the cuneus. It is probable that the horizontal part of the sulcus represents in part a sulcus limitans areae striatae superioris.

The sulcus limitans praecunei (21*l*) presents a very striking condition. It is short and fails to meet the dorsal border of the hemisphere. Its lower half is deeper than the upper half and tends to be operculated. Its upper end is directed somewhat forwards into the praecuneus. It has none of the appearance of a fissure parieto-occipitalis, which, when fully developed, is directed backwards as it cuts the dorsal border. If one opens up the more fully developed type of fissure the upper end of the sulcus limitans praecunei can almost invariably be located under the operculum anterior fossae parieto-occipitalis where it occupies the same relative position as does the upper end of the same sulcus in S.13.L. The whole condition of S.13.L. points to the failure of development of the medial surface of the superior parietal lobule with the consequent ill-development of the operculum anterior fossae parieto-occipitalis. At its lower end the sulcus limitans praecunei is definitely separated from the sulcus calcarinus by a slightly submerged gyrus cunei. The separate nature of the sulcus limitans praecunei, the clearly defined incisura parieto-occipitalis (21*i*) crossing the dorsal border and indenting the upper part of the arcus intercuneatus, and the striking similarity of the whole of the features in this specimen with those shown by the type specimens in the papers referred to seem to establish beyond question the identity of the sulcus paracalcarinus.

A sulcus limitans inferior areae striatae is confluent posteriorly with an inferior polar sulcus, the outer end of which is superficially confluent with an inferior occipital sulcus lying on the tentorial border of the hemisphere.

The very primitive pattern of the sulci on the medial surface of this hemisphere is emphasized by comparing it with the medial surface of the Gorilla's brain depicted as figure 247 in the Catalogue of the Museum of the Royal College of Surgeons. The pattern of the sulci is reproduced with a remarkable degree of correspondence ; the only important difference being that, in the brain of the Gorilla depicted, the lower end of the sulcus paracalcarinus comes into contact with the sulcus limitans praecunei.

S.10.L. (Plate 24)—The general features of the medial surface of this brain are very similar to those seen in S.13.L. The sulcus limitans praecunei (21*l*) is short and fails to meet the dorsal border of the hemisphere. Inferiorly it is separated from the sulcus calcarinus by a superficial gyrus cunei ; superiorly the sulcus limitans praecunei ends in two short branches. Superficially the posterior branch might be taken for the sulcus paracalcarinus, especially as there is a small sulcus passing over the dorsal border to lie between the two branches. This small sulcus is not the incisura parieto-occipitalis, however, it is the inner arm of the sulcus parietalis transversus. The incisura lies posterior to the posterior branch of the sulcus limitans praecunei. We must, therefore, regard the L-shaped sulcus in the anterior part of the cuneus as the sulcus paracalcarinus (21*p*) and, in part, a sulcus limitans superior areae striatae. The arcus intercuneatus is, therefore, an exposed gyrus directly continuous anteriorly with the praecuneus both above and below the sulcus limitans praecunei, and posteriorly with the cuneus both above and below the sulcus paracalcarinus.

The general direction of the folding of the striate cortex is horizontal. The posterior end of the sulcus retrocalcarinus is slightly branched. The sulcus retrocalcarinus (20) is succeeded by a Y-shaped sulcus calcarinus externus as part of the general grouping of the second type of lateral occipital region with fully curved sulcus lunatus and concentric U-shaped sulcus accessorius.

In four of the other hemispheres (S.5.L., S.6.L., S.11.L., S.9.R.) there is a sulcus within the cuneus which bears a close similarity with the form of the sulcus paracalcarinus described above. With these four specimens there is sufficient doubt as to its identity to warrant their exclusion from group 1. They will be fully discussed with their appropriate groups.

Group 2

Type Figures in the Literature.

Elliot Smith (1904, *c*), figs. 19 and 20.

In this group the lower ends of the sulci limitans praecunei and paracalcarinus have become folded into the fossa parieto-occipitalis, the upper ends diverging to expose the triangular area of cortex known as the arcus intercuneatus. The arcus is indented by the incisura parieto-occipitalis.

In the majority of cases the upper end of the sulcus limitans praecunei is directed forwards and fails to reach the dorsal border. It would appear that the operculum anterior fossae parieto-occipitalis has become developed inferiorly but that there is a failure in the development of the upper part of the precuneus. It is therefore suggested that the first stage in the evolution of the medial surface of the superior parietal lobule takes place from the parasplenial area of Elliot Smith.

Ten hemispheres belong to this group. S.5.L., S.4.L., S.2.R., S.2.L., S.3.L., S.7.L., S.12.L., C.4.R., C.4.L., and R.C.S.703.5.L.

S.5.L. (Plate 19)—The features of this brain are well known from the writings of Flashman. He described the medial surface accurately and his description is here given.

" *Fossa Parieto-occipitalis*—The incisura parieto-occipitalis is deep and completely isolated by a superficial gyrus intercuneatus and an arcus parieto-occipitalis. The posterior limb of the gyrus intercuneatus is narrower than the anterior and shows a slight tendency to submergence. The sulcus limitans praecunei is much deeper than the sulcus paracalcarinus and the anterior operculum fossae parieto-occipitalis is much better marked than the posterior.

" On opening up the fossa parieto-occipitalis, one sees that it is not a simple fissure ; the bottom of the fossa is broad, and shows an elevation on its floor ; on either side of this elevation is a slight fissure. These fissures, if followed dorsally along the floor of the fossa, are seen to become continuous with the bounding sulci of the gyrus intercuneatus. The inferior extremity of the fossa is marked off from the calcarine fissure by *a very definite gyrus cunei.* The walls of the fossa between the gyrus intercuneatus and the gyrus cunei are marked by ridges and sulci, none of which, however, are, so far as can be seen, continuous across the floor of the fossa ".

The form of the sulcus limitans praecunei (21*l*) in S.5.L. is exactly reproduced in the brain of the Gorilla depicted by Elliot Smith (1904 *c*, fig. 19). It has the shape of an inverted question mark. The upper end is directed somewhat forwards into the precuneus and fails to meet the dorsal border of the hemisphere. The lower part has a marked forward concavity and is the only part of the sulcus which can be regarded as being operculated. It would seem that in this type of hemisphere the expansion of the precuneus takes place mainly from the direction of the parasplenial area of Elliot Smith—areas 23 and 31 of Brodmann. This development covers over the lower end of the sulcus limitans praecunei and consequently the gyrus cunei becomes hidden from view. In more highly developed brains the anterior operculum becomes more fully formed dorsally. This hides the upper end of the sulcus limitans praecunei. The next stage in the development produces the approximation of the edges of the anterior and posterior opercula fossae parieto-occipitalis with the subsequent extension of the fissura parieto-occipitalis on to the dorsal surface. This dorsal extension must not be confused with the incisura parieto-occipitalis which becomes buried.

The sulcus retrocalcarinus (20) in S.5.L. is straight and partly telescoped into the sulcus calcarinus externus. Within the cuneus there is an L-shaped sulcus, the horizontal part of which constitutes a sulcus limitans areae striatae superioris; the vertical part is a posterior cuneal sulcus. The form of this sulcus reminds one of the form of the sulcus paracalcarinus seen in group 1 and the question as to how far they are homologous must be left open. Personally I regard the resemblance as fortuitous. The sulcus lying immediately anterior to the vertical limb and cutting the dorso-medial border is difficult to name. It has some affinity with both the sulcus paramedialis and the sulcus occipitalis transversus; perhaps both sulci enter into its constitution.

S.4.L. (Plate 18)—All the features seen in S.5.L. are exaggerated. The fossa parieto-occipitalis is widely open exposing a large arcus intercuneatus. The anterior wall of the fossa is formed by the sulcus limitans praecunei which is hidden in its lower part by the development of the inferior part of the operculum anterior fossae parieto-occipitalis. The lower part of the operculum has, as it were, bulged over the lower part of the fossa so that the lower ends of the sulci limitans praecunei and paracalcarinus, together with the gyrus cunei, are hidden. The upper end of the sulcus limitans praecunei is free and reaches the dorsal border of the hemisphere. The inverted question mark form of the anterior wall is well marked in this brain.

The arcus intercuneatus is fully exposed. The posterior part—sometimes known as the anterior cuneal gyrus of Zuckerkandl—is more extensive than the anterior part. The surface of the arcus intercuneatus is indented by three small furrows, the anterior of which is the incisura parieto-occipitalis. The incisura is deep and extends to the sulcus intraparietalis, from which, however, it is separated by a buried gyrus.

The sulcus paracalcarinus passes backwards from the convexity of the anterior operculum towards the dorso-medial border of the hemisphere. Here it is superficially confluent with the sulcus paramedialis. The sulcus paramedialis is clearly defined and forms the medial boundary of the gyrus occipito-parietalis superior. The posterior wall of the parieto-occipital fossa is thus formed by a paracalcarine-paramedial operculum.

In this hemisphere the striate cortex is folded horizontally. The sulcus retrocalcarinus passes towards the occipital pole where it ends by bifurcating. The sulcus calcarinus externus is Y-shaped having the arms of the Y enclosed by the branches of the sulcus retrocalcarinus.

Superior to the sulcus retrocalcarinus is a sulcus limitans superior areae striatae ; and inferior to the posterior extremity of the sulcus retrocalcarinus an inferior polar sulcus is present.

S.2.R. (Plate 16)—This brain is very contracted and hard. It is difficult to obtain any information beyond that visible from surface examination. The pattern of the sulci is, however, perfectly clear. The wedge-shaped arcus intercuneatus is exposed between the diverging sulci limitans praecunei and paracalcarinus. The sulcus limitans praecunei extends somewhat more dorsally than it does in the specimens already described. It just reaches the dorsal border and ends in a small branching. Its general direction is vertical, rather than oblique ; and it looks as though this is due to the greater development of the inferior half of the anterior operculum of the parieto-occipital fossa. This cannot be definitely determined because of the difficulty of opening up the sulci. The sulcus paracalcarinus passes upwards and backwards to reach the dorsal surface, where it joins the sulcus paramedialis.

The incisura parieto-occipitalis lies on the dorsal surface and is an independent furrow.

The sulcus retrocalcarinus is short and bifurcates on the medial surface. It is followed by a straight sulcus calcarinus externus. The confluence of the sulcus limitans areae striatae inferior with the inferior polar sulcus makes a striking picture.

S.2.L. (Plate 16)—In this specimen the type of parieto-occipital fossa with which we are dealing is found in association with vertical folding of the striate cortex. This association of types again draws our attention to the criteria for homologizing the sulcus paramedialis.

There is a large triangular arcus intercuneatus. In front it is bounded by the sulcus limitans praecunei, which fails to meet the dorsal border, is vertical in its disposition, and tends to show again the greater development of the parasplenial area. The incisura parieto-occipitalis is partly folded under the sulcus limitans praecunei. Behind the incisura there is a small sulcus which fails to meet the sulcus paroccipitalis and may be regarded as a second incisura.

The sulcus paracalcarinus is directed upwards and backwards into the cuneus, where it becomes superficially confluent with the superior polar sulcus. From the general form of the intrastriate sulci it seems probable that the posterior part of the superior polar sulcus is a sulcus limiting the area striata. The small sulcus confluent with the superior polar sulcus and lying between the superior polar sulcus and the sulcus paracalcarinus may be paramedial in type.

Sulci limitantes areae striatae superioris et inferioris are present. The inferior limiting sulcus is confluent behind with an inferior polar sulcus, and in front with the sulcus paracollateralis.

S.3.L. (Plate 17)—This hemisphere is very similar to those which have been described above. The form of the sulcus limitans praecunei again suggests the failure of development of the superior parietal lobule.

S.7.L. (Plate 21)—This hemisphere is considerably distorted; the dorsal border has become rounded and its exact position is difficult to define. The figure of the medial surface is therefore somewhat reconstructed.

The fossa parieto-occipitalis is open above but the exposed surface of the arcus intercuneatus is not so extensive as it is in the other members of the group. The specimen is practically a transition type between groups 2 and 3. The sulcus limitans praecunei fails to meet the dorsal border and turns forwards to a slight extent at its upper end. The incisura parieto-occipitalis splits the arcus intercuneatus into two equal parts. The incisura just reaches the point of junction of the sulci paracalcarinus and limitans praecunei. The projecting upper end of the sulcus paracalcarinus is short; the remainder of the sulcus is buried under the posterior operculum of the fossa. The sulcus retrocalcarinus is horizontally placed and ends in a terminal bifurcation. Superior and inferior polar sulci are present. The superior limiting sulcus of the area striata is well marked.

S.12.L. (Plate 26)—The figure showing the medial surface of this hemisphere seems to put beyond question that this hemisphere belongs to group 2. The figure is somewhat reconstructed for the brain is very much flattened and distorted. On the medial surface the diverging sulci limitans praecunei and paracalcarinus expose a triangular area of cortex intersected by the incisura parieto-occipitalis. The sulcus retrocalcarinus ends in a bifurcation which is immediately succeeded by a T-shaped sulcus calcarinus externus.

The figure of the same hemisphere seen from the posterior aspect shows the complex nature of the sulcus occipitalis transversus and casts doubt upon the interpretation made from the appearance of the medial surface. No sulcus lunatus is present. The sulcus occipitalis transversus extends well on to the lateral part of the hemisphere and seems to be mixed up with what may be the pars dorsalis sulci lunati. The inner arm of the sulcus occipitalis transversus appears to lie between the sulci limitans praecunei and paracalcarinus. This arm is deeply confluent with the sulcus paroccipitalis. Despite these appearances I am of the opinion that the apparent inner arm of the sulcus occipitalis transversus is in reality the incisura parieto-occipitalis.

Two of the Cambridge hemispheres are placed in this group, C.4.R. and C.4.L. (Plate 34).

C.4.L. (Plate 34)—In this hemisphere the upper ends of the sulci limitans praecunei and paracalcarinus are widely divergent, exposing a large triangular wedge of cortex, the arcus intercuneatus, intersected by the incisura parieto-occipitalis. The shape of the sulcus limitans praecunei and the other features are so similar to S.2.L. that reference to the description of that hemisphere will suffice for its description.

C.4.R. (Plate 34)—The only difference between this hemisphere in the medial occipital region and C.4.L. is in the difference in the direction of the sulcus paracalcarinus and in the non-confluence of this sulcus with the paramedial sulcus on this side.

R.C.S.703.5.L. (Plate 35)—The arrangement of the sulci in this hemisphere is very similar to the other members of the group. The sulcus limitans praecunei fails to reach the dorsal border of the hemisphere. The sulcus paracalcarinus is short and emerges from the fissure at about its midpoint and can be seen as a separate sulcus within the fissure. The sulcus paramedialis has much the same relations as in S.2.L., but in this case is separated from the sulcus paracalcarinus by a narrow gyrus. The incisura parieto-occipitalis lies mainly on the dorsal surface and is confluent with the sulcus paroccipitalis.

Group 3

This group is represented by two specimens, S.1.R. and A.954.L.

The features of this group are very similar to those of group 2; they represent a further stage in the infolding of the fossa parieto-occipitalis and in the development of the anterior and posterior opercula of the fossa. The lower angle of the arcus intercuneatus has become pinched by the approximating edges of the two opercula. Consequently the lower end of the incisura becomes hidden and there appears to be a fissura parieto-occipitalis passing on to the dorsal surface. It is necessary to emphasize that the upper end of the fissura parieto-occipitalis which extends on to the dorsal surface in higher types is not the upper end of the incisura but the sulcus caused by the meeting of the two opercula, under which are buried the three component sulci of the fossa. In group 3 the upper ends of these three sulci are exposed. The fissura parieto-occipitalis sprays out, as it were, into three branches about half-way up the medial surface.

A.954.L. (Plate 36)—The form of the occipital region in the Amsterdam brain appears less distorted than in many of the other brains. Attention is therefore drawn to the shape and form of the occipital pole. It has a peculiar square-cut and drawn-out appearance. Both Flashman and Duckworth, who were presumably working on material which was less distorted than it is now, refer to the drawn-out appearance of the occipital region. On both sides of the Amsterdam brain the area of the cuneus is very small and it is obvious that this drawn-out appearance is not so much a question of lengthening of the occipital pole, or of the results of dolichocephaly, but of lack of development of the association areas related to the visual territory.

On the left side the lower ends of the sulci limitans praecunei et paracalcarinus have come together to form a fissura parieto-occipitalis ; whilst superiorly the sulci diverge to expose a U-shaped arcus intercuneatus intersected by an incisura parieto-occipitalis. The shape of the lower part of the fissura parieto-occipitalis and of the upper end of the sulcus limitans praecunei (21*l*) is very similar to that of many of the other hemispheres and illustrates very well the posteriorly directed convex bulging of the lower part of the sulcus and the turning forward of the upper end of the sulcus limitans praecunei. The sulcus retrocalcarinus arches upwards into the cuneus, after which it bends downwards and is directed towards the occipital pole where it bifurcates. Sulci limitantes areae striatae superioris et inferioris are present.

S.1.R. (Plate 15)—The features described above are well shown in this specimen. The branching of the fissura parieto-occipitalis clearly portrays a condition almost as primitive as that seen in group 2. The anterior branch—the sulcus limitans praecunei (21*l*)—fails to reach the dorsal border and bends forwards into the praecuneus. The anterior operculum is clearly ill-developed above. The middle branch is the incisura parieto-occipitalis (21*i*), which is seen to be a separate sulcus when the lips of the fossa are drawn apart. The posterior branch is the upper end of the sulcus paracalcarinus (21*p*).

Group 4

This variety illustrates a stage further in the infolding of the arcus intercuneatus to form a true fissura parieto-occipitalis. Whilst the upper part of the arcus intercuneatus is still exposed, the process of development of the two opercula of the parieto-occipital fissure has progressed further so that the upper ends of the sulci limiting the opercula now extend to the dorsal surface of the hemisphere. The small area of the arcus intercuneatus peeps through between the upper ends of the opercula. The anterior operculum is still vertical in direction but is fuller than in the other groups. It is difficult to say in every case whether the upper end of the sulcus limiting the anterior operculum is the upper end of the sulcus limitans praecunei or whether it is the upper end of a true opercular sulcus. Similarly the upper end of the posterior opercular sulcus may be the sulcus paracalcarinus or this sulcus may be hidden from view.

There are two members of this group : S.1.L. and S.3.R.

S.1.L. (Plate 15)—The lips of the opercula of the parieto-occipital fossa are in contact until the dorsal border is approached, when they diverge slightly to expose the arcus intercuneatus. The sulcus bounding the anterior operculum passes well on to the dorsal surface and becomes a feature of the arcus parieto-occipitalis. In

S.1.L. this sulcus is not the sulcus limitans praecunei but a new compensatory sulcus formed by the expansion of the superior parietal lobule. In some cases in the brain of the Chinese this folding extends so as to include the inner arms of the sulcus parietalis transversus and thus becomes superficially confluent with the sulcus intraparietalis.

The posterior operculum fossae parieto-occipitalis is confluent with the sulcus paramedialis and an extensive operculum is thereby produced. The point of contact between the two sulci can be seen lying deeply on drawing back the operculum.

The incisura parieto-occipitalis lies in the arcus parieto-occipitalis and is wholly dorsal in position.

The sulcus retrocalcarinus is continued backwards in a bent sulcus towards the occipital pole where it is superficially confluent with the sulcus calcarinus externus. Within the anterior part of the cuneus is a vertical posterior cuneal sulcus lying parallel with the posterior operculum. This posterior cuneal sulcus closely resembles the sulcus which is regarded as the sulcus paracalcarinus in group 1. The exact interpretation of this sulcus must be left undecided. Behind the posterior cuneal sulcus lies a sulcus limitans superior areae striatae which is superficially confluent with the sulcus retrocalcarinus. A sulcus limitans inferior areae striatae is also present ; it is confluent with the sulcus paracollateralis of ELLIOT SMITH.

S.3.R. (Plate 17)—In the figure drawn to show both the dorsal and medial surfaces of the hemisphere, the diverging lips of the fossa parieto-occipitalis, the upper narrowed part of the arcus intercuneatus and the incisura parieto-occipitalis are well shown. At first sight the condition here seen might be regarded as being more advanced than in S.1.L., but a comparison of the form of the sulcus retrocalcarinus, with its obliquely placed upper branch, with BRODMANN's figures of the Orang-utan and with MINGAZZINI's figures of the Chimpanzee, leads to the conclusion that in S.3.R., the area striata extends to the posterior lip of the posterior operculum of the fossa parieto-occipitalis. Although this brain is in a poor state of preservation the sulci can be readily made out ; and, further, the condition seen is so similar to that observed in other members of the series that there can be little doubt as to the interpretation here put forward.

The sulcus paramedialis is clearly defined on the dorso-mesial border of the hemisphere. It is separated from the sulcus lunatus by a narrow superior occipito-parietal gyrus.

GROUP 5

The outstanding feature of this group is the fact that practically the whole area of the cuneus is occupied by the area striata. This finds its expression in the vertical folding of the intrastriate sulci ; and gives rise to a grouping of the sulci on the medial aspect of the hemisphere which is as significant as is the effect of the same vertical folding on the pattern of the sulci on the lateral aspect of the hemisphere.

Before proceeding to the description of the individual members of the group the main features of the group will be discussed, using S.4.R. as the basis for comparison.

The fissura parieto-occipitalis (21) is deep and extends well on to the dorsal surface. The sulcus retrocalcarinus (20) is short and ends in an obliquely-placed bifurcation. The upper arm of the bifurcation is directed forwards and upwards into the cuneus. The sulcus retrocalcarinus is followed by a deep obliquely situated sulcus retrocalcarinus verticalis (19*v*) which extends from beyond the occipital pole to a point immediately posterior to the fissura parieto-occipitalis. The extent of the area striata could not be determined in this specimen, but there can be little doubt that both these sulci are entirely intrastriate and that there is little, if any, extension of the area striata on to the lateral surface. The presence of superior polar and inferior polar sulci as well as a sulcus limitans inferior areae striatae accentuates the whole method of the folding of the area striata in this specimen. The parieto-occipital fossa appears to belong to the group 4 type in which the arcus intercuneatus peeps between the opercula of the fossa. How are we to interpret the condition? It certainly looks as though there is a definite operculum posterior fossae parieto-occipitalis. We have a situation in which the posterior operculum, apparently limited by a sulcus paracalcarinus, limits the area striata. Morphologically this operculum is a superior polar sulcus, topographically it is a sulcus paracalcarinus. Furthermore, if this opercular sulcus is traced backwards in the figures it is quite clearly a paramedial sulcus topographically, but not morphologically, for it must limit the striate cortex. I feel that it is better to state the problem frankly and admit that exact homology cannot be instituted between specimens of different type.

R.C.S.703.5.R. (Plate 35)—Is almost identical with S.4.R. ELLIOT SMITH (1911) has given his interpretation of the extent of the striate cortex in this brain. He clearly interprets it as I have S.4.R. It will be noted that in my figures of the medial surface the superior polar sulcus is shown running into the fissura parieto-occipitalis, whereas in his figure it falls short of it. The burying of the inner end of the superior polar sulcus within the fissure I have confirmed.

There are eleven hemispheres showing the vertical folding of the striate cortex: (S.4.R., S.6.R., S.6.L., S.13.R., S.12.R., S.8.R., S.5.R., C.3.L., C.3.R., R.C.S. 703.5.R., and S.10.R.). The condition is so obviously an entity that one is forced to the tentative opinion that in this type of folding there is something peculiar to the Australian aboriginal. It would appear to be rare in other races although ELLIOT SMITH also describes the condition in the Mott Memorial Volume (fig. 8). I have only seen occasional instances of it in the brain of the Chinese.

S.4.R. (Plate 18)—This specimen is sufficiently described above. The appearance of the lateral aspect has been described elsewhere; it is sufficient here to state that a definite sulcus lunatus is not present and the identity of the sulci is obscured by the complexity of the foldings about the posterior end of the sulcus paroccipitalis.

S.6.R. (Plate 20)—The arrangement of the sulci on the medial surface is very similar to that in S.4.R. The superior polar sulcus—a medial operculum limiting the striate cortex—is separated from the fissura parieto-occipitalis by a narrow gyrus. Within the concavity of the superior polar sulcus lie the upper ends of the sulci retrocalcarinus and retrocalcarinus verticalis. These two sulci are very obliquely situated and clearly intrastriate. It was possible to ascertain the extent of the stria of Gennari. It is almost wholly confined to the medial surface and deeply folded within the retrocalcarine sulci. On the lateral surface there is no definite sulcus lunatus and the identity of the sulcus occipitalis transversus is obscured.

S.6.L. (Plate 20)—This hemisphere is somewhat distorted and the drawings are, therefore, partly reconstructed. Contrasted with the opposite hemisphere the superior polar sulcus is placed more posteriorly and conforms to the descriptions of BOLTON and ELLIOT SMITH. It is a sulcus limiting the area striata and is clearly produced by the vertical folding of the striate cortex expressed by the form of the intrastriate sulci. These bear the same form as we have seen in the previous examples.

The most interesting feature of this part of the brain is the reversed L-shaped sulcus lying between the fissura parieto-occipitalis and the superior polar sulcus. The fissura parieto-occipitalis is complete and extends into the arcus parieto-occipitalis ; inferiorly it is separated from the sulcus calcarinus by a superficial gyrus cunei. The horizontal part of the cuneal sulcus is clearly a sulcus limitans superior areae striatae. What is the vertical element ? If it is the sulcus paracalcarinus the gyrus situated between it and the fissura parieto-occipitalis is the posterior part of the arcus intercuneatus, or anterior cuneal gyrus ; and the folding which has produced a complete fissura parieto-occipitalis is confined to the anterior part of the arcus intercuneatus. Whilst it is not possible to say in the absence of histological evidence whether it is the sulcus paracalcarinus, the presence of the superficial gyrus cunei and the appearance of the L-shaped sulcus in S.13.L. rather suggest that the sulcus in S.6.L. is paracalcarine in nature.

A well-marked inferior polar sulcus is present.

As in the previous specimens of this type there is no sulcus lunatus recognizable and the identity of the sulcus occipitalis transversus is obscured by the complexity of the folding of the posterior end of the sulcus paroccipitalis.

S.13.R. (Plate 27)—This hemisphere presents many interesting features which can be harmonized with the conditions already described in this grouping. The fissura parieto-occipitalis branches about one inch above its point of departure from the sulcus calcarinus. The anterior branch is the sulcus limitans praecunei (21*l*) ; it is found to be comparatively simple in its constitution and it extends on to the dorsal surface of the hemisphere. The posterior branch is separated from the anterior branch by a superficial gyrus. Traced to the dorsal surface it is found to enter into the composition of a large medial operculum reaching well on to the lateral surface of the hemisphere. This large operculated sulcus can be resolved into three elements separated from one another by deep gyri. The medial element is paracalcarine in nature, the dorsal element is of the nature of a superior polar sulcus and the lateral element is the sulcus occipitalis transversus. The composite curved sulcus arches over two intrastriate sulci. The anterior one has the form and relations of the upper arm of the bifurcated sulcus retrocalcarinus in S.4.R., but in S.13.R. it is separated from the sulcus retrocalcarinus and joined to a sulcus having the form and relations of the sulcus limitans superior areae striatae. A well-marked inferior polar sulcus is present.

S.12.R. (Plate 26)—This hemisphere reveals the separate nature of the sulci retrocalcarinus verticalis and calcarinus externus, for both are present. The sulcus calcarinus externus is horizontally disposed and is related laterally with a sulcus lunatus of the group 2 or accessory type. The sulcus retrocalcarinus verticalis is vertically disposed and surmounted by a medial operculation which is a typical superior polar sulcus in this specimen. This superior polar sulcus passes well into the cuneus on the medial surface, and on the lateral surface is conjoined with the complex of sulci at the posterior end of the sulcus paroccipitalis involving the sulcus occipitalis transversus. This specimen is very similar to the hemisphere of the Australian woman described by ELLIOT SMITH and with the brain depicted by him as fig. 8 in the Mott Memorial Volume. It finally disposes of the problem as to whether any curved sulcus surmounting the anterior end of a lateral intrastriate sulcus and limiting the striate cortex should be named the sulcus lunatus. It furnishes the proof of the incorrectness of FLASHMAN's interpretation in S.5.R. and in both hemispheres of S.6. It is on this interpretation of FLASHMAN's that opinions have been expressed as to the presence of the sulcus lunatus being a primitive feature in the brain of the Australian and on the relative frequency of the sulcus lunatus on the right and left sides of the brain. The form and direction of the terminal bifurcation of the sulcus retrocalcarinus and of the sulcus retrocalcarinus verticalis are precisely similar to S.4.R. and both sides of S.6.

In dealing with the lateral region of the occipital lobe I have used the name gyrus occipito-parietalis superior to indicate the gyrus which lies between the sulcus lunatus and the sulcus paramedialis and which splits to pass on either side of the sulcus occipitalis transversus to form the first and second plis de passages of Gratiolet. This gyrus is very well shown in this specimen. It is a non-striate area of cortex interposed between the vertical and horizontal extensions of the area striata on to the lateral surface. At the posterior end of this gyrus the sulci calcarinus externus and retrocalcarinus verticalis meet, and are very deeply folded, indicating how the area striata compensated itself against the invasion from the parietal region.

Sulci limitantes areae striatae superioris et inferioris are present.

The fissura parieto-occipitalis is completely folded in this specimen and extends well on to the dorsal surface where it bifurcates in the arcus parieto-occipitalis.

S.8.R. (Plate 22)—This hemisphere is essentially similar to other members of the group showing the effect of the vertical folding of the striate cortex. The features are the T-shaped sulcus calcarinus externus, the vertical element of the T being the sulcus retrocalcarinus verticalis, the well-marked superior and inferior polar sulci, the vertical disposition of the upper limb of the bifurcation of the sulcus retrocalcarinus ; and, on the lateral side, the confused nature of the posterior end of the sulcus paroccipitalis, the absence of a sulcus lunatus and the presence of a horizontal sulcus passing from the sulcus occipitalis anterior and extending backwards to the occipital pole.

The fissura parieto-occipitalis is completely folded, and ends in the arcus parieto-occipitalis on the dorsal surface.

S.5.R. (Plate 19)—The arrangement of the sulci on the lateral surface of this hemisphere and the form taken by the superior polar sulcus in response to the vertical folding of the striate area have already been discussed with the lateral surface. It was then shown how FLASHMAN was in error in regarding the superior polar sulcus as the sulcus lunatus. The form of the sulcus retrocalcarinus, the extensive sulcus retrocalcarinus verticalis, and the curved inferior polar sulcus are shown in the figures. Two features of interest in connexion with the fossa parieto-occipitalis deserve mention. The fissura parieto-occipitalis has the form of a branched sulcus. The sulcus limitans praecunei (21*l*) is buried by the anterior operculum fossae parieto-occipitalis in its lower part, but its upper end emerges and passes forward into the praecuneus. The apparent continuation of the fissura is the incisura parieto-occipitalis (21*i*) which passes to the arcus parieto-occipitalis. On the posterior wall of the fossa the sulcus paracalcarinus is seen emerging. Posterior to the fossa parieto-occipitalis is a triradiate cuneal sulcus somewhat similar to the sulcus considered to be the sulcus paracalcarinus in S.13.L.

C.3.R. (Plate 33)—The form of the intrastriate sulci—the sulci retrocalcarinus and calcarinus externus—shows a very definite vertical folding of the striate cortex on the medial surface, and yet there is a well-marked sulcus lunatus of the group 2 type on the lateral surface. Although the fissura parieto-occipitalis is complete on the medial surface, the arms of the fissure diverge on the dorsal surface. From the appearance of the sulci it seems to be very definite that the whole of the medial surface of the occipital region is occupied by striate cortex. The posterior part of the fissura parieto-occipitalis is homologous with the superior polar sulcus, whilst on the tentorial margin there is a fully curved inferior polar sulcus confluent with the sulcus collateralis.

C.3.L. (Plate 33)—In this hemisphere the area of the cuneus is exceedingly small. The upper bifurcation of the sulcus retrocalcarinus is directed upwards into the arch formed by the operculated sulcus paracalcarinus. The arcus intercuneatus forms a small triangular area between the sulcus paracalcarinus and the sulcus limitans praecunei. The upper end of the sulcus limitans praecunei extends on to the dorsal surface and is a feature of the arcus parieto-occipitalis. The incisura parieto-occipitalis is a separate sulcus and lies on the dorsal surface.

R.C.S.703.5.R. (Plate 35)—The description of this hemisphere has been given in dealing with the lateral surface in Elliot Smith's own words. The figures show the arrangement of the sulci conforming with the general features of the group and so no further description is necessary.

S.10.R. (Plate 24)—This hemisphere is very distorted and the cortex has been shaved off the lateral surface ; nevertheless, the pattern of the sulci clearly conforms to the group 5 type. The figures of this brain shown in the plate have been to a considerable extent reconstructed.

Group 6

This group comprises those cases in which the general folding of the striate cortex is horizontal, and in which there is a well-developed fissura parieto-occipitalis.

There are seven hemispheres which show the fissure completely closed (S.11.L., S.7.R., S.8.L., S.9.R., C.2.L., C.2.R., and A.954.R.). In many of these the area of the cuneus is contracted and small, suggesting that these cases cannot be compared with those of higher types in which there is a completed fissura parieto-occipitalis.

S.8.L. (Plate 22)—The two opercula of the parieto-occipital fossa are in contact with one another as far as the dorsal surface. Here the sulci limiting the opercula diverge to some extent and the incisura parieto-occipitalis is visible between them. The posterior branch of the fissure is deeply confluent with the sulcus paroccipitalis just anterior to the sulcus occipitalis transversus ; the anterior branch ends in the arcus parieto-occipitalis. The sulcus retrocalcarinus passes directly backwards for some distance and then turns downwards towards the occipital pole ; its posterior end reaches the lateral surface. There is no sulcus calcarinus externus. Superior and inferior sulci limitantes areae striatae are present.

S.7.R. (Plate 21)—This hemisphere is somewhat deformed and its borders are rounded ; the pattern of the sulci could, however, readily be determined. The fissura parieto-occipitalis passes on to the dorsal surface, turning backwards at its upper end towards the inner arm of the sulcus occipitalis transversus. Close to the dorsal border a short branch is given off anteriorly from the fissura parieto-occipitalis ; this is the upper end of the sulcus limitans praecunei.

Immediately posterior to the inner arm of the sulcus occipitalis transversus a deep superior polar sulcus crosses the dorsal border to extend well on to the lateral surface of the hemisphere. The sulcus retrocalcarinus passes backwards towards the occipital pole where it ends in a terminal bifurcation. This is succeeded by a lateral intrastriate sulcus whose upper end lies in the concavity of the superior polar sulcus. This sulcus is intermediate in type between the horizontal sulcus calcarinus externus and the sulcus retrocalcarinus verticalis.

The occipital region of this hemisphere is interesting in showing types of sulci which are transitional. Thus it is difficult to determine whether the lateral surface should be classed with the translunate type or with the vertical type. Similarly the lateral intrastriate sulcus is intermediate in form between the strongly marked vertical type and the type showing a mere divergence of the branches of the Y-shaped sulcus calcarinus externus.

S.9.R. (Plate 23)—There is a question as to whether this hemisphere should be placed in group 1 as an example of the fully exposed type of arcus intercuneatus. The sulci retrocalcarinus and calcarinus externus form a horizontal series of typical form as shown in Plate 23. The parieto-occipital sulcus crosses the medial border to pass into the arcus parieto-occipitalis. On opening up the fissure the upper end of the sulcus limitans praecunei is seen on the medial surface extending forward into the praecuneus. The sulcus which passes to the dorsal surface is the incisura parieto-occipitalis. Behind the fissura parieto-occipitalis there is a complex sulcus which passes upwards and backwards to cross the cuneus and reach the dorsal surface. The part of this sulcus on the dorsal surface is the sulcus paramedialis ; the lower part of it is a sulcus limitans areae striatae superior. The difficulty lies in the identification of the remainder of the sulcus. Whether to name it a posterior cuneal sulcus or the sulcus paracalcarinus must be left undecided. An inferior polar sulcus is present.

S.11.L. (Plate 25)—The calcarine sulci are clearly defined and require no description. The fissura parieto-occipitalis is completely formed by the approximation of the two opercula and extends on to the dorsal surface, where it bifurcates within the area of the arcus parieto-occipitalis. Within the cuneus there is an L-shaped sulcus continuous above with the superior polar sulcus. The inferior part of the sulcus is a sulcus limitans areae striatae superior. As to how far the remaining part of the sulcus is comparable with the sulcus paracalcarinus seen in group 1 cannot be determined.

C.2.L. (Plate 32)—The fissura parieto-occipitalis is fully closed and extends well into the arcus parieto-occipitalis where it ends in a terminal branching. The area of the cuneus is relatively extensive when compared with the other Australian cerebra. The occipital pole in this hemisphere has been injured, but sufficient remains to make it clear that the general folding of the striate cortex is horizontal.

C.2.R. (Plate 32)—The fissura parieto-occipitalis is completely closed and extends well on to the dorsal surface of the hemisphere. Despite this the contrast with the opposite hemisphere is very striking. In this hemisphere the area of the cuneus is very small. The retrocalcarine sulcus is somewhat broken up posteriorly with the result that the intrastriate sulci consists of several disconnected segments. There is a well-marked sulcus limitans areae striatae superior. Between this sulcus and the fissura parieto-occipitalis one sees the inner end of a superior polar sulcus which has been described in connexion with the lateral surface of this hemisphere.

A.954.R. (Plate 36)—The fissura parieto-occipitalis is completely closed and extends well on to the dorsal surface of the hemisphere. The sulcus retrocalcarinus passes horizontally backwards to the occipital pole where it bifurcates, the two branches lying vertically. Shortly after its commencement the sulcus retrocalcarinus arches sharply upwards and has the same form as on the opposite side. There is a well-marked sulcus limitans areae striatae superior. The area of the cuneus is small. This hemisphere is a transition form between group 5 and group 6, because the ends of the branches of the retrocalcarine sulcus are surmounted by superior and inferior polar sulci.

Group 7

Type specimen fig. 248, Catalogue of the Royal College of Surgeons (Elliot Smith, 1902).

This grouping is made for one specimen, S.11.R., because the features shown do not occur in any other specimen, because of its difficulties of interpretation and because of its striking similarity with the brain of the Gorilla shown in fig. 248 of the Catalogue of the Royal College of Surgeons.

S.11.R. (Plate 25)—The gyrus cunei is exposed and separates the sulcus calcarinus anterior from the fissura parieto-occipitalis. The sulcus calcarinus anterior and the sulcus retrocalcarinus form a straight continuous sulcus quite separate from any other sulci. The sulcus retrocalcarinus bifurcates posteriorly. Above the calcarine sulci there is an inverted Y-shaped sulcus separating the cuneus from the precuneus. The stem of the Y is clearly the parieto-occipital fissure and it passes well on to the dorsal surface. The question of the identity of the posterior arm of the inverted Y is a difficult one. It is probably the sulcus paracalcarinus which has become involved in the fossa parieto-occipitalis superiorly, but widely divergent from it inferiorly. In the posterior part of the cuneus a curved paramedial sulcus cuts the dorsal border of the hemisphere.

It is unfortunate that the lateral surface of this hemisphere is damaged so that the pattern of the sulci cannot be exactly determined, beyond being certain that there is no defined sulcus lunatus.

I have not previously seen, either in the brain of the Chinese or the Australian, an arrangement of the sulci on the medial surface comparable with S.11.R. The great interest lies in its comparison with the Gorilla's brain mentioned above.

When the facts concerning the medial occipital region are summarized and compared with the types seen in the Southern Chinese, the features distinguishing the aboriginal Australian stand out. The open condition of the fossa parieto-occipitalis characterizing the first two groups is present in 45% of the Australian hemispheres, and in 10% of the Chinese. There are 27% showing the vertical type of folding in the Australian, and 6% in the Chinese; and finally the formation of a fissura parieto-occipitalis characterizing group 6 is present in 17% of the Australian brains, and in 69% of the Chinese.

In the Australian the open condition of the fossa parieto-occipitalis is more common on the left side than on the right; whether this is associated with the asymmetry of the lateral part of the hemispheres it is not at present possible to say.

TABLE II—CLASSIFICATION OF THE MEDIAL OCCIPITAL REGION.

Australian hemispheres (41)

Groups

	1		2		3		4		5		6		7	
	R.	L.	R.	L.	R.	L.	R.	L.	R.	L.	R.	L.	R.	L.
Sydney	0	2	1	6	1	0	1	1	7	1	2	2	1	0
Cambridge	0	0	1	1	0	0	0	0	1	1	1	1	0	0
Amsterdam	0	0	0	0	0	1	0	0	0	0	1	0	0	0
R.C.S. London	0	0	0	1	0	0	0	0	1	0	0	0	0	0
Karplus	0	0	1	1	0	0	0	0	0	0	0	0	0	0
Adelaide*	0	0	1	3	0	0	0	0	0	0	0	0	0	0
Totals	0	2	4	12	1	1	1	1	9	2	4	3	1	0
%	0	5	10	30	2·5	2·5	2·5	2·5	22	5	10	7	2·5	0
Southern Chinese (100)†	0	0	5	5	1	4	1	5	4	2	39	30	0	0

* Taken from the figures of WOOLLARD's paper.

† Four are uncertain in their classification.

THE PARIETAL REGION

In the present state of our knowledge the difficulty of giving a composite picture of the parietal region in so many hemispheres is obvious. For this reason it is deemed advisable to describe the salient features of each hemisphere in detail, classifying them into arbitrary groups so far as it is possible to do so.

In the prosecution of this task the works of CUNNINGHAM, ELLIOT SMITH, INGALLS, JEFFERSON, and others have been freely consulted and their results have been compared with those of BRODMANN, CAMPBELL, and others on the cortical areas. Any review of these works would be out of place here, but particular reference is made to INGALL's (1914) work on "The Parietal Region of the Primate Brain". He recognized the great difficulty of exact description in this region. In his general discussion of the problem he states that,

> "Individual variations in the cerebrum can only be variations of these cortical areas, doubtless in different degrees, which latter variations are in turn reflected in the varying fissural pattern. In comparing brains we should compare areas, functional subdivisions, rather than the largely mechanical results of their development. A mere comparison of gyri and sulci is vain and idle for any adequate understanding of the brain as an organ of mind. The best we can do at present is to institute comparisons between anatomical areas, in a few cases functional also, but not until we are able to speak throughout in terms of function shall we be able to appreciate the differences which we already recognise."

In my earlier work on the interpretation of the cerebral sulci it seemed possible to select certain features which might be sufficiently constant to serve as landmarks from which a survey might be carried out. I have now almost arrived at the conclusion that each brain must be examined separately and that we are hardly yet in a position to speak in general terms of a group of brains. It is for this reason that the classifications are put forward in this paper, not as fixed bases for description, but as foundations for further work. The posterior end of the fissure of Sylvius was just one of those features which it was felt might be sufficiently fixed so as to pivot the description of the parietal region ; but in this series the posterior end is so variable in position, and the form of the sulcus intra-parietalis is likewise so variable that the parietal region can only be described by taking each sulcus separately. This requires somewhat tedious description, but it is felt that if we are to arrive at definite conclusions concerning the brain, the importance of a large series of hemispheres of a race, admittedly lowly, warrants detailed description as a permanent record for reference.

The Posterior End of the Fissure of Sylvius

The usual definition of the posterior end of the fissure of Sylvius dividing into ascending and descending branches leaves the impression that these branches are homologous in different brains, although many writers infer that this is not so by stating that the extent of the folding in of the posterior part of the island of Reil varies. The work of ANTHONY (1912) on the morphology of the island of Reil, and particularly his description of the posterior part of the operculum as the "operculе holopériphérique", should be referred to by the reader in this connexion.

In describing (1927, *a*) what I considered to be the important part played by the cortex on the posterior wall of the parallel sulcus in the evolution of the parietal lobe, I was particularly impressed by the retention of the connecting link between the visual and auditory areas in the visuo-auditory band of ELLIOT SMITH. The growth of the inferior parietal region appears to take place on either side of it ; and in order to get some index of the amount of cortical folding the distance between the lower end of the sulcus centralis and the posterior end of the fissure of Sylvius was measured in a large number of Chinese brains. A definite asymmetry was found, for on the right side the distance is less than on the left in a large percentage of cases.

EBERSTALLER (quoting from CUNNINGHAM, 1892) first made the observation that the length of the posterior horizontal limb of the fissure of Sylvius is, on the average, longer in the left hemisphere than in the right ; and observed further that it is longer in the male than in the female.

CUNNINGHAM (1892) confirmed the findings of EBERSTALLER. RETZIUS in his series of brains found too much variation to warrant his expressing an opinion. These writers measured the length from the Sylvian point anteriorly to the point of bifurcation posteriorly ; and referred to the difficulty of making exact measurement.

GENNA (1924) has given an excellent summary of the form taken by the posterior end of the fissure of Sylvius. In his fig. 1 and in his plate IV he depicts the separation of the posterior end of the fissure of Sylvius from the main fissure. This separated part is the pars postrema of KAPPERS.

My own observations were not at first so much concerned with the length of the fissure as on the extent of the folding of the parietal area and the cortical extent of the postcentral region. In the Australian aboriginal, measuring twenty-one brains, the distance from the lower end of the sulcus centralis to the posterior end of the fissure of Sylvius (taken as the point of bifurcation) is less on the left side than it is on the right in only one brain (S.1) in the ratio of 0·8 to 1. In four brains (S.8., R.C.S.703.5., S.11., and A.954) the distance was the same on the two sides. In the remaining sixteen brains the distance was greater on the left side than on the right in the average ratio of 1·6 to 1. On account of the amount of contraction of some of the brains the difference could not be expressed in centimetres, but I should estimate that the average difference is more than one centimetre. In the European brain CUNNINGHAM, measuring from the Sylvian point, found the average difference to be 0·6 centimetre. The meaning of the difference in the two sides is therefore to be found in the region posterior to the central sulcus.

To what is the asymmetry due? The work of Anthony indicates that it is due to the failure in development of his opercule holopériphérique, causing the pars postrema of KAPPERS to appear as a surface sulcus free from the island. In other words, the point which may be regarded as the posterior end of the fissure of Sylvius may actually lie on a sulcus posterior to the main fissure. GENNA (1924), whilst not explicitly stating so, indicates this by labelling a separate sulcus in the gyrus supramarginalis "lcpm", a designation given to the posterior end of the fissure of Sylvius in his other figures; and this sulcus "lcpm" he describes as the "pars postrema della f. silviana di A. KAPPERS". After a long study of the brains of the

TABLE III—DISTANCE FROM THE LOWER END OF THE SULCUS CENTRALIS TO THE POSTERIOR END OF THE FISSURE OF SYLVIUS.

Brain	Right cm.	Left cm.	Brain	Right cm.	Left cm.
S.1	2·6	2·1	S.10	2·0	3·5
S.2	1·6	2·4	S.11	2·5	2·5
S.3	2·4	2·8	S.12	2·5	3·7
S.4	1·5	2·8	S.13	2·0	3·5
S.5	1·6	3·0	Q.2640	2·0	2·5
S.6	2·5	3·0	Q.1487	1·4	3·5
S.7	2·0	3·0	Q.1905	2·0	3·5
S.8	2·0	2·0	Q.2788	1·5	3·0
C.2	1·7	3·9	C.4	2·3	3·4
C.3	1·4	3·8	A.954	3·0	3·0
R.C.S. 703.5	2·9	3·0			

The average measurement in centimetres is left, 3·0; right, 2·0. On account of the shrinkage the difference is probably nearer 1·5 than 1·0 cm.

Chinese I am convinced that, including only branches definitely joined to the fissure of Sylvius, the ascending terminal limb has a different value in different brains. In some brains it may lie immediately posterior to the sulcus centralis ; in others it appears to correspond with the sulcus postcentralis transversus ; and in the remainder it is placed further posteriorly and appears to agree with the ascending limb of the pars postrema of KAPPERS. In contrast with this inconstancy of position of the posterior end of the fissure of Sylvius one finds that the outer end of the sulcus temporalis transversus of Heschl, when it appears on the surface, occupies a position on the temporal operculum which is remarkably constant as measured from the level of the lower end of the central sulcus.

That there should be a lesser extent of cortical folding on the right side than on the left, involving just that area which should be most concerned in the attainment of higher intelligence and closely related to the band of connexion between the visual and auditory territories, suggests that the undue attention paid to the area of Broca has detracted from the importance of this visuo-auditory connexion in the development of speech. The question of the extent of the folding of the cortex in this region as a possible basis for racial comparison justifies a somewhat full quotation of CUNNINGHAM's (1892) attempt to explain the asymmetry. He says :—

> p. 127. " I have seen that the insula on the left side is relatively longer than the corresponding area on the right side, and the question, therefore, naturally arises : Is this difference in the size of the two insulae not the cause of the difference in the length of the two posterior limbs of the Sylvian fissure ?
>
> " My own belief is that it is not, because, as we shall see later on, a similar difference in the size of the insula in the two sexes is not followed by a corresponding difference in the length of the fissure in the male and female ; and, further, the fissure in the ape is relatively much longer than in man and yet the insula is shorter. The cause is to be looked for in the condition of the transverse temporal convolutions of Heschl, and also of the arching convolutions which connect the supramarginal and angular gyri with the upper two convolution-tiers of the temporal lobe. . . .
>
> " The greater relative length of the fissure in the ape is partly due to the fact that in man we have not included in the measurements the ramus posterior ascendens. But this is not the sole cause. The decrease in the length of the Sylvian fissure in man is largely brought about by an increase in the size of the arching convolutions which connect the supramarginal and angular gyri of the parietal lobe with the upper convolutions of the temporal lobe. These arching gyri bear a very close connexion with the transverse convolutions of Heschl which appear on the deep surface of the temporal operculum. EBERSTALLER has very properly called attention to this. . .
>
> " In well-marked cases the transverse gyri of Heschl are arranged in the human brain one behind the other in the form of a series of steps and stairs which gradually lead to the surface. Further it is no uncommon thing to find that the hindmost of these gyri has completely reached the surface and has ranged itself

in front of the supramarginal convolution. To one who studies the development of the Sylvian region the explanation is simple. In its early condition the Sylvian fossa is surrounded by steep perpendicular banks which ultimately form the lips of the different opercula. The posterior rounded angle of the region, however, ascends with a gradual and easy inclination towards the surface of the cerebral mantle, so that in many cases it is exceedingly difficult to fix accurately the posterior end of the insula. It is upon the surface of this inclined plane that the transverse gyri of Heschl are formed, but the process is hidden from view by the meeting of the parietal and temporal opercula over them. The anterior gyrus of Heschl appears first and the others assume shape in regular order from before backwards ".

It has been necessary to give this somewhat full reference because a detailed discussion of the form of the Australian hemispheres bears out CUNNINGHAM's analysis to a very great extent. Our present knowledge of the functions of Heschl's convolutions and the indications of the function of the parietal lobes derived from HEAD's (1926) work emphasizes the part played by these areas in the evolution of speech. Whilst it is tempting to indulge in speculations on these questions no useful purpose can be served in doing so until the comparison of a large number of brains of other races has been made ; but I would point out that the asymmetry which has been observed in the visual territory in other races is not so marked in these brains as it is in the auditory territory.

GROUP 1

The ascending terminal limb of the fissure of Sylvius lies immediately posterior to the lower end of the central sulcus and there is no sulcus separating the two. The ascending limb is wholly, or in part, constituted by the sulcus subcentralis posterior. Q.1487.R. is the only specimen in this group.

Q.1487.R. (Plate 29)—The *fissure of Sylvius* ends 1·4 cm. behind the lower end of the central sulcus by bifurcating into ascending and descending branches. The descending branch is about 2 cm. long and continues the direction of the main fissure with a bend in the downward and backward direction. The ascending branch is a well-marked and deep sulcus passing upwards and forwards to end in the concavity of the inferior genu of the sulcus centralis. It passes deeply into the Sylvian fossa. This ascending branch cannot be homologous with the ascending branch of the opposite side, because it lies wholly within the gyrus postcentralis inferior, the sulcus postcentralis inferior lies wholly behind it, and the sulcus is clearly a sulcus separating the areas postcentralis B and parietalis inferior C of ELLIOT SMITH ; whereas the usual ascending branch lies more posteriorly, separates the area postcentralis inferior C from the area postcentralis inferior B, or it may lie within area parietalis inferior B, and, finally, the ascending branch lies posterior to the sulcus postcentralis inferior. The ascending branch in Q.1487.R. from its topographical position is a sulcus subcentralis posterior. It might be confused with the sulcus postcentralis transversus in some cases, but here that sulcus is very clearly attached to the main sulcus postcentralis inferior. This specimen is certainly confirmatory of CUNNINGHAM's view that the extent of the arching convolutions between the supramarginal and superior temporal gyri has increased from that of the ape, but has not become sufficiently extensive to become folded into the fissure of Sylvius. It illustrates the great difficulty in homologizing the condition of the Sylvian fissure of the Ape with that of Man.

Within the supramarginal gyrus there are three small sulci which probably represent foldings of the cortex which, combined together, might correspond with the ascending branch of the fissure of Sylvius in other brains. But not only does there appear to be less folding of the region of the posterior end of the fissure of Sylvius, but the diminished folding is apparent also from the open condition of the elements of the sulcus intraparietalis which is described later.

The left hemisphere shows a condition in marked contrast with the right. At first I wondered whether the more greatly folded condition may be due to a shorter distance between the occipital pole and the central sulcus causing the folding of the cortex on the left side to be more marked than on the right. In Q.1487. (Plate 29) the distance from the occipital pole to the lower part of the sulcus centralis is actually greater on the left side ; furthermore, I have superimposed orthogonal drawings of Chinese hemispheres showing somewhat similar differences in the form of the fissure of Sylvius, and find that the position of the central sulcus may superimpose on the two sides, or else the discrepancy is so slight that the explanation lies elsewhere than in mere mechanical causes. On the left side the posterior end of the fissure of Sylvius lies well posterior to the level of the lower end of the sulcus postcentralis inferior, and it ends in ascending and descending branches. All the elements of the intraparietal sulcus are deeply folded and confluent, and deep foldings—supramarginal, angular and anterior occipital—occur in each of the three arcades formed along its inferior aspect.

The arterial supply is here of great value in confirming the findings derived from the pattern of the sulci. One of the most constant branches of the middle cerebral artery is the middle central branch entering the lower end of the sulcus centralis to supply the middle third of the gyrus praecentralis (*see* SHELLSHEAR, 1930). The next posterior branch of the middle cerebral artery is the posterior central branch, which frequently arises in common with the anterior postcentral branch. It reaches the surface by passing through the sulcus subcentralis posterior and supplies both sides of the sulcus centralis and a part of the gyrus praecentralis above the area of the middle central artery. Although in this specimen the terminal vessels to the gyrus praecentralis could not be dissected out, the whole arrangement is so essentially similar to that in the Chimpanzee that the identity of the sulci subcentralis posterior and postcentralis inferior is definitely established.

The facts become striking by comparing the arterial areas in this hemisphere with those in Q.2788.R. and Q.2788.L. (Plate 30). In Q.2788.R. the distance between the sulcus centralis and the posterior end of the fissure of Sylvius is again short, but the lower end of the sulcus postcentralis inferior is interposed between the sulcus centralis and the ascending limb of the fissure of Sylvius. The identity of the lower end of the sulcus postcentralis inferior—here probably the sulcus postcentralis inferior—is established by the position of the area of supply of the middle postcentral branch of the middle cerebral artery. In Q.2788.L. the ascending terminal limb of the fissure of Sylvius is placed far back and the obvious difference in the extent of folding of the cortex is very marked.

This is the only hemisphere in which it can be definitely shown that the sulcus subcentralis posterior forms the ascending terminal limb of the fissure of Sylvius.

Group 2

The ascending terminal limb of the fissure of Sylvius lies very close behind the lower end of the central sulcus, the gyrus postcentralis inferior is narrow, the sulcus postcentralis transversus is interposed between the sulcus centralis and the ascending limb ; finally, the remainder of the sulcus postcentralis inferior lies on a more posterior plane than the ascending limb of the fissure of Sylvius. Three specimens are included in the group : S.13.R., S.5.R., and S.7.R.

S.13.R. (Plate 27)—The fissure of Sylvius ends in a definite bifurcation. The descending limb is short and is directed backwards and slightly downwards ; the ascending limb is about 2 cm. long and is directed upwards. Immediately anterior to the point of bifurcation there is a short sulcus subcentralis posterior just appearing on the surface. In the gyrus postcentralis inferior there is a branched sulcus the posterior limb of which arches backwards over the top of the ascending limb of the fissure of Sylvius. The anterior part of the arch, from its relations to the inferior genu, is the sulcus postcentralis transversus ; the posterior part represents the sulcus postcentralis inferior either wholly or in part. The sulcus postcentralis superior is confluent below with a sulcus which passes downwards almost to the parallel sulcus. This is interrupted by a submerged gyrus below the level of the posterior end of the sulcus postcentralis inferior ; so that the lower part of the vertical sulcus probably represents the pars postrema of KAPPERS.

S.5.R. (Plate 19)—The relations of the sulci immediately posterior to the sulcus centralis are so essentially similar to those seen in S.13.R. that no detailed description is necessary. The ascending limb is slightly more complicated ; the sulcus postcentralis superior is confluent with a sulcus lying behind the ascending limb and the branched sulcus formed by the sulci postcentralis transversus and inferior has the same form and relations. The conditions are different, however, immediately posterior to the point of bifurcation of the fissure of Sylvius. The pars postrema is not attached to the postcentral sulci but to the parallel sulcus. The difficult question of the homology of the posterior ends of the fissure of Sylvius and of the parallel sulcus in the Apes again presents itself. Is this pars postrema the first ascending branch of the parallel sulcus of Kappers (the superior parallel mihi) ? The complexity of the pattern of the sulci in the parietal region of this brain forbids an answer to the question and makes one doubt whether, considering the great changes which have occurred in this region, it is of value to attempt to institute homologies in the inferior parietal lobule in every case.

S.7.R. (Plate 21)—Unfortunately, this brain is considerably deformed and the figures are to some extent reconstructed. The pattern of the sulci is, however, similar in every way to that seen in S.13.R. and S.5.R. The ascending limb is not so folded ; the sulcus subcentralis posterior, if it be so, lies some distance posterior to the central sulcus and arises at the point of bifurcation, the sulcus within the lower part of the inferior postcentral gyrus is so small that the greater part of the inferior postcentral sulcus lies posterior to the ascending limb of the fissure of Sylvius. Is the sulcus lying posterior to the fissure of Sylvius and superficially confluent with the parallel sulcus a separated pars postrema ? The question is asked to emphasize the presence of these vertical foldings in this group.

Group 3

This group is very similar to group 2. *The gyrus postcentralis inferior is narrow but here the lower end of the sulcus postcentralis inferior passes between the sulcus centralis and the ascending limb of the fissure of Sylvius. One specimen placed in the group is more or less intermediate between groups* 2 *and* 3. There are five members of the group :—S.2.R., S.4.R., S.8.R., Q.2788.R., and C.2.R.

S.2.R. (Plate 16)—The fissure of Sylvius ends by dividing into ascending and descending branches. The descending branch is short ; the ascending branch turns forward to end a short distance behind the central sulcus, but there is interposed between it and the central sulcus the backwardly directed arm of the sulcus post-centralis transversus. This latter sulcus is almost included into a fossa with the ascending limb. The superior and inferior postcentral sulci are confluent and form a parallel arcade with the sulcus centralis. Between the point of bifurcation of the fissure of Sylvius and the point at which the posterior end of the parallel sulcus turns upwards into the inferior parietal lobe there is a moderately wide expanse of cortex connecting the supramarginal and angular gyri with the superior temporal convolution. Within this area there are sulci representing the pars postrema.

S.4.R. (Plate 18)—This specimen is essentially similar to the last. The postcentral sulci form a sulcus parallel with the sulcus centralis and the lower end lies between the ascending limb of the fissure of Sylvius and the sulcus centralis. Again, behind the bifurcation of the fissure of Sylvius there is the moderately wide expanse of cortex connecting the supramarginal gyrus with the superior temporal convolution and within it are compensatory sulci, one of which is superficially connected with the parallel sulcus.

S.8.R. (Plate 22)—This hemisphere is in many respects similar to group 2 types. The sulcus with which the superior postcentral sulcus is confluent, passes behind the ascending terminal limb of the fissure of Sylvius. Within the postcentral gyrus is a branched sulcus representing the sulcus postcentralis transversus (15*t*) and possibly a part of the inferior postcentral sulcus. It is placed in group 3 in preference to group 2 on account of the greater width of the gyrus postcentralis inferior.

Q.2788.R. (Plate 30)—This hemisphere is particularly interesting because the areas of arterial distribution could be ascertained. The ascending limb of the fissure of Sylvius is a well-marked sulcus passing upwards into the supramarginal gyrus. It is surmounted by a fully curved arcade, the anterior part of which seems to agree with the sulcus postcentralis transversus, the posterior part confluent above with the superior postcentral sulcus agrees with the vertical sulcus lying behind the ascending limb in the other specimens. The arterial distribution does not point to this posterior sulcus being the sulcus postcentralis inferior. The area of the anterior postcentral branch is normally distributed and lies between the lower end of the sulcus centralis and the sulcus postcentralis inferior. The area of the posterior postcentral branch is bounded anteriorly by the inferior postcentral sulcus for a short distance and then the area becomes completely buried under the sulcus to emerge again in the middle part of the postcentral gyrus. These relationships of the posterior postcentral artery are quite regular and have been described by me in a previous communication. This appears to be a case in which the ascending terminal limb of the fissure of Sylvius is a bounding sulcus between areas parietalis inferior B and C of ELLIOT SMITH.

C.2.R. (Plate 32)—The arrangement of the sulci is the same as in the other members of the group—the narrow inferior postcentral gyrus, the combined sulcus postcentralis transversus and postcentralis inferior, and the general arrangement of the posterior end of the fissure of Sylvius.

Attention is, however, called to the vertical folding extending from the sulcus postcentralis superior and reaching almost to the parallel sulcus. The upper part of this sulcus is the sulcus postcentralis superior, the remainder of the sulcus probably represents sulci having different relations in other brains. Thus the upper part of it appears to correspond with the posterior pillar of the supramarginal arcade—the sulcus intermedius primus of INGALLS—and the lower part has affinities with the superior parallel sulcus or with the ascending terminal limb of the fissure of Sylvius in left-sided types. In Q.2640.R. the separation of the elements of the sulcus and the clear definition of the three intraparietal arcades seem to establish the interpretation put forward for the condition in C.2.R.

The vertical folding passing downwards from the sulcus postcentralis superior and lying behind the posterior end of the fissure of Sylvius occurs in eight of these hemispheres, seven on the right side—S.8.R., S.1.R., S.5.R., S.6.R., S.13.R., Q.1905.R. and C.2.R. and one on the left side, Q.2640. It is also present but not to such a marked extent in Q.1487.R. and Q.2788.R. This vertical folding, then, is further confirmatory evidence of the asymmetry of the brains of the Australian.

In the brain of the Southern Chinese the condition is found in twelve hemispheres, eleven of which are on the right side. In five hemispheres the sulcus is confluent with the parallel sulcus and establishes the fact that in many cases the vertical folding is in part the superior parallel sulcus—ascending 1 of KAPPERS.

So far nine hemispheres have been described in which the fissure of Sylvius bifurcates close to the sulcus centralis. All of them are on the right side and there is no hemisphere in which the conditions described above occur on the left hemisphere.

GROUP 4

This group is very similar to the last group. In it the extent of cortex between the sulcus centralis and the posterior end of the fissure of Sylvius is somewhat greater and the postcentral sulci clearly lie anterior to the ascending terminal limb.

There are ten hemispheres in the group:—Q.1905.R., S.1.R., S.1.L., S.6.R., S.10.R., S.12.R., S.13.L., Q.2640.R., C.3.R., and R.C.S.703.5.R. These classifications are put forward to give expression, as far as possible, to the extent of the folding of the cortex; and it is striking that of the nineteen hemispheres seventeen right and only two left hemispheres occur in the first four groups.

Q.1905.R. (Plate 28)—The fissure of Sylvius extends backwards to end in a small branching in the supramarginal region. Between the posterior end and the sulcus centralis there is a branched sulcus lying in the gyrus postcentralis which is formed by the sulcus postcentralis transversus and the sulcus postcentralis inferior. The sulcus postcentralis inferior is separated from the sulcus postcentralis superior. This separation of the elements of the postcentral sulcus presents a striking picture with the areas of arterial distribution. The anterior postcentral supply lies anterior to the sulcus postcentralis inferior and supplies the lower half of the postcentral gyrus. The posterior postcentral supply, which is often buried in its middle part within the sulcus postcentralis, here lies on the surface and extends upwards into the superior postcentral region. The picture of this area of distribution clearly shows, when compared with Q.1487.R., the relations of the cortex in this specimen.

S.1.R. (Plate 15)—In this hemisphere the cortex of the right temporal lobe has been destroyed. The brain is of historic interest, for it is that of the famous bushranger, Joey Governor, who was shot in the head causing the destruction of the temporal region. The fissure of Sylvius ends immediately posterior to the lower end of the sulcus postcentralis inferior. The sulcus subcentralis posterior is clearly defined. The region posterior to the terminal bifurcation contains two vertical sulci. The anterior is quite separate in the gyrus connecting the supramarginal and superior temporal gyri and probably represents the termination of the fissure of Sylvius in other forms; the posterior sulcus connects above with the postcentral sulci and below with the parallel sulcus, but it is separated from each by a submerged gyrus. Morphologically it is the ascending 1 branch of ARIËNS KAPPER —the superior parallel (mihi). The arrangement is very instructive ; for there is almost a type arrangement for description and comparative work. The intraparietal sulcus forms three arcades in each of which is an ascending sulcus. The first arcade arches over the ascending terminal limb of the fissure of Sylvius and is related with the superior parallel sulcus ; the second arcade, formed in part by the pars horizontalis, arches over the angular gyrus and contains the angular sulcus ; the third arcade, formed by the pars occipitalis, arches over the anterior occipital sulcus. These arcades and sulci will be fully discussed later.

S.1.L. (Plate 15)—The different sulci in this specimen are readily distinguished and are sufficiently described in the previous specimens, except for the highly branched sulcus lying behind the terminal limb of the fissure of Sylvius. It probably represents the superior parallel sulcus and a part of the pars postrema. The hemisphere is of interest in that it is the first left hemisphere showing the small extent of cortex between the central sulcus and the ascending limb of the fissure of Sylvius.

S.6.R. (Plate 20)—This specimen is essentially similar to the preceding ones. The only points which require emphasis are the separate postcentral sulcus and the vertical tier lying parallel with it passing into the region behind the fissure of Sylvius. The angular and anterior occipital sulci are clearly defined.

S.10.R. (Plate 24)—In this hemisphere the superficial layer of the cortex has been shaved off and the hemisphere is very much flattened. The posterior end of the fissure of Sylvius is seen to be substantially similar to the other members of the group.

S.12.R., S.13.L., Q.2640.R., C.3.R., and R.C.S.703.5.R. are similar to the other specimens and require no special description.

GROUP 5

In this group the folding of the posterior end of the fissure of Sylvius is somewhat more extensive than in group 4. *The vertical foldings in the region posterior to the terminal bifurcation in group* 4 *have become included into the sylvian opercula.* Some of the hemispheres are very similar to group 4 and may be regarded as transition types. The line of demarcation between groups is necessarily arbitrary since the features of the different groups form an almost complete series from the diminutive area, posterior to the lower end of the sulcus centralis, to extensive expansions.

There are eighteen members of the group (13 left and 5 right) :—Q.1905.L., Q.1487.L., S.5.L., Q.2640.L., S.2.L., S.4.L., S.3.L., S.3.R., S.12.L., S.11.R., S.6.L., S.8.L., C.4.R., C.4.L., A.954.R., A.954.L., R.C.S.703.5.L., and S.9.R.

Q.1905.L. (Plate 28)—The sulcus centralis is superficially confluent with the fissure of Sylvius. Behind this there are three ascending branches from the fissure of

Sylvius. The first is a deep sulcus passing well into the postcentral region and representing the sulci postcentralis transversus and inferior ; the second is small and seems to correspond with the ascending terminal limb of the previous group. Behind this is apparently a second sulcus postcentralis inferior and then comes the third and terminal ascending limb of the fissure of Sylvius. Posterior to the upper end of the ascending limb a vertical sulcus lies in the angular gyrus entirely separate from surrounding sulci. From its relations with the intraparietal sulcus this sulcus is regarded as the ascending 1 of ARIËNS KAPPERS.

Q.1487.L. (Plate 29)—The terminal bifurcation in this hemisphere lies in approximately the same position as in the previous specimen. The lower end of the sulcus postcentralis transversus comes into close contact with the sulcus subcentralis posterior on the upper lip of the fissure of Sylvius. There are three arcades of the sulcus intraparietalis. Within the first arcade is a separated sulcus which occupies the topographical position of the ascending terminal limb of the fissure of Sylvius in many of the members of the previous groups. In this specimen the terminal bifurcation of the fissure of Sylvius lies directly under the posterior pillar of the first arcade. The sulcus lying in the second arcade is clearly a derivative of the parallel sulcus and need not concern us here.

S.5.L. (Plate 19)—The sulcus subcentralis posterior and the sulcus postcentralis transversus are both clearly defined and the terminal bifurcation lies well posterior to the latter sulcus with the lower end of a vertical sulcus interposed. The whole parietal region of this hemisphere is peculiar and will be more fully discussed with the sulcus intraparietalis.

S.4.L., S.3.L., S.2.L., and Q.2640.L. all show the point of bifurcation of the fissure of Sylvius at approximately the same level as in the other members of the series. In S.4.L. and S.2.L. there is a folding of the cortex immediately posterior to the bifurcation which topographically agrees with the posterior pillar of the first intraparietal arcade ; and in Q.2640.L. this sulcus is connected with the sulcus intraparietalis. It probably represents the ascending 1 branch of the parallel sulcus of ARIËNS KAPPERS.

S.3.R., S.6.L., S.11.R., and S.12.L. all show the termination of the fissure of Sylvius in approximately the same position but each has distinctive features requiring mention.

In *S.6.L.* there is a prominent vertical sulcus passing from the temporal to the supramarginal region. This sulcus is split off from the parallel and agrees in every way with the sulcus which I have named the superior parallel sulcus. At first sight it appears to be the sulcus pars postrema of KAPPERS, but it is placed too far posteriorly. It is possible that it may become included in the folding of the fissure of Sylvius in some cases.

In *S.3.R.* there are two concentric arcades over the ascending terminal limb of the fissure of Sylvius. The upper arcade is the inferior postcentral sulcus anteriorly and the posterior pillar of the first intraparietal arcade posteriorly. The lower arcade perhaps represents in part the superior parallel sulcus. It is the first of the three ascending sulci into the inferior parietal lobule ; the other two are well marked and definitely related with the parallel sulcus.

S.11.R. also shows an arcade related to the ascending terminal limb of the fissure of Sylvius. There is little doubt from its general form and relations that it is the superior parallel sulcus. It is separated superiorly from the intraparietal sulcus by a narrow gyrus.

S.12.L. shows a number of fragmentary sulci related to the posterior end of the fissure of Sylvius, whose exact identity it is unprofitable to try to determine.

The remaining brains, C.4.R., C.4.L., A.954.R., A.954.L., R.C.S.703.5.L., S.8.L., and S.9.R., are typical of this group and are adequately portrayed in the figures.

Group 6

This group is characterized by the greater posterior extent of the fissure of Sylvius than in the previous groups. Naturally the members of the group shade off from those of group 5, but, taking the whole series, we have clearly an ascending one from a minimum folding to a maximum folding. In group 6 there is definite evidence from S.11.L. that the backward extension is due to the folding in of the pars postrema. There are six members of the group :—S.11.L., S.7.L., S.10.L., Q.2788.L., C.2.L., and C.3.L.

S.11.L. (Plate 25)—This brain is very much flattened, so that all the sulci are shown in the figures reaching almost to the medial border. The fissure of Sylvius ends well back in the inferior parietal lobule by dividing into three terminal branches. The two inferior branches are small, the ascending branch is somewhat longer than the other two. The lower end of the inferior postcentral sulcus ends immediately anterior to an ascending branch from the fissure of Sylvius. This ascending branch corresponds with the ascending branch of other groups, for immediately posterior to it there is a submerged gyrus separating the main fissure from the pars postrema. The ascending branch of the pars postrema occupies the position of the separated vertical sulcus in the other brains and therefore agrees in many respects with the ascending 1 branch of the parallel sulcus of Kappers.

S.7.L. (Plate 21)—The fissure of Sylvius ends well back in the inferior parietal lobule by bifurcating into two branches. The upper branch passes into the first intraparietal arcade, the lower branch passes backwards and slightly upwards to end in the inferior parietal lobule. The parallel sulcus passes backwards to end in the third intraparietal arcade. It gives off no ascending branches into the parietal lobe, but the place of the second ascending branch is taken by a separate branching sulcus lying posterior to the posterior end of the fissure of Sylvius.

The remaining members of the group are sufficiently described by the figures.

The grouping of the hemispheres in accordance with the extent of the folding of the posterior end of the fissure of Sylvius, whilst admittedly arbitrary, gives a very good idea of the amount of the asymmetry between the two hemispheres. The Australian hemispheres are tabulated in Table IV and contrasted with the hemispheres of the Southern Chinese.

TABLE IV—CLASSIFICATION OF THE POSTERIOR END OF THE FISSURE OF SYLVIUS

Australian Hemispheres

Group	1		2		3		4		5		6	
	R.	L.	R.	L.	R.	L.	R.	L.	R.	L.	R.	L.
Sydney	0	0	3	0	3	0	4	2	3	7	0	3
Queensland	1	0	0	0	1	0	2	0	0	3	0	1
Cambridge	0	0	0	0	1	0	1	0	1	1	0	2
Amsterdam	0	0	0	0	0	0	0	0	1	1	0	0
Karplus	0	0	0	0	0	0	1	0	0	1	0	0
R.C.S.	0	0	0	0	0	0	1	0	0	1	0	0
Totals	1	0	3	0	5	0	9	2	5	14	0	6
%	2·2	0	6·6	0	11	0	20	4·5	11	31	0	13·4
Southern Chinese (100) . . .	3	0	4	0	7	1	16	3	19	37	1	9

THE INTRAPARIETAL SULCUS

Under this term are included four morphologically distinct sulci—the sulci postcentralis superior et inferior, the pars horizontalis, and the pars occipitalis, or sulcus paroccipitalis of Wilder. CUNNINGHAM, omitting the pars occipitalis, classified the sulcus intraparietalis into five varieties depending upon the amount of confluence or separation of the different elements.

FLASHMAN, in his observations on some of the brains here described, classes sulci as being separate which I regard as being confluent. It is obvious that such difference of opinion must occur with a classification of an arbitrary nature and that percentage tables derived therefrom must not be given undue weight from the standpoint of racial difference. Nevertheless, CUNNINGHAM'S classification is a useful one in dealing with a large number of brains and must be used until a better one is available.

The Sulcus Paroccipitalis of Wilder

This sulcus will be dealt with before the remaining parts of the sulcus intraparietalis. ELLIOT SMITH (1907, *b*), fig. 2, depicts the sulcus paroccipitalis as an H-shaped sulcus separated from the remainder of the sulcus intraparietalis and having definite cortical relations. The posterior cross-limb of the H is the sulcus occipitalis transversus ; the anterior cross-limb is not named by him, although in another paper on the folding of the visual cortex (1907, *a*) (p. 205), he emphasizes its importance. Again he did not name it and so far as I know it has not been named. The inner limb of this sulcus is obviously a sulcus of importance in limiting the area peristriata; and, because it is in some respects analogous with the sulcus occipitalis transversus, it seems desirable to designate it the "sulcus parietalis transversus". In describing it ELLIOT SMITH says :—

> "It is interesting to observe that whereas the main stem (fig. 3, *s. parocc.*) and its mesial cephalic (fig. 3*a*) and lateral caudal (*d*) branches are essentially parts of the limiting furrow, the lateral cephalic (*c*) and the mesial caudal (*c*) branches are morphologically unimportant furrows, being apparently mere kinks resulting from the mechanical condition incidental to the bending of the cortex at these points".

JEFFERSON (1913) depicts the sulcus parietalis transversus in many of his figures; and clearly distinguished the sulcus paroccipitalis as a separate and generically distinct furrow from the remainder of the sulcus intraparietalis.

The inner arm of the sulcus parietalis transversus must be distinguished from the sulcus parietalis superior. This latter sulcus lies within the superior parietal lobule, whereas the inner arm of the sulcus parietalis transversus separates the arcus parieto-occipitalis from the superior parietal lobule. The inner arm of the sulcus parietalis transversus is clearly defined in a large number of the Australian hemispheres. I have examined it in many Chinese brains and have used it as a guide in determining the extent of the area of the arcus parieto-occipitalis and in determining the amount of the folding of the operculum anterior fossae parieto-occipitalis.

The outer arm of the sulcus parietalis transversus is not so constant in position as the inner arm. INGALLS has named this outer arm the sulcus intermedius secundus and quite clearly depicts it lying between the upper ends of the sulci angularis and occipitalis anterior. Although variable in position it is convenient to regard it as forming the boundary between the angular and postparietal gyri.

In the Australian cerebra the whole sulcus parietalis transversus is clearly defined in a large number of cases. In the brain of the Chinese, whilst the sulcus is also well shown in many cases, the outer limb tends to become obscured by its absorption into the pars horizontalis. Again in the brain of the Chinese the anterior operculum of the fossa parieto-occipitalis is frequently so well developed that, in the same way as it comes to cover over the sulcus limitans praecunei, on the medial surface, it extends on to the lateral surface and folds over the sulcus parietalis transversus resulting in the formation of a large operculum extending from the sulcus calcarinus on the medial surface to the sulcus intraparietalis on the lateral surface.

Two other conditions occur in the Australian brains which are unusual: firstly, there are cases where the three parts of the sulcus paroccipitalis may each or all be separate and, indeed, difficult to define; and, secondly, the sulcus occipitalis transversus is frequently connected with sulci in the occipital region. The latter sulcus tends to become highly branched ending in a conglomerate of sulci, probably representing, in part, remnants of the sulcus lunatus. DUCKWORTH (1908), in the

Cambridge series, also found difficulty in clearly defining the sulcus occipitalis transversus.

The sulcus paroccipitalis is here classified into groups to facilitate description and comparison. The basis for classification is as far as possible the extent of the folding of the H-shaped sulcus proceeding from cases where the three parts are separate to those in which they are confluent with one another, and, finally, to those in which the confluence is continued into the pars horizontalis sulci intraparietalis.

Group 1

In this group the sulcus paroccipitalis is fragmentary ; its different elements are difficult to define and the boundaries of the arcus parieto-occipitalis are lost. There are two hemispheres which show this condition (S.5.R. and S.5.L.). In my examination of many hundred Chinese brains I have not met with a condition comparable with these two hemispheres.

S.5.L.—In Plate 19 the figure taken from the dorso-lateral aspect shows the fragmentary condition of the sulci of the inferior parietal lobule. The incisura parieto-occipitalis (21*i*) extends on to the dorsal surface and ends in a right-angled bifurcation. This bifurcation is definitely a part of the incisura. Not only is this sulcus clearly defined, but also the lunate operculum (18), and yet with these landmarks it is almost impossible to give a name to any of the sulci related with them. FLASHMAN identified the sulcus connected anteriorly with the sulcus lunatus as the sulcus occipitalis transversus. This sulcus is, however, definitely confluent with the sulcus lunatus, and probably is the sulcus praelunatus (18*p*). The only sulcus, then, which could possibly represent the sulcus occipitalis transversus lies immediately posterior to the incisura parieto-occipitalis. This sulcus passes well on to the medial surface and, if it represents the sulcus occipitalis transversus, must also represent in part the sulcus paramedialis. The horizontal part of the sulcus paroccipitalis may be the sulcus lying lateral to the incisura ; but it lies wholly lateral to the sulcus occipitalis transversus. It is better to say that it cannot be defined. The sulcus parietalis transversus is non-existent, unless it is represented by the sulcus superficially confluent with the upper end of the angular sulcus, which is here more complicated than usual. The extraordinary arrangement of the remaining elements of the sulcus intraparietalis may be noticed in passing. There appear to be two inferior postcentral sulci. The posterior one forms the lower part of an oblique sulcus whose upper end is the sulcus parietalis superior, and there is no sulcus to represent the pars horizontalis, except perhaps the branched sulcus superficially confluent with the sulcus angularis.

It seems more profitable to emphasize in this specimen the peculiarity of the foldings and to draw attention to the primitive condition of the lunate operculum and of the arcus intercuneatus and to the almost superficial position of the gyrus cunei, than to attempt to homologize the sulci in an exact manner.

S.5.R. (Plate 19)—Again the sulcus paroccipitalis is broken up. The incisura parieto-occipitalis (21*i*) passes on to the dorsal surface and is bifurcated. The horizontal sulcus immediately lateral to the incisura is all there is to represent the horizontal element of the sulcus paroccipitalis. There is no sulcus occipitalis transversus. It may be represented by the slight branching of the posterior end of the sulcus identified as the horizontal element, or it may be in part included in the medial operculum ; it is impossible to say. The sulcus parietalis transversus is confluent with the pars horizontalis sulci intraparietalis. The arcus parieto-occipitalis is not in any way elongated, in fact rather contracted, so that the question as to whether dolichocephaly plays any part in the open condition of these sulci must be ruled out. It seems more reasonable to attribute the condition seen in these two hemispheres to lack of development of the parietal lobe.

Group 2

In this group the arcus parieto-occipitalis is well defined. The sulcus paroccipitalis is broken and the cortex of the arcus parieto-occipitalis is continuous with that of the post-parietal lobule either anteriorly or posteriorly. There are two specimens included in the group :—S.13.R. and Q.1487.R.

S.13.R. (Plate 27)—The posterior end of the sulcus paroccipitalis is buried on the anterior wall of the medial operculum. Under the operculum the sulcus occipitalis transversus (17) is confluent with the horizontal part of the paroccipital sulcus. This part ends anteriorly without any confluence and immediately in front of it is a Y-shaped sulcus. The two posterior arms of this Y-shaped sulcus are the inner and outer arms of the sulcus parietalis transversus bounding respectively the arcus parieto-occipitalis and the gyrus postparietalis. The anterior horizontal arm is the pars horizontalis sulci intraparietalis (16*h*). The figure of the posterior aspect is drawn to show the dorsal and medial surfaces. It is seen that the arcus parieto-occipitalis is wedge-shaped and contracted in area.

Q.1487.R. (Plate 29)—This hemisphere has been described as a group 1 type of lateral occipital region. The sulcus lunatus is a subordinate part of the much larger occipital opercular sulcus, the floor of which above the sulcus lunatus is formed by the sulcus occipitalis transversus. The sulcus occipitalis transversus (17) is entirely separate from the sulcus paroccipitalis. The horizontal part of the sulcus paroccipitalis is the outer boundary of the arcus parieto-occipitalis and is confluent anteriorly with the sulcus parietalis transversus. The inner arm of the sulcus parietalis transversus limits the arcus anteriorly ; the outer arm is turned forwards and lies horizontally. As Elliot Smith has pointed out, this outer arm is not so constant in position as the inner arm, and does not necessarily correspond in different brains.

The arterial supply throws light on the homology of the sulci. The area of the posterior parietal branch of the middle cerebral artery includes the whole area of the postparietal gyrus and overflows to a slight extent into the arcus parieto-occipitalis. I have repeatedly confirmed this area of supply in the brain of the Chinese and in the brain of the Australian aboriginal. The upper element of the sulcus occipitalis anterior is an axial furrow in the gyrus postparietalis and always lies within the area of the posterior parietal artery. Turning to the figure showing the arterial supply of the lateral surface of Q.2788.R. (Plate 30), the area supplied by the posterior parietal artery passes in the same way in the interval between the sulcus parietalis transversus and the pars horizontalis sulci intraparietalis to include a small part of the superior parietal lobule. In Q.1905.R. (Plate 28), where the pars occipitalis is confluent with the pars horizontalis sulci intraparietalis the area of supply of this artery runs along the line of confluence and also supplies a small part of the superior parietal lobule. The arterial supply, therefore, confirms the morphological value of recognizing three elements of the sulcus paroccipitalis.

JEFFERSON, in pointing out the separate nature of the sulcus paroccipitalis, makes use of the argument that " whilst there is abundant testimony to show that sulci originally distinct may subsequently become confluent, there is not a tittle of evidence to show that disruption of a primarily single furrow can occur ". If this be true the sulcus paroccipitalis must be composed of three primarily distinct sulci. I do not know of any evidence, however, to support JEFFERSON's contention.

GROUP 3

The sulcus paroccipitalis is H-shaped and separated from the pars horizontalis sulci intraparietalis anteriorly. This variety occurs in fifteen hemispheres :—S.3.R., S.4.R., S.8.R., S.8.L., S.9.R., S.10.R., S.11.L., S.12.R., S.12.L., S.13.L., Q.2788.R., C.2.R., C.3.R., C.4.R., and R.C.S.703.5.R.

The lateral occipital region of these hemispheres has already been described and it will suffice to give a general description of the condition in place of describing each hemisphere separately.

Plate 30, the figure representing the lateral aspect of Q.2788.R. and the areas of arterial supply, shows the morphological features of the group. The sulcus paroccipitalis is clearly H-shaped. The sulci occipitalis transversus and parietalis transversus are distinct. Superiorly the upper curve of the H-shaped sulcus bounds the arcus parieto-occipitalis and inferiorly the lower curve bounds the gyrus postparietalis. The arcus parieto-occipitalis in this specimen is probably entirely occupied by the area peristriata of ELLIOT SMITH and is supplied by the parieto-occipital branches of the posterior cerebral artery. The line of demarcation between the middle and posterior cerebral arteries lies close to the sulcus paroccipitalis within the arcus parieto-occipitalis. In many brains the line of demarcation lies more superiorly within the arcus, but in all cases both walls of the sulcus paroccipitalis are supplied by the middle cerebral artery. The whole of the lobulus postparietalis, within the arcade formed by the lower curve of the H (the third intraparietal or postparietal arcade), is supplied by the posterior parietal branch of the middle cerebral artery. The area of supply of this artery extends posteriorly to the sulcus lunatus, anteriorly and superiorly it passes into the gyrus separating the pars occipitalis from the pars horizontalis, reaching well into the superior parietal lobule. In all the brains which I have examined, the line of demarcation between the main cerebral arteries is within the superior parietal lobule ; and so the whole of the sulcus intraparietalis, with the exception of the upper part of the sulcus postcentralis superior, is supplied by the middle cerebral artery. The sulcus within the postparietal lobule is the upper part of the sulcus occipitalis anterior.

A comparison of the areas of arterial supply in this specimen with Q.1905.R. demonstrates in a striking way how the arterial supply forms a useful aid in determining homologies.

The remaining members of the group are best described by concentrating on two morphological features : firstly, the form of the sulcus occipitalis transversus and its attachments to neighbouring sulci, and, secondly, the form and size of the arcus parieto-occipitalis.

In S.9.R. and S.8.L. the sulcus occipitalis transversus is clearly defined and uncomplicated by fusion with any other sulci. In the remaining hemispheres either the inner or outer arm of the sulcus occipitalis transversus is linked up with sulci of the occipital region. In S.3.R. and C.2.R. the outer limb is superficially confluent with the sulcus lunatus and there is no difficulty in recognizing the sulci of the lateral occipital region.

Six hemispheres (S.4.R., S.8.R., S.11.L., S.12.L., S.12.R., and C.4.R.) show the outer limb of the sulcus occipitalis transversus confluent with sulci so as to form a branching conglomeration in the position of the pars dorsalis sulci lunati. In all of these, with the exception of S.12.R., there is no sulcus lunatus, and so it seems moderately certain that the sulcus occipitalis transversus has retained its attachment to the lunate sulcus even after this sulcus has become broken up and obscured. In S.12.R. the outer limb of the sulcus occipitalis transversus is secondarily attached to the medial operculum on the dorso-medial border. This attachment is a peculiar one, for it is generally the case that, where the sulcus occipitalis transversus is confluent with occipital sulci, the inner arm is attached to the paramedial sulcus or to the medial operculum and that the outer arm is attached to the pars dorsalis sulci lunati.

In the other hemispheres in this group, S.10.R., S.13.L., C.3.R., R.C.S.703.5.R., and Q.2788.R., the inner arm of the sulcus occipitalis transversus is confluent with the sulcus paramedialis.

The form and the extent of the arcus parieto-occipitalis will be dealt with when the other types of sulcus paroccipitalis have been considered.

Group 4

The sulcus paroccipitalis is confluent with the pars horizontalis sulci intraparietalis. The sulcus paroccipitalis is clearly H-shaped, having both the upper and lower arms of the sulcus parietalis transversus defined. There are eleven hemispheres in this group :—S.1.L.,

S.1.R., S.7.R., S.10.L., S.11.R., Q.2640.R., Q.1905.R., Q.1487.L., Q.2788.L., C.2.L., and C.3.L.

In Q.2788.L., Q.2640.R., Q.1487.L., Q.1905.R., and C.2.L. the outer arm of the sulcus parietalis transversus forms a very definite boundary between the post-parietal and angular gyri and lies between the sulcus occipitalis anterior and the sulcus angularis. In these five hemispheres the pars horizontalis sulci intraparietalis is joined to the sulcus paroccipitalis at about the midpoint of the sulcus parietalis transversus. In Q.2788.L. and Q.1487.L. the sulcus occipitalis transversus is free and uncomplicated, in Q.2640.R. and C.2.L. the outer limb of the sulcus occipitalis transversus is partly buried under the lunate operculum, and in Q.1905.R. this sulcus is completely buried under the occipital operculum.

In S.1.R., S.1.L., and S.7.R. the form of the pars horizontalis rather confuses the identity of the outer arm of the sulcus parietalis transversus ; but it would appear that the confluence is brought about by the end of the outer arm of the sulcus parietalis transversus.

In S.11.R. the outer arm of the sulcus parietalis transversus is placed more anteriorly than in the other specimens and appears to lie anterior to the position of the angular sulcus.

Group 5

The sulcus paroccipitalis is confluent with the pars horizontalis and there is no definite outer arm of the sulcus parietalis transversus. The explanation of the absence of this arm may perhaps lie in the condition of the sulci in S.11.L. where the outer arm has come to lie parallel with the pars horizontalis and is partly buried with it.

There are thirteen members of this group :—S.2.R., S.2.L., S.3.L., S.4.L., S.6.R., S.6.L., S.7.L., Q.2640.L., Q.1905.L., A.954.R., A.954.L., C.4.L., and R.C.S.703.5.L.

The sulcus paroccipitalis forms a long curved sulcus by confluence with the pars horizontalis. The figures illustrating them are sufficiently explanatory.

The Sulcus Occipitalis Transversus

This sulcus has already been described in great part in dealing with the individual specimens. Table V summarizes the condition of this sulcus in the brain of the Australian.

Cunningham confirmed the statement of Ecker and Wilder that the union takes place more frequently on the left side than on the right. This is also confirmed above for the Australian and the Chinese.

Cunningham records that a union of the two elements takes place in 87·5% of the left hemispheres, and in only 58·4% of the right hemispheres. I find in the Australian brain that 77% of the left hemispheres have the elements continuous and 36% of the right hemispheres ; in the Chinese, 70% of the left hemispheres and 36% of the right hemispheres continuous.

The parietal region in man is phylogenetically young, and therefore variable in pattern. It is difficult to make a classification showing a continuity of its members

Table V—Sulcus Occipitalis Transversus

Clearly defined	Buried under occipital operculum	Outer arm lying under lunate operculum	Inner arm confluent with medial operculum or with medial sulci	Outer arm confused with sulci lying in the lateral occipital region	Separate from the pars occipitalis	Difficult or impossible to define clearly
S.11.L.	Q.1905.R.	S.2.R.	S.6.L.	S.1.R.	Q.1487.R.	S.5.R.
S.1.L.	Q.1487.R.	S.3.R.	S.10.R.	S.4.R.		S.5.L.
S.2.L.	C.2.R.	Q.2640.R.	S.11.R.	S.8.R.		
S.3.L.		C.2.L.	S.13.L.	S.4.L.		
S.7.L.		R.C.S. 703.5.L.	S.12.R.	S.10.L.		
S.7.R.			S.13.R.	S.12.L.		
S.8.L.			C.3.L.	S.6.R.		
S.9.R.			C.3.R.	Q.2640.L.		
Q.2788.L.			A.954.L.	C.4.R.		
Q.1487.L.			R.C.S. 703.5.R.	Henry Bob.L.		
Q.1905.L.						
Q.2788.R.						
C.4.L.						
A.954.R.						
4.R. 10.L.	3.R.	3.R. 2.L.	6.R. 4.L.	5.R. 5.L.	1.R.	1.R. 1.L.

Table VI—Classification of Sulcus Paroccipitalis

Australian hemispheres (44)

Groups	1		2		3		4		5	
	R.	L.	R.	L.	R.	L.	R.	L.	R.	L.
Sydney . .	1	1	1	0	6	4	3	2	2	6
Queensland	0	0	1	0	1	0	2	2	0	2
Cambridge .	0	0	0	0	3	0	0	2	0	1
Amsterdam .	0	0	0	0	0	0	0	0	1	1
R.C.S. . . .	0	0	0	0	1	0	0	0	0	1
Totals	1	1	2	0	11	4	5	6	3	11
% . . .	2·3	2·3	4·5	0	25	9	11·5	13	7	25
Southern Chinese 100 . . .	0	0	0	0	32	15	11	19	7	16

Table VII—Relative Frequency of the Confluence of the Pars Occipitalis with the Pars Horizontalis

	Continuous			Separated		
Australian (44)	8.R.	17.L.	(57%)	14.R.	5.L.	(43%)
Cunningham; European (77).	49		(63·7%)	28		(36·3%)
Chinese (100)	18.R.	35.L.	(53%)	32.R.	15.L.	(47%)

in a phylogenetic series similar to that used for the occipital region. Furthermore, the varying extent of the area of the striate cortex on the lateral surface must produce a marked difference in pattern. Any attempt to produce a classification by dealing with the different elements of the sulcus intraparietalis separately would be cumbersome, and so there remains CUNNINGHAM's classification into five types determined solely by the confluence or separation of the different sulci entering into its composition. Before grouping the Australian hemispheres in accordance with this classification it is desirable to describe Q.1487.L. and Q.2788.R. to form a standard for naming the sulci.

Q.1487.L. (Plate 29)—This hemisphere belongs to CUNNINGHAM's *Variety* 4 in having all the parts of the sulcus intraparietalis confluent. The whole sulcus, including the sulcus paroccipitalis, is arranged in the form of three arcades. This arrangement is a common one, and the gyri related to the arcades have been named the supramarginal, angular, and postparietal gyri ; care must be taken, however, not too readily to assume that they are necessarily homologous in different brains.

The first intraparietal or supramarginal arcade is formed anteriorly by the sulcus postcentralis inferior and posteriorly by a sulcus which INGALLS has named the sulcus intermedius primus. INGALLS places the sulcus intermedius primus between areas 39 and 40 of BRODMANN. The supramarginal arcade in its conventional form has within its concavity two sulci : firstly, the ascending limb of the fissure of Sylvius and, secondly, the anterior ascending branch (24) of the parallel sulcus. The variability of the ascending limb of the fissure of Sylvius has already been dealt with. It is probable that the detached sulcus within the arcade in Q.1487.L. corresponds with the ascending limb of the fissure of Sylvius in other hemispheres. The ascending limb of the parallel sulcus turns forwards over the upper end of the fissure of Sylvius in the Gorilla. An examination of a large number of Chinese brains has led me to the conclusion that this branch, which I have named superior parallel (24), becomes separated off in the human brain and lies as a detached sulcus in the supramarginal gyrus. It is probable that the obliquely placed sulcus attached to the lower end of sulcus intermedius primus in Q.1487.L. is the remains of the superior parallel sulcus—the ascending 1 of KAPPERS.

The second intraparietal or angular arcade is formed by the sulcus intermedius primus, the pars horizontalis, and the lower arm of the sulcus parietalis transversus. INGALLS names the posterior limb separating the angular and postparietal lobules the sulcus intermedius secundus. The angular arcade defines the angular gyrus and frequently contains an axial folding—the angular sulcus. JEFFERSON (1913), in writing on the parietal lobe, confused the angular sulcus with the anterior occipital sulcus, but I fail to understand his statement that ELLIOT SMITH regarded the two sulci as identical. There is no doubt that the angular sulcus is often difficult to define, but when it is present it is clearly a different sulcus from the anterior occipital, which bounds the praeoccipital cortex. In the latest editions of

CUNNINGHAM's " Text-book of Anatomy " ELLIOT SMITH describes the angular sulcus as a new compensatory sulcus in the inferior parietal lobule.

The third intraparietal or postparietal arcade has already been described. It is formed by the lower concavity of the H of the sulcus paroccipitalis. It is occupied by the sulcus occipitalis anterior.

In Q.1487.L. the parallel sulcus is continued into the upper element of the sulcus occipitalis anterior. The lower element is quite separate and is confluent with a parieto-temporal sulcus.

The superior postcentral sulcus is confluent with the sulcus postcentralis inferior and passes upwards as far as the medial border of the hemisphere lying parallel with the sulcus centralis. The posterior part of the sulcus postcentralis is separated off, and lies in the superior parietal lobule. It therefore constitutes the superior parietal sulcus, and has lying within its concavity the posterior end of the sulcus calloso-marginalis.

Q.2788.R. (Plate 30)—Here again there are three well-marked arcades. The first arcade arches over the upper end of the ascending branch of the fissure of Sylvius and this is the only axial sulcus within the arcade. The posterior boundary of the arcade is formed by a branched sulcus intermedius primus, which is deeply folded and may include the superior parallel sulcus.

The second arcade is very typically arranged, being a very definite arcade surrounding the angular gyrus and being intersected by the sulcus angularis. The posterior boundary of the arcade is formed by a sulcus continuous with the pars horizontalis (16*h*) above and with the parallel sulcus below. This is not the lower arm of the sulcus parietalis transversus as in Q.1487.L., for that sulcus is very clearly defined posterior to it and separated from it by a gyrus which is supplied by the posterior parietal artery in common with the arcus postparietalis.

The upper end of the sulcus postcentralis superior (15*s*) is branched and the posterior end of the sulcus calloso-marginalis lies between the branches.

This hemisphere also belongs to variety 4 of CUNNINGHAM.

GROUP 1

Variety 1 of CUNNINGHAM. *All the parts of the sulcus intraparietalis are separate.*

There are five hemispheres in this group :—S.5.L., S.8.R., S.13.L., S.13.R., and C.3.L.

The arrangement of the sulci of the inferior parietal lobule in S.5.L. is very irregular. Immediately posterior to the sulcus centralis there are three separate sulci to represent the postcentral sulci. The most inferior is a deep T-shaped sulcus which cuts deeply into the fissure of Sylvius. This sulcus is the sulcus postcentralis transversus (15*t*) of EBERSTALLER. The intermediate sulcus is small and probably represents the inferior postcentral sulcus (15*i*). The superior sulcus is clearly the sulcus postcentralis superior (15*s*); bifurcated at its upper extremity.

Immediately behind these three sulci there is a long, deep, obliquely placed sulcus passing from a point one centimetre anterior to the ascending terminal limb of the fissure of Sylvius to the middle of the superior parietal lobule. FLASHMAN named this sulcus the sulcus postcentralis inferior. Whilst inferiorly it bears a close resemblance to that sulcus, its upper end is undoubtedly the superior parietal sulcus. In many of the Australian cerebra vertical foldings occur immediately posterior to the postcentral sulci (*see* S.13.R., S.1.R., S.5.R., S.6.R., C.2.R., S.8.R., S.9.R., Q.2788.R., Q.1487.R., Q.1905.R., S.1.L., Q.2640.L.). In some cases they appear to correspond with the first ascending branch of the parallel sulcus, in others they seem to be more closely related to the postcentral sulci. The pars horizontalis (16*h*) is probably represented by the branched sulcus confluent with the second ascending branch (25) of the parallel sulcus. This sulcus is separated from the terminal bifurcation by a deep gyrus. FLASHMAN depicts the pars horizontalis as being entirely separate from the second ascending branch, or angular sulcus. The parallel sulcus ends behind the posterior end of the fissure of Sylvius in the anterior wall of the complex and vertical sulcus seen in the figure. Between this vertical sulcus and the posterior end of the fissure of Sylvius a separate sulcus lies within the supramarginal gyrus which corresponds with the sulcus which I have named superior parallel (24).

S.13.L. (Plate 27)—The sulci in this hemisphere are in many respects similar to those in S.5.L. There are three sulci immediately posterior to the sulcus centralis. The inferior one is a combined sulcus postcentralis inferior (15*i*) and postcentralis transversus. The superior sulcus is a definite sulcus postcentralis superior (15*s*). Between the two postcentral sulci a horizontal sulcus is insinuated. This sulcus is the pars horizontalis (16*h*). The great length of the pars occipitalis in this hemisphere suggests that this sulcus is confluent with the superior parietal sulcus. The superior branches of the parallel sulcus are the first ascending branch (24), wh ch lies separate in the supramarginal gyrus, the angular sulcus (25), and the upper part of the anterior occipital sulcus (26) or second and third ascending branches of the parallel. The hemisphere is remarkable in showing the small extent of the folding of the cortex of the inferior parietal lobule indicated by the fact that there are no sulci passing downward from the sulcus intraparietalis and marking off the three parietal arcades.

S.13.R. (Plate 27)—In this hemisphere the ascending terminal limb of the fissure of Sylvius is close to the lower end of the sulcus centralis. The sulcus postcentralis inferior (15*i*) arches over the ascending terminal limb and is separate from the sulcus postcentralis superior (15*s*). Between these two sulci a small detached sulcus lies immediately posterior to the middle of the sulcus centralis.

The sulcus postcentralis superior ends superiorly by bifurcating into two terminal limbs. Inferiorly it is continuous with a sulcus which passes almost to the parallel sulcus. The lower third of this sulcus is separated from the upper two-thirds by a submerged gyrus. The lower third corresponds topographically with the posterior limbs of the fissure of Sylvius in the left hemispheres; it would also appear to be homologous with the superior parallel sulcus. The middle third of the vertical sulcus extending downwards from the superior postcentral sulcus corresponds topographically with the sulcus intermedius primus of INGALLS separating the supramarginal and angular gyri. The upper third is a typical sulcus postcentralis superior. The angular gyrus becomes defined, then, by the sulcus intermedius primus anteriorly and the lower limb of sulcus parietalis transversus (sulcus intermedius secundus) posteriorly. The angular gyrus is intersected by the angular sulcus, which is here superficially confluent with the parallel sulcus.

The postparietal arcade and the sulcus occipitalis anterior are well defined.

S.8.R. (Plate 22)—In this hemisphere there is an arcade over the ascending terminal limb of the fissure of Sylvius which at first sight appears to be the first intraparietal or supramarginal arcade. It is certainly difficult to interpret the posterior limb of the arcade. It has the topographical features of the posterior end of the fissure of Sylvius, of the superior parallel sulcus, and in some respects of the sulcus intermedius primus. It reveals the difficulty of giving exact homology to the sulci in the absence of histological evidence.

The sulcus postcentralis superior is normally placed and branched superiorly.

The pars horizontalis is represented by a separate sulcus lying vertically between the postcentral region and the sulcus parietalis transversus.

The sulcus paroccipitalis is separate and clearly defined. The peculiar arrangement of the sulcus which lies behind the ascending terminal limb of the fissure of Sylvius makes it a question whether this hemisphere should be regarded as belonging to CUNNINGHAM's group 3, in which the postcentral sulci are confluent and the pars horizontalis separate.

C.3.L. (Plate 33)—The sulcus postcentralis superior is branched superiorly and is separate. There are apparently two inferior postcentral sulci, but it is probable that the posterior sulcus is the superior parallel sulcus because in this hemisphere the posterior end of the fissure of Sylvius is situated well posteriorly. The pars horizontalis is separate from the postcentral sulci and confluent behind with the pars occipitalis.

GROUP 2

" CUNNINGHAM's variety 2. *Ramus horizontalis confluent with the sulcus postcentralis inferior, sulcus postcentralis superior separate.*"

This variety occurs in four hemispheres (S.2.L., S.10.L., C.2.L., and R.C.S. 703.5.L.). The hemispheres are very similar in appearance. The sulcus postcentralis superior (15*s*) is separated from the remainder of the sulcus intraparietalis by a slightly submerged gyrus. In S.2.L. and S.10.L. the sulcus postcentralis superior is Y-shaped, and between the arms of the Y the upper end of the sulcus calloso-marginalis is found. The sulcus postcentralis inferior (15*i*) passes uninterruptedly into the pars horizontalis and in both cases this is continuous with the pars occipitalis forming a long arcade extending from the inferior postcentral region to the sulcus occipitalis transversus. In S.2.L. the sulcus intermedius primus (here also the superior parallel sulcus) lies posterior to the bifurcation of the fissure of Sylvius and forms the posterior boundary of the supramarginal gyrus. In the same brain the sulcus intermedius primus is superficially confluent with the pars horizontalis, whereas in S.10.L. it is a separate sulcus. In S.2.L. there is no definite demarcation between the angular and postparietal arcades. In S.10.L. these arcades are definitely separated by the lower arm of the sulcus parietalis transversus. The sulcus occipitalis anterior is a curved sulcus extending across the hemisphere in both cases. The angular and supramarginal sulci are represented in both hemispheres by detached sulci. Again in both hemispheres the parallel sulcus is continued into the upper element of the sulcus occipitalis anterior (26). Not only, therefore, are these two hemispheres linked together by belonging to CUNNINGHAM's variety 2 but they are also very similar in general appearance.

R.C.S.703.5.L. (Plate 35) is essentially similar to S.2.L. and S.10.L. The superior postcentral sulcus is somewhat longer and more branched.

In *C.2.L.* (Plate 32) the point of junction of the sulcus postcentralis inferior with the pars horizontalis is complicated, and it would suggest that some part of the sulcus postcentralis superior is included. The sulcus postcentralis superior is a simple sulcus running parallel with the sulcus centralis. It is not branched superiorly, and posterior to it is a superior parietal sulcus which appears to be homologous with the posterior branch of the superior postcentral sulcus when this sulcus is bifurcated.

GROUP 3

CUNNINGHAM's variety 3. *Postcentral sulci confluent, ramus horizontalis separate.*

Thirteen hemispheres belong to this group (S.1.L., S.1.R., S.2.R., S.3.R., S.4.R., S.6.R., S.7.R., S.7.L., S.8.L., S.9.R., S.12.L., A.954.R., and Q.1487.R.).

For convenience of description S.4.R., S.8.L., S.1.R., S.1.L., and A.954.R. may be described together.

The postcentral sulci form a continuous sulcus lying parallel with the sulcus centralis, and are separated from any other sulci except in S.1.R., where the postcentral sulci are superficially confluent at about the midpoint with a sulcus having characters of resemblance with both the sulcus intermedius primus and the superior parallel sulcus.

The ramus horizontalis is represented by a four-rayed sulcus, the upper one or two rays of which represent in part the sulcus parietalis superior. In S.4.R. and S.8.L. the four-rayed sulcus is separate from the pars occipitalis. In S.1.R., S.1.L., and A.954.R. it is confluent with the latter.

In S.6.R., S.9.R., and Q.1487.R. the postcentral sulci lie parallel with the sulcus centralis. The ramus horizontalis forms a long vertical sulcus parallel with the sulci postcentralis and is clearly formed by the fusion of various sulci. In all three the superior parietal sulcus enters into the composition of this vertical sulcus. In S.9.R. the vertical sulcus is confluent with a posteriorly directed arm which comes to lie between the sulci angularis and occipitalis anterior. In S.6.R. the vertical sulcus is confluent with a supramarginal sulcus. The general arrangement of the sulci is well shown in the figures.

In S.3.R. the supramarginal gyrus is occupied by two concentric arcades looping over the upper end of the ascending branch of the fissure of Sylvius. In the remaining four hemispheres (S.2.R., S.7.L., S.7.R., and S.12.L.) the ramus horizontalis is clearly defined and in all except S.12.L. it is confluent with the pars occipitalis.

Group 4

Cunningham's variety 4. *All parts confluent.*

There are eighteen hemispheres belonging to this group :—S.3.L., S.4.L., S.6.L., S.10.R., S.11.R., S.11.L., S.12.R., Q.1905.L., Q.1487.L., Q.2640.L., Q.2640.R., Q.2788.L., Q.2788.R., C.4.L., C.4.R., A.954.L., C.3.R., and R.C.S.703.5.R.

The general features of the group have already been described with Q.1487.L. and Q.2788.R. in the introduction to this section. The remaining hemispheres are shown in their figures and require no special mention.

Group 5

Cunningham's variety 5. *Ramus horizontalis apparently joined to the lower end of the upper part of the postcentral sulcus ; lower part of the postcentral sulcus separate.*

Three hemispheres belong to this group (S.5.R., C.2.R., and Q.1905.R.).

In the three specimens the width of the gyrus between the lower end of the sulcus centralis and the ascending terminal limb of the fissure of Sylvius is contracted. Within the interval there is a detached sulcus which is taken as the sulcus postcentralis inferior. In all cases the sulcus postcentralis superior is clearly defined on a plane posterior to the sulcus postcentralis inferior. It is confluent below with an arching sulcus which lies posterior to the plane of the ascending limb of the fissure of Sylvius. We have already seen how this sulcus, in the absence of histological evidence for definite identification, may be looked upon as the sulcus intermedius primus of Ingalls, the termination bifurcation of the fissure of Sylvius in cases where the fissure is more fully folded, or even the superior parallel sulcus. It will therefore suffice to say that the sulcus postcentralis superior is confluent with a sulcus which lies in the posterior part of the supramarginal gyrus.

In Q.1905.R. (Plate 28) the ramus horizontalis, confluent with both the superior parietal sulcus and the pars occipitalis, is readily identified. In S.5.R., as has already been stated, the form of the pars occipitalis is so confused that the limits of the ramus horizontalis and the sulcus parietalis transversus are not easy to define.

The grouping of the intraparietal sulcus is summarized in Table VIII, and is compared with CUNNINGHAM's grouping for the European and the Negro, and with my own for the Southern Chinese.*

These comparative tables are put in because CUNNINGHAM's grouping has been previously used as a basis for comparison. My own feeling is that the mere fact of confluence or separation of sulci does not give sufficient information to warrant the tables being taken too seriously. Moreover, in comparing brains which belong to the same grouping in the Chinese and the Australian, I find that they look dissimilar in many cases and from their general appearance are more similar to brains in other groups. Having pointed out, however, the differences at the posterior end of the fissure of Sylvius, having drawn the brains carefully, and having described the salient features of the hemispheres, it is hoped that the above account may be of use in comparing this very interesting series of parietal regions with those of other races.

TABLE VIII—CUNNINGHAM'S CLASSIFICATION OF THE SULCUS INTRAPARIETALIS

Australian Hemispheres (44)

Group	1		2		3		4		5	
	R	L	R	L	R	L	R	L	R	L
Sydney . .	2	2	0	3	7	4	3	4	1	0
Queensland	0	0	0	0	1	0	2	4	1	0
Cambridge .	0	1	0	1	0	0	2	1	1	0
Amsterdam .	0	0	0	0	1	0	0	1	0	0
R.C.S. . . .	0	0	0	1	0	0	1	0	0	0
Totals .	2	3	0	5	9	4	8	10	3	0
% . . .	4·5	7	0	11·3	21	9	18	23	7	0
	11·5		11·3		30		41		7	
Cunningham European (63)	6·3		19·1		11·1		60·3		1	
Cunningham Negro (8)	12·5		25		25		37·5		0	
Southern Chinese (100)	7	2	8	20	17	10	17	18	1	0
	9		28		27		35		1	

The Parallel Sulcus and its Associated Branches

The occipital region in this series of Australian cerebra seems to reveal a very definite evolutionary sequence. Whilst we are yet hardly in a position to discuss racial difference with any degree of certainty, the idea is suggested that individual features, being static in nature, are of little avail ; that tendencies in the general movements of evolutionary changes hold the clues to the solutions of the problems of cerebral evolution which are determined by time factors and are therefore dynamic in character. There appears to be a definite movement running through the series of the forty-four hemispheres in the inferior parietal region. The hemispheres can almost be arranged in a regular sequence ; and, further, this sequence follows on a similar sequence seen running from the Cercopithecidae to the higher Apes. It is desirable, therefore, to treat the description of the parallel sulcus and its derivatives as a continuous series and not to attempt a classification into groups ; at least until the main general description is completed.

I have dealt with the evolution of the parallel sulcus in a previous communication (1927, *b*). In her paper on the brain of the Chinese, Mrs. A. J. VAN BORK-FELTKAMP (1930) confirmed the interpretations outlined in my paper on the evolution of the parallel sulcus. The Australian cerebra almost diagrammatically illustrate the sequence of changes ; but before proceeding to their description it is necessary to review briefly the preliminary changes in lower forms which have led up to the condition seen in the human brain. I shall refer to figures in well-recognized works to avoid the addition of figures in this communication.

In the Cercopithecidae (BRODMANN, 1909, fig. 90) the upper end of the parallel sulcus lies in the angle formed by the sulcus intraparietalis and the " Affenspalte ". It separates areas 7 and 19. From its cortical relations, as INGALLS and JEFFERSON have pointed out, the sulcus intraparietalis, so far as it is visible on the surface, cannot be homologized with the pars horizontalis of human anatomy ; it is more probably only representative of the sulcus postcentralis inferior. In the human brain, below the sulcus intraparietalis, the whole of the new areas of the inferior parietal lobule have become interposed between the areas 7 and 19 ; and so, for the purposes of homology, all the sulci within these new areas must be regarded as new sulci, and can only be homologous with the parallel sulcus of the Cercopithecidae if these new areas are evolved from the cortex in which the parallel sulcus of the Cercopithecidae is lying. If cortical relations are to be regarded as final criteria for homology, they must be looked upon as new sulci. The evidence, on the other hand, suggests that the sulci of the inferior parietal lobule are derivatives of the upper end of the parallel sulcus. I have, therefore, spoken of these sulci as the associated branches of the parallel sulcus ; but with the distinct reservation that homology is not verified by cortical relations. I must emphasize, however, that I regard cortical relations as of paramount importance, and that the overlooking of this important criterion is solely for the convenience of description and as the necessary introduction to further investigation.

In the Gibbon (ELLIOT SMITH, 1902, fig. 244) the parallel sulcus has become separated from the fissure of Sylvius by a definite gyrus, its upper end is bent forward over the posterior end of the fissure of Sylvius, and is directed towards the angle formed by the sulcus postcentralis inferior and the pars horizontalis, the intraparietal arcade has lengthened ; and, finally, at the point where the upper end of the parallel sulcus begins to enter the inferior parietal lobule, there is a short descending branch directed downwards and backwards. In many Gibbon brains which I have examined the sulcus praelunatus is directed towards the angle formed by the parallel sulcus and its descending branch. This descending branch is the lower element of the sulcus occipitalis anterior and forms the anterior limiting boundary of area 19 at this point.

The Chimpanzee is subject to a considerable range of variability in the inferior parietal region. For the purpose of discussion, however, fig. 48 from CUNNINGHAM (1898) and fig. 11 from MINGAZZINI (1928) are referred to. The parallel sulcus forms a sharp bend around the posterior end of the fissure of Sylvius, and again its upper end is directed towards the angle formed by the sulcus postcentralis inferior and the pars horizontalis sulci intraparietalis. This anteriorly directed upper end of the parallel sulcus has been named by me the superior parallel sulcus; it is the ascendens I of KAPPERS. That part of the parallel sulcus which is placed between the areas 21 and 22 of BRODMANN I have named the inferior parallel sulcus. Turning to the figures referred to, there is seen lying tangentially to the sharp bend of the parallel sulcus a sulcus which lies parallel with the sulcus lunatus. The lower half of this sulcus is the lower element of the sulcus occipitalis anterior. Although these two elements are in reality one sulcus, it is convenient to refer to them as two elements because they are frequently separate in the human brain. The sulcus occipitalis anterior (26) is definitely derived from the parallel sulcus. I have examined specimens where this sulcus has been hidden on the posterior wall of the parallel sulcus with neither end projecting. The sulcus occipitalis anterior forms the anterior boundary of the praeoccipital cortex—area 19 of BRODMANN. The sulcus praelunatus is directed towards the sharp bend of the parallel sulcus. In dealing with the brain of the Bushwoman (1933) I have referred to this bend as a dynamic centre in the inferior parietal region. The upper element of the sulcus occipitalis anterior is the ascendens III of KAPPERS. The presence of the upper part of the sulcus occipitalis anterior shows the upper end of the parallel sulcus as a bifurcated sulcus with a triangular gyrus between the two branches. Occasionally in the Chimpanzee and in the Orang a small compensatory sulcus is found within this triangular gyrus. This is the sulcus angularis—the ascendens II of KAPPERS. It is more frequently found in the Gorilla.

The next change in the evolution of the parietal region may be occasionally seen in the Orang and Gorilla. The sulcus occipitalis anterior becomes further extruded in such a way that the dynamic centre of the inferior parietal lobule is placed at the central point of an X; the two posterior arms of the X being the sulcus occipitalis anterior. Such is the condition seen in some of the Australian cerebra, and from this point the further changes in the parietal region can be traced.

In *A.954.L.* (Plate 36) the sulcus lunatus is divided into a pars dorsalis and a pars ventralis, the sulcus praelunatus is the direct continuation of the pars dorsalis, and it is directed to the X-shaped branching of the parallel sulcus. The two posterior limbs of the X constitute the sulcus occipitalis anterior (26), which forms an arcade probably limiting the praeoccipital cortex. The antero-superior limb of the X—the superior parallel sulcus (24)—has become mainly separated from its short stem and is anteriorly directed to the angle between the sulcus postcentralis inferior and the pars horizontalis sulci intraparietalis. Above the parallel sulcus, and lying between the superior parallel and anterior occipital sulci, are small compensatory sulci representing the sulcus angularis. There is a well-marked sulcus of the praeoccipital notch confluent with the inferior occipital sulcus.

The appearance of this specimen—an appearance also seen in many others—suggests that at this stage the sulci lying immediately anterior to the sulcus lunatus are relatively stable and that the main expansions have taken place in the supramarginal gyrus.

I have not previously encountered a human specimen where the X-shaped form is as clear as it is in A.954.L. In the next stage the sulcus occipitalis anterior becomes completely extruded and is connected with the parallel sulcus by a short connecting piece which I have named the sulcus annectans. The postparietal arcade contains not only the upper end of the sulcus occipitalis anterior but also detached sulci which may be considered as parts of that sulcus. The angular sulcus (25) must be distinguished from the superior parallel sulcus. In this brain the form of the intraparietal arcades leaves little doubt that the sulcus is correctly called angular and it is here separate from the parallel sulcus. The superior parallel sulcus is a sulcus within the supramarginal gyrus and the sulci related with the ascending limb of the fissure of Sylvius in this hemisphere are regarded as being superior parallel in nature. The question of this interpretation will be more fully discussed with the other specimens.

In S.13.L. the inferior parallel sulcus is separated from the posterior group of sulci by a submerged gyrus. It is common to find this breaking of the parallel sulcus at the point where the sulcus ceases to act as the boundary between areas 21 and 22 of Brodmann. The anterior occipital sulcus has the angulated appearance noted in the previous specimens, and its inferior element has become separated off and become confluent with the sulcus of the preoccipital notch. The sulcus angularis (25) is confluent with the upper element of the anterior occipital sulcus. The sulcus parallelus superioris (24) is the branched sulcus which is directed forwards towards the angle between the sulcus postcentralis inferior and the pars horizontalis. Comparing this specimen with C.2.L., it is apparent that it is in the supramarginal gyrus that the difficulties of interpretation are most apparent. In fact, in identifying the sulci in this region by means of numbers, it is to be pointed out that these numbers cannot bear the same implications in each brain. The difficulties of homology are of the same order as those found in identifying such sulci as the sulcus paramedialis.

In S.13.R. in which the distance between the lower end of the sulcus centralis and the posterior end of the fissure of Sylvius is short, the complicated nature of the sulci of the supramarginal region is accentuated and further confirmation is added to the opinion that it is in the supramarginal region of the Australian that the first expansions of the inferior parietal lobule take place. For in this hemisphere the sulci occipitalis anterior and angularis are readily identified both by their topographical positions and by their form ; but in the supramarginal region the sulci bear a pattern which I have not seen in the brain of the anthropoid apes. A long vertical sulcus extends from the superior postcentral sulcus almost to the parallel sulcus. The upper part of this long vertical sulcus is definitely the sulcus postcentralis superior ; the middle section might with equal right be identified as the sulcus intermedius primus of Ingalls, the ascending terminal limb of the fissure of Sylvius, or as the superior parallel sulcus. The lower third, which is separated from the middle third by a submerged gyrus, might be either the superior parallel sulcus or the ascending terminal limb of the fissure of Sylvius. It appears preferable to leave the interpretation undefined rather than to appear exact by insisting upon precise identification in each case.

The vertical furrow connecting the sulcus postcentralis superior with sulci of the supramarginal gyrus lying posterior to the posterior end of the fissure of Sylvius, as seen in S.13.R., occurs in nine other hemispheres, eight of which are on the right side (C.2.R., S.1.R., Q.2788.R., Q.1905.R., Q.1487.R., S.6.R., Q.2640.L., S.5.R., and S.8.R.). In the majority of these cases the width of the inferior postcentral gyrus is reduced.

In S.1.R. the cortex of the temporal lobe has been destroyed, but sufficient remains to establish the fact that the inferior parallel sulcus is closely connected with the long vertical sulcus passing up to the sulcus postcentralis superior. Posterior to this, the pattern of the sulci of the inferior parietal lobule is H-shaped. The sulcus occipitalis anterior forms a complete arcade parallel with the sulcus lunatus. The three ascending branches of the parallel sulcus into the inferior parietal lobule are here clearly seen and identified by their relations with the arcades of the sulcus intraparietalis.

The conception of the three arcades of the intraparietal sulcus and of the three ascending branches is admittedly somewhat diagrammatic, but it has come into being by a study of the phylogenetic sequence. With the diagram as a background all the remaining hemispheres are to a great extent capable of being interpreted.

In R.C.S.703.5.R., C.3.R., Q.2788.R., Q.1905.R., Q.1487.R., and S.9.R. the anterior occipital and angular sulci are clearly defined, and the superior parallel sulcus is represented by fragmentary sulci within the supramarginal lobule. There is one feature of interest to comment on in passing as it often forms an important landmark. In Q.1905.R. the sulcus occipitalis anterior is separate. The sulcus annectans has been divided, as it were, longitudinally. This method of splitting is fairly common in the human brain and it occurs along the line of the visuo-auditory band of Elliot Smith. It is of interest to note in these brains how the expansions appear to be taking place on either side of this band which is the locus of the dynamic centre of the parietal lobe already referred to. It is not within the province of this paper to enter into the functional significance of this interesting morphological fact.

The hemispheres so far considered have been mainly on the right side. On the left side, where the fissure of Sylvius extends further backwards into the parietal region, the pattern of the sulci, although according with the general plan, is somewhat different. There are fourteen hemispheres, two of which are on the right side, which are all essentially similar (C.3.L., S.10.L., S.6.L., S.8.L., S.2.L., S.11.L., S.11.R., S.3.L., Q.1905.L., Q.1487.L., Q.2640.L., Q.2640.R., R.C.S.703.5.L., and S.12.L.). It is unnecessary to describe each of these in detail. The description of C.3.L. will suffice to show the salient features and from this description a reference to the figures of the other hemispheres will show the types of variation in the connexions of the ascending branches.

In C.3.L. the parallel sulcus extends backwards to end in the upper element of the sulcus occipitalis anterior. The parallel sulcus is remarkably free from branching in its course. At the point where the upper element of the sulcus occipitalis anterior arises there is a posteriorly directed branch which comes to lie above and parallel with the sulcus praelunatus. This branch is not the lower element of the sulcus occipitalis anterior; it is an axial folding which is sometimes spoken of as a reduplication of the sulcus praelunatus. It is a relatively common appearance in the brain of the Chinese, where sometimes the sulcus praelunatus and this branch coalesce in such a way that the sulcus parallelus runs into the occipital lobe. In the Australian series this condition is seen in R.C.S.703.5.R., Q.2788.R., S.13.R., and S.3.L. In C.3.L. the angular sulcus is separate from the parallel sulcus but occupies a normal position in relation with the angular arcade. The superior parallel sulcus lies in the supramarginal gyrus and has become separated from the parallel sulcus by the backward extension of the fissure of Sylvius. Comparing the condition with S.10.L., it is seen that the superior parallel sulcus lies behind the termination of the fissure of Sylvius. The limitation of the use of names to identify sulci is apparent, as is also the difficulty of instituting exact homology in this experimental region of human cerebral evolution.

The remaining hemispheres do not require separate description. They have been referred to in the sections dealing with the occipital region, with the posterior end of the fissure of Sylvius and with the intraparietal sulcus. In studying the parallel sulcus from the figures of this paper the reader is referred to a paper by Kappers and Wang Hwei-wen (1924) and to a paper by Shellshear (1927 *b*).

The Medial Surface of the Frontal and Parietal Lobes

Genna, in his description of the brains of the natives of the Cameroons, gives an excellent and comprehensive account of the general morphology of these regions and has given a complete review of the literature. It is therefore not necessary to deal with the morphology in any detail except so far as it concerns the material under consideration.

The sulci under consideration are the sulcus cinguli, the rostral sulci, and the sulci of the praecuneus. It is possible from the works of Brodmann and Elliot Smith to reconstruct what might be regarded as a standard pattern for comparative purposes, but in actual specimens it is not always possible to differentiate certain of the sulci from one another.

Eberstaller divided the sulcus cinguli into three parts—anterior, middle, and posterior—from which he derived a classification which has been used by Retzius and others. From the microscopic and macroscopic investigations of Brodmann and Elliot Smith it is clear that the three parts of the sulcus cinguli are morphologically and genetically distinct sulci. The anterior part of the sulcus cinguli commences under the genu of the corpus callosum and, passing concentrically round the genu, ends at about the level of the anterior commissure. It forms the boundary between the callosal areas C and D and the area frontalis D of Elliot Smith, the areas 24 and 32 of Brodmann. The sulcus rostralis lies below the anterior part where it lies under the genu ; it is horizontally disposed, and separates areas praefrontalis and praefrontalis B of Elliot Smith, areas 10 and 11 of Brodmann. In some cases there is a sulcus within the area praefrontalis, below the sulcus rostralis, known as the sulcus subrostralis. It is not always possible to differentiate between the lower end of the anterior part of the sulcus cinguli and the sulcus rostralis ; in fact, the sulcus cinguli sometimes passes well backwards on the medial part of the frontal lobe so as to include the sulcus rostralis (compare S.12.L. and S.5.L.). Genna (1924) in his plates 3 and 4, suggests the same thing by labelling the lower end of the anterior part of the sulcus cinguli " csf (ros) ".

The middle part of the sulcus cinguli is variable in length and appears to be merely a compensatory folding between the area callosus B and the area frontalis superior of Elliot Smith, the areas 6 and 24 of Brodmann.

The posterior part of the sulcus cinguli is a definite paracentral sulcus limiting the area of the paracentral lobule. It forms an arcade whose anterior vertical limb is often a separate sulcus named the sulcus parapraecentralis ; the posterior vertical limb passes almost to the medial border immediately posterior to the sulcus centralis.

The sulcus paracingularis of Elliot Smith lies between the sulcus cinguli and the medial border of the hemisphere. Whilst having the appearance of being a duplicated sulcus cinguli, it must be regarded as a distinct morphological entity because it separates the area frontalis D from the other three frontal areas of Elliot Smith, area 32 from areas 8 and 9 of Brodmann. Duplication of the sulcus cinguli in the apes is uncommon ; so that this sulcus would appear to be a distinctly human sulcus. It is present in fourteen of the Australian hemispheres (40%) ; in the Southern Chinese it is present in 61% of cases. In the Chinese the general folding is deeper and more complicated than in the Australian.

The form of the sulcus cinguli is used to classify the medial surface into three groups depending upon the amount of confluence of the three parts. In keeping with the other groupings, the more separated condition is taken first.

Group 1

The anterior, middle, and posterior parts of the sulcus cinguli are separate from one another. The anterior part may be confluent with the rostral sulci or not ; and the posterior part may be confluent with the sulci of the praecuneus.

There are twelve hemispheres in the group (33%) (S.13.L., S.1.R., S.1.L., S.3.L., S.12.R., S.5.L., S.4.L., S.7.L., S.11.L., C.2.L., C.3.R., and H.B.L.).

S.13.L. (Plate 27)—It is not necessary to describe each hemisphere in detail. The salient features of S.13.L. will be described, after which any special features in the other hemispheres will be mentioned. In the infragenual region of S.13.L. there are three horizontal sulci. The uppermost is the anterior part of the sulcus cinguli; it passes concentrically around the genu to end by becoming superficially confluent with the middle part. The second horizontal sulcus is the sulcus rostralis; it is confluent with the sulcus suprarostralis. This connexion of the sulcus rostralis with the sulcus suprarostralis occurs in four cases in the group (S.13.L., S.4.L., C.3.L., and S.11.L.). The third horizontal sulcus is the sulcus subrostralis. The sulcus paracingularis is represented as a shallow sulcus lying parallel with the anterior part of the sulcus cinguli.

The posterior part of the sulcus cinguli is a crescentic sulcus forming the posterior and inferior boundaries of the paracentral lobule. The anterior boundary is formed by a separate sulcus praeparacentralis. Within the paracentral lobule there is a small sulcus paracentralis. This sulcus is named by CAMPBELL the sulcus cruciatus hominis (5).

The sulci praecuneus and subparietalis are separate sulci within the praecuneus. The lower part of the sulcus subparietalis lies parallel with the splenium of the corpus callosum and presumably forms the upper boundary of the area parasplenialis of ELLIOT SMITH.

In S.1.R., S.12.R., and S.4.L. the posterior part of the sulcus cinguli forms the complete boundary of the paracentral lobule, the sulcus praeparacentralis being confluent with the remainder of the posterior part of the sulcus.

In S.3.L. and S.7.L. the sulcus rostralis is confluent with the anterior part of the sulcus cinguli forming a complicated folding of sulci in this region.

In S.3.L., S.11.L., and S.12.R. the anterior part of the sulcus cinguli is continued upwards to become confluent with the sulcus paracingularis.

In S.1.L. and S.11.L. the posterior part of the sulcus cinguli is confluent with the sulci of the praecuneus.

Whilst these variations in types of union between sulci cannot be given very much morphological value, the condition seen in S.5.L. suggests that the separation of the elements may have more value than at first sight appears.

In S.5.L. the broken condition of the sulcus intraparietalis, the full rounded sulcus lunatus, the open arcus intercuneatus, and other features have already been referred to. The appearance of the sulci on the medial surface is in harmony with these features. The three parts of the sulcus cinguli are separate; the posterior part of the same sulci is broken so that the three boundaries of the lobulus paracentralis are formed by separate sulci and, finally, the precuneal region is less folded than in higher types.

Group 2

The sulcus cinguli is in two parts. The anterior part may be confluent with the middle part, or the middle part may be confluent with the posterior part.

There are thirteen hemispheres in the group (36%). In six (S.12.L., S.3.R., S.8.R., S.13.R., R.C.S.703.5.L., and C.4.R.) the anterior part is confluent with the middle part of the sulcus cinguli, and in seven (S.2.L., S.2.R., S.7.L., S.8.L., S.10.R., S.10.L., and C.4.L.) the posterior part of the sulcus cinguli is confluent with the middle part.

With the exception of R.C.S.703.5.L., the specimens in which the anterior part is confluent with the middle part are all very similar. The anterior part commences under the genu of the corpus callosum, and, running concentrically around the genu, ends just anterior to the sulcus praeparacentralis in a branching which represents the middle part. The sulcus rostralis is defined in all except S.12.L. where the anterior part and the sulcus rostralis are apparently fused.

R.C.S.703.5.L. (Plate 35) differs from all the other Australian hemispheres in the greater folding of the sulci of the medial surface. The sulci rostralis and subrostralis are defined. The anterior part of the sulcus cinguli passes well backwards on the hemisphere and is confluent with the sulcus paracingularis. This sulcus is not only well developed but there are also secondary small sulci between it and the dorsal border of the hemisphere.

In all six hemispheres the posterior part of the sulcus cinguli is clearly and diagrammatically defined as a paracentral arcade. The praecuneal sulci call for no comment.

The seven hemispheres in which the middle part of the sulcus cinguli is confluent with the posterior part are sufficiently shown in the figures. It may be mentioned, however, that, although in S.10.L. and C.4.L. the hemispheres have been injured to a considerable extent, the pattern of the sulci seems to be clear.

Group 3

The three parts of the sulcus cinguli are confluent with one another.

There are eleven hemispheres in the group (S.4.R., S.6.R., S.6.L., S.9.R., S.11.R., S.5.R., C.2.R., C.3.L., A.954.R., A.954.L., and R.C.S.703.5.R.).

There is no need to describe these in detail. The most striking feature of the group is the relative simplicity of pattern and the ill-development of the sulcus paracingularis. This simplicity of pattern is strikingly emphasized by contrasting the members of the group with the one exception in R.C.S.703.5.R. In this hemisphere the rostral and subrostral sulci are well developed. The sulcus paracingularis is more extensive and more deeply folded than in any other member of the group. In discussing group 2 it was seen that the left hemisphere of this brain was more complex than the other members.

The classification of the sulcus cinguli is shown in Table IX. Whilst this table expresses the lesser extent of the folding of the medial surface of the brain of the aboriginal Australian in a striking way, it does not express the difference with the other brains compared as vividly as does the comparison of the actual figures of the Australian hemispheres with the figures of the Chinese hemispheres. Throughout this investigation I have had for comparison orthogonal drawings of one hundred Chinese hemispheres taken from every aspect. In the Australian the sulcus cinguli is in many cases a very simple sulcus lacking the radiating branches which extend towards the medial border of the hemisphere. In the Chinese these radiating branches are well marked and, furthermore, there is much more indication of duplication of the cingular sulcus producing deep and well marked paracingular sulci. The comparison then of the group 3 type in which the three parts are confluent, showing 61% in the Chinese and only 31% in the Australian, fails to express adequately how different the brain of the Australian is in this region. In other words, the percentage tables fail to give expression to the extent of the folding apart from the question of the separation of the parts of the sulcus.

Whilst percentage figures are admittedly inadequate to express morphological differences, it is arresting to find such differences in the medial surface of the frontal region in a series where the medial surface of the parietal and occipital regions shows so many primitive features.

TABLE IX—CLASSIFICATION OF THE SULCUS CINGULI

Group		1			2			3	
	R	%	L	R	%	L	R	%	L
Australian (36) . . .	4	33	8	6	36	7	8	31	3
European Retzius (100)		14			44			41	
Chinese (100)	8	15	7	11	24	13	31	61	30

The Frontal Lobe

The description of the frontal lobe involves, in the first place, a discussion on the general form and cranio-cerebral relations, and, secondly, a discussion on the sulcal pattern.

The importance of a correct appreciation of the general form and relations of the brain to the skull is exemplified in the amount of information which has been gleaned from the endocranial casts of fossil Man. No description of the brain of any race can be regarded as adequate without reference to the endocranial casts and general brain form of that race. Unfortunately, the amount of distortion of the hemispheres under consideration is so great that any conclusions derived from their form can only be accepted with the greatest reserve. Nevertheless, the comparison of these hemispheres with certain endocranial casts of the Australian which I have had the opportunity of examining, and the comparison of the form of the brain of MARSHALL's Bushwoman taken from photographs and published elsewhere, point to certain features which will be briefly mentioned subject to revision if more suitably fixed material comes to hand. I hope, moreover, to collect a number of Australian endocranial casts in order to supplement this description at a future date.

Exposure of the Orbital Surface of the Frontal Lobe

In Q.1487 and Q.1905, in which the fixation is quite good, the anterior end of the temporal pole does not extend more anteriorly than the level of the stem of the anterior limbs of the fissure of Sylvius. The tip of the temporal pole is turned somewhat inwards and is less bulky than it is in Chinese brains. The orbital surface of the frontal lobe is in consequence more fully exposed. These features, which find their fullest expression in many of the endocranial casts of primitive Man, are also well shown in MARSHALL's (1864) Bushwoman's brain, and they may be taken as evidence of lack of temporal and frontal development. The figures of the inferior surface of many of the other Australian brains (S.5., S.12., Q.1487., S.2., S.3., S.4., S.6.) show a considerable degree of exposure of the orbital surface and it does not seem possible that this is entirely due to distortion and shrinkage. In S.5. the anterior end of the temporal pole is placed so far posteriorly that the orbital opercular sulcus is visible from below, and the orbital sulci are exposed to their full extent. In other words the anterior part of the island of Reil has failed to become completely covered by the temporal lobe. In the remaining cerebra the orbital opercular sulcus is hidden, but the orbital sulci are exposed to a considerable amount. This question is more fully discussed in my review of MARSHALL's Bushwoman's brain to which the reader is referred (SHELLSHEAR (1933)).

The Rostral Keel—The presence of the rostral or frontal keel is generally regarded as a primitive feature in the human brain. It is present in a marked degree in every hemisphere except S.2.R. The presence of a well-marked sulcus passing downwards and forwards on the anterior aspect of the frontal lobe into the orbital keel, together with the hollowing out of the anterior margin of the orbital surface, gives a curious ape-like appearance to this region. The sulcus of the keel is, as will be discussed in dealing with the sulci, the homologue of the sulcus rectus, which maintains its relation with the frontal pole throughout the whole series of the anthropoids and man. The exception to the presence of the orbital keel in S.2.R. is obviously due to distortion. In all the other specimens, regardless of the degree of deformation due to handling and bad fixation, the presence of the keel in an accentuated form must be a normal feature of these brains ; it is difficult to imagine that the forces of deformation would produce a picture so constant as the anterior views of these brains show. Furthermore, the extent of rostration is similar to that shown in the endocranial casts of the Australian which I have had the opportunity of examining.

Exposure of the Island of Reil

Closely associated with the degree of under development of the frontal and temporal regions is the extent of the closure of the opercular lips of the island of Reil. In the brain of the Bushwoman, described by MARSHALL, the anterior part of the insula is exposed ; and this is due to the slender form of the temporal poles and to their failure to extend in a forward direction so as to cover the orbital surface of the frontal lobe. CUNNINGHAM makes the curious statement :—" There appears to be a widespread impression amongst anatomists that the exposure of a portion of the island of Reil in the adult brain is a mark of inferiority ". He goes on to discuss the condition in twelve hemispheres of Negroes, in only one of which there is any exposure of the island of Reil and this to a very small degree. The use of the term inferiority is to be deprecated. We are not even yet in a position to express the morphological features of the brain in terms of mental superiority or inferiority. The failure of the lips of the fossa to meet may be present in the brain of the adult European, as CUNNINGHAM points out. This failure, whilst in no way suggestive of lack of cerebral development, may be attributed to the retention of a primitive feature or may have other explanation. In the forty-two hemispheres of the Australian the island of Reil is exposed to a considerable degree in thirteen cases, slightly exposed in six cases, and hidden in the remaining twenty-three cases. Admitting fully, in order to avoid undue emphasis being attributed to features of form and shape in these brains, the possibility that this high degree of exposure may be due to shrinkage and distortion, one cannot help feeling that the exposure is not alone due to these factors but to actual failure of expansion of the temporal and frontal lobes. From what has already been seen in the occipital lobe in the parieto-occipital region, and in the form of the sulci on the medial surface of the hemispheres, the conclusion seems to be justified that the open condition of the island of Reil is in keeping with the condition of the other areas of these brains.

The Sulci of the Frontal Lobe

The description of the sulci of the frontal lobe in terms of the usually accepted definition of the sulci presents grave difficulties. The usual conception of three horizontal tiers of sulci and gyri cannot be arrived at from a phylogenetic series. It is true that the hemispheres under consideration might be so described, but the results would fail to show the direction of expansion, and would fail to fulfil the purpose of this paper which is to act as a basis for comparison with the brains of other races. Any description must start from the foundation of a sulcal pattern based upon correct homology with the three fundamental sulci in lower forms—the sulci rectus, arcuatus, and fronto-orbitalis. In the prosecution of this problem, on which I have been engaged for some years, I have used the distribution of the arteries as an auxiliary method of determining sulcal homologies. In the description of the arteries of the brain of the Chimpanzee (1930) I arrived at certain conclusions concerning the homologies of the fundamental sulci of the frontal lobe. I had not at that time access to COLE's original papers dealing with the same subject. My conclusions were substantially the same as those arrived at by him concerning the homology of the rectus and arcuate sulci. Those conclusions, briefly put, were that the inner part of the sulcus fronto-marginalis of Wernicke combined with the anterior part of the sulcus frontalis medius constituted the rectus sulcus in man; and that the sulcus praecentralis inferior represented the lower part of the sulcus arcuatus, the upper part being represented by a sulcus or sulci lying in the middle of the frontal lobe in relation to areas 6 and 8 of BRODMANN. This sulcus may in some cases become incorporated with the so-called sulcus frontalis superior.

It is from the standpoint of the studies of the arterial supply, combined with a careful survey of the works of BRODMANN, CAMPBELL, and ELLIOT SMITH, that the description of the sulci of the frontal lobe is here given. Before knowledge of the histological structure was acquired by these writers, CUNNINGHAM had written his masterly account of the frontal lobes. Despite the fact that he had not this information to aid him, his memoir must still act as the foundation for any description of the frontal lobes. His account of the individual sulci and their relationships still stands as a monument of accuracy, but certain of his views concerning homology must be modified. Throughout this account CUNNINGHAM's arrangement will be very closely followed, so that direct comparison may be made between the brain of the Australian and the brain of the European.

Before proceeding to the description of the hemispheres themselves, it is desirable to give a brief account of the sequence of changes in the evolution and development of the sulci of the frontal lobe, as they appear to the writer, to serve as an introduction to the Australian brain.

In the Cercopithecidae the pattern of the sulci of the frontal lobe is almost constant. The morphological features appear to be stabilized in an evolutionary sense. The sulci rectus and arcuatus are so obvious and so clearly defined that one expects to find their homologies in the human brain. Whilst morphologists have very rightly contended for exact criteria in homologizing the sulci of the occipital region and have insisted upon exact relations of cortical areas to sulci, for example, the striate cortex in relation to the limiting and intrastriate sulci, in the frontal region the demand for accurate criteria does not appear to have been so insistent.

In the Cercopithecidae these relationships are exact. The sulcus arcuatus is as closely related to areas 6 and 8 of BRODMANN as is the sulcus lunatus to areas 17 and 18. The motor cortex (area 4) has attained its full development as a lower centre for motor control in the cerebral cortex. It is probably analogous on the motor side with the general sensory, auditory, and visual centres on the sensory side. The concentric areas around the primary sensory areas exemplified by areas 18 and 19 around the primary visual cortex are well developed. With these more highly discriminatory sensory areas there are developed at the same time, and apparently analogously, the concentric premotor areas 6 and 8 for the more discriminatory aspects of movement.

The lower end of area 6, together with 4, forms a prominent bulging at the level of the anterior end of the temporal pole. This bulging is sometimes known as the frontal cap of Anthony. This old frontal cap retains its position and frequently its form in man in relation to the lower end of areas 4 and 6; but in man a new frontal cap is formed lying in the same relation to the temporal pole as in the Cercopithecidae. This new frontal cap—the cap of Broca—is not homologous with the old frontal cap because the temporal pole has now grown forward to cover the sulcus fronto-orbitalis and a great part of the under surface of the frontal lobe.

The upper end of the sulcus arcuatus in the Cercopithecidae arches over the posterior end of the sulcus rectus. It forms the anterior boundary of area 6 throughout its whole length. Therefore the only sulcus which can fulfil the criteria for homology of the sulcus arcuatus in man must limit area 6. The sulcus praecentralis inferior (5*i*) in its vertical part fulfils this criterion. The upper part of the sulcus arcuatus may often be seen in the human brain still in connexion with the sulcus praecentralis inferior as the anterior horizontal limb (5*a*) so clearly defined and emphasized by CUNNINGHAM. In other cases it may become detached from the sulcus praecentralis inferior and take on secondary connexions with the so-called sulcus frontalis medius, or it may even be represented in the sulcus frontalis superior when this compensatory sulcus is lower than usual. This is entirely in keeping with COLE's (1911, *a*, *b*) interpretation.

The arteries supplying areas 6 and 8 can be homologized from the Cercopithecidae to Man and confirm the above interpretation. Area 6 is supplied by the posterior inferior frontal branch of the middle cerebral artery, which emerges from the upper end of the sulcus fronto-orbitalis (lying well anterior to the temporal pole in the Cercopithecidae) and supplies area 6 almost exactly as far as the level of the upper end of the sulcus arcuatus. Above this point the supply of area 6 is taken over by the anterior cerebral artery. The upper end of the sulcus arcuatus lies wholly within the middle cerebral area in every case which I have examined.

Area 8 is supplied by the middle inferior frontal branch of the middle cerebral artery and reaches a higher level than the posterior end of the sulcus rectus. The areas of supply of the posterior and middle inferior frontal branches of the middle cerebral artery are shown as arterial areas 16 and 17 in Q.2788.R. and L., Q.1487.R., and Q.1905.R. Even if the hypothesis that the arteries have a definite relationship with functional areas cannot be fully established in the cerebrum, there can be little doubt that their areas of supply reveal the sulcus arcuatus in its correct relations with areas 6 and 8 of BRODMANN. Using these arteries as aids to homology, the sulcus arcuatus is seen to have become straightened up in the higher apes and man. This straightening out has been brought about by an increase in the extent of area 8 and in the development of new areas in the region which lies in the angle formed by the sulcus arcuatus and the posterior end of the sulcus rectus. The great expansion in man is taking place in front of the arm and head areas of the motor cortex.

The rectus sulcus in the Cercopithecidae has constant relations. It is a sulcus within area 9 posteriorly and separating areas 9 and 10 anteriorly. Its anterior end is an axial sulcus in the rostral keel of the frontal pole. The sulcus posteriorly lies on the line of arterial demarcation between the anterior and middle cerebral arteries, and anteriorly lies within the area of the fronto-polar branch. These cortical and vascular criteria in man are all fully realized in the inner branch of the sulcus frontomarginalis of Wernicke and in the anterior part of the sulcus frontalis medius. The sulcus frontalis inferior has no relations to either the cortical or vascular areas, and cannot have been derived from the sulcus rectus. The vascular relations in Q.1487.R. and Q.1905.R. reveal the identity of the sulcus rectus in man. KAPPERS

(1929, *a*, p. 309) discusses the homology of the sulcus rectus, and reaches a conclusion in harmony with the above.

Two facts so far stand out : firstly, the areas 6 and 8 remain in relation to area 4 ; secondly, area 10 retains its relation to the frontal pole. The fundamental sulci of the frontal lobe in the Cercopithecidae become separated from one another in a way analogous to the separation of the sulcus lunatus from the sylvian and parallel sulci in man.

One other area remains fixed in position and gives the key to the solution of the problem of the position of the expansion of the frontal cortex. The orbital surface of the frontal lobe, with its included sulci orbitales, retains its identity, and is limited laterally by the line of vascular demarcation between the anterior and middle cerebral arteries. The expansion has taken place within the area of the middle cerebral artery.

The central point between these fixed areas is the upper end of the sulcus fronto-orbitalis and round it the great human expansion has taken place. Areas 44 to 47 of BRODMANN are developed in this region. Area 10 maintains its relation with the frontal pole in the same way as does the visual cortex to the occipital pole when the parietal region expands ; areas 8 and 9 are thrust upward and the general morphological disposition of the features is not in keeping with the usual conception of horizontal tiers of sulci and gyri. These displacements of old sulci and the development of compensatory sulci in the new areas produce a varying pattern in which the individual sulci are difficult to homologize and conform with any conventional pattern. And this because the process of evolution has not become stabilized as it appears to have been in the Cercopithecidae. The new sulci in the frontal lobe are now compensatory and limiting sulci to new areas. The sulcus fronto-orbitalis becomes the orbital opercular sulcus of the island of Reil and perhaps the anterior horizontal limb of the fissure of Sylvius. The sulcus subfrontalis (1) of KAPPERS is an inferior limiting sulcus to the new expansion ; the so-called sulcus frontalis inferior (4)—already foreshadowed in the higher apes—limits the new areas 44 and 45, and within these areas are compensatory sulci such as the axial sulcus of the frontal operculum. The sulcus radiatus is an anterior limiting sulcus, and the sulcus diagonalis a posterior limiting sulcus.

Above the sulcus frontalis inferior the general increase in size of the frontal lobe produces also compensatory sulci exemplified in the posterior part of the sulcus frontalis medius and in the greater complexity of the sulcus frontalis superior.

It is therefore clear that many of the sulci present in the human parietal and frontal regions can have no homology with sulci in the lower apes ; they are only partially capable of homology in the higher apes where the new expansions are already foreshadowed.

The Sulcus Praecentralis Inferior—CUNNINGHAM describes this sulcus as presenting a vertical and a more or less horizontal portion which are, as a rule, in direct and uninterrupted continuity with one another. After describing accurately the form and relations of the vertical part he goes on to discuss the horizontal part. His description of the mode of branching of the upper part of the sulcus praecentralis inferior is entirely confirmed in the Australian cerebra. In the numbering used to designate the sulci in this paper the horizontal portion of this sulcus is numbered 5*a* to indicate its association with the precentral sulcus and to indicate, so far as it is possible, which sulcus is regarded by me as being homologous with the upper end of the sulcus arcuatus. In twenty-six hemispheres the horizontal portion is clearly defined. The most diagrammatic picture is that shown by R.C.S.703.5.R. Before describing it the reader is referred to CUNNINGHAM's memoir (1892, figs. 53, 57, 59 and 69). In R.C.S.703.5.R. the ramus horizontalis (5*a*) " is not horizontal in its direction, but is directed from behind obliquely upwards and forwards into the posterior part of the middle frontal convolution. The obliquity is, in a measure, due to the backward curve of the vertical limb of the fissure " (CUNNINGHAM, 1892, p. 252). In R.C.S.703.5.R. this horizontal limb is branched to a small extent. This is the element of the sulcus praecentralis inferior which occupies a position which would lie between areas 6 and 8 of BRODMANN. It is the part of the fissure which I have found constantly to lie between the arterial areas 16 and 17 supplying these areas of BRODMANN (see figures of arterial supply in Q.2788, 1487, and 1905). These arterial relations I have traced from the Cercopithecidae to man. COLE arrived at similar conclusions by using BRODMANN's cortical areas. In R.C.S.703.5.L. the picture is a little more complicated. The horizontal portion (5*a*) arches forwards and is confluent with sulci which might be termed the posterior part of the sulcus frontalis medius and through these with anterior elements of the sulcus frontalis superior. It is probable that from such types COLE derived his opinion that " the sulcus arcuatus is represented in anthropoids and man, not only in its lower part by the inferior precentral sulcus as is generally agreed, but also in its upper part ; for we often find one, or even two, sulci curving forward in arcuate fashion, following roughly the lines of BRODMANN's areas, particularly 8 and 9 (in man). Into the composition of such an arcuate sulcus a part of the superior frontal sulcus sometimes, but not always, enters ". It must be apparent that, although a horizontal tendency of the sulci may conform to the usual diagrammatic description, the general morphological features of the frontal lobe can be better understood by following the sulci along the direction of the cortical areas of BRODMANN.

The posterior part of the horizontal portion of the sulcus praecentralis inferior is directed towards the sulcus centralis. It is variable in its arrangement and will be described later as the sulcus praecentralis medius (5*m*).

The remaining twenty-four hemispheres may be passed in review as they all show, with minor modifications, the essential features described above. These hemispheres are Q.2788.L., C.2.L., C.2.R., S.4.R., S.2.L., S.7.R., A.954.R., A.954.L., C.4.R., S.13.L., S.13.R., S.12.L., Q.2640.L., S.8.R., S.8.L., S.9.R., S.6.R., S.11.R., C.3.R., C.3.L., Q.1487.R., Q.1905.R., C.3.R., C.3.L.

In Q.2788.L. the upper end of the sulcus praecentralis inferior is bifurcated. The anterior branch is the horizontal part corresponding with the upper end of the sulcus arcuatus. Its vascular relations leave no doubt as to its identity.

In C.2.R. the pattern of the sulci looks at first sight to agree with those already described. But it is to be noted that the lower end of the branched sulcus is placed more anteriorly. It is probable that the major part of the vertical sulcus represents the sulcus diagonalis. Where the sulcus diagonalis is well marked it is not uncommon to see that the vertical limb of the sulcus praecentralis inferior is diminutive ; so it is possible that the small sulcus immediately anterior to the sulcus centralis is the sulcus praecentralis inferior. This is rather borne out by the separation of the sulcus praecentralis intermedius. On the left side of C.2. the upper part of the sulcus praecentralis inferior is normally disposed, the lower part has buried in it the sulcus diagonalis. In S.4.R., S.2.L., and S.7.R. the form of the sulcus praecentralis inferior shows clearly the vertical portion of the sulcus and the branching of the upper end with the forwardly directed horizontal portion. In A.954.R. (Plate 36) the picture is the same, but at first sight it appears different because the sulcus frontalis inferior is confluent with the sulcus diagonalis. Of the remaining hemispheres a brief comment on Q.1905.R., Q.1487.R., and S.8.R. is all that is necessary. In S.8.R. and Q.1487.R. the horizontal portion of the sulcus praecentralis inferior is connected with the sulcus diagonalis. In Q.1905.R. (Plate 28) the upper end of the horizontal element is confluent with the sulcus frontalis medius ; and there is the rather unusual picture of the sulci of the inferior frontal gyrus where there is no sulcus frontalis inferior.

There are fifteen hemispheres in which the sulci are not so clearly defined as in those which have been already described. In some of these the horizontal element of the sulcus praecentralis inferior is separated off and is continuous with sulci which may be interpreted either as sulcus frontalis medius or as sulcus frontalis superior. I have numbered each specimen as I interpret it and therefore detailed description, beyond that already given, is not necessary.

Connexion of Sulcus Praecentralis Inferior with the Sulcus Frontalis Inferior

The occurrence of confluence or separation of different sulci is a more or less fortuitous matter, but, although perhaps having little morphological significance, is worthy of mention in the light of the differences seen in other parts of the brain.

The sulcus frontalis inferior is confluent with the vertical limb of the sulcus praecentralis inferior in only seven of the forty-one hemispheres ; it is separated by a slightly submerged gyrus in two ; and it is completely free from the sulcus praecentralis in the remaining thirty-two hemispheres. In five hemispheres the sulcus frontalis inferior is confluent with the sulcus diagonalis.

The comparison between the Australian, Chinese, and European brains is shown in Table X. The sulcus frontalis inferior is seen to be separated more commonly in the Australian brain. Furthermore, we shall see when we come to describe the inferior frontal sulcus that this is not so clearly defined as a horizontal arcade in the Australian.

I have avoided so far as possible drawing conclusions concerning the status of the brains of the Australian aboriginal. The literature abounds in suggestions as to inferiority and primitiveness, and in most cases the conclusions are unfounded. One cannot, however, here resist commenting on the fact that the inferior frontal region is obviously different in the Australian from what it is in the other two races with which it is compared. CUNNINGHAM shows that the separation of the two sulci occurs more commonly in the foetal brain than in the adult ; but even in the eighth-month foetus the separation is only in 50·2% of cases in the European as compared with 83% in the Australian adult.

TABLE X—CONFLUENCE OF THE SULCUS PRAECENTRALIS WITH THE SULCUS FRONTALIS INFERIOR IN THE AUSTRALIAN, CHINESE, AND EUROPEAN

	Separate		Confluent	
Australian (41) .	34	83%	7	17%
Chinese (100) .		41%		59%
European . .		32·6%		67·4%

The Sulcus Praecentralis Superior

CUNNINGHAM (1892) describes three principal varieties of this sulcus. His description is applicable to these hemispheres and is therefore used for them.

1. *In the first variety the furrow is broken into two pieces—a superior and an inferior—by the presence of a deep annectant gyrus. This interruption takes place immediately above the junction of the sulcus frontalis primus (superior), which passes continuously into the inferior portion of the sulcus. In certain cases the upper portion of the superior precentral sulcus is completely cut off from the lower piece by the presence of this annectant gyrus on the surface.*

This variety is seen in thirteen hemispheres (S.1.R., S.1.L., S.2.L., S.7.L., S.8.R., S.11.R., S.11.L., S.9.R., S.12.R., S.13.R., S.13.L., C.3.R., and A.954.L.).

2. *In the second variety the deep annectant gyrus is placed below the junction of the first frontal sulcus, which is therefore brought into direct and uninterrupted continuity with the upper part of the superior precentral sulcus, whilst the lower portion is partially separated from both. This variety is not so common as the first.*

This variety is only found in one hemisphere (C.2.R.).

3. *In the third variety we have the cruciform arrangement mentioned by* EBERSTALLER. *The sulcus frontalis primus is carried backwards beyond the line of the superior precental furrow. In this case the upper and lower portions of the upper precentral sulcus are separated from the frontal sulcus by deep annectant gyri. In this variety one or both of these bridging gyri may reach the surface, and produce a complete separation of the fissural system into two or three parts.*

This variety occurs in one hemisphere (C.2.L.).

The common variety is the one in which the precentral sulcus is a simple sulcus parallel with the sulcus centralis, and joined at about its midpoint by the sulcus frontalis superior to form a triradiate sulcus. This triradiate sulcus is commonly found in the anthropoids. EBERSTALLER considered the connexion between the posterior part of the superior frontal sulcus and the superior precental sulcus as a constant one. My examination of the Chinese brain and the examination of the arterial supply in the anthropoids shows that this triradiate form is the common one. The posterior element of the sulcus frontalis superior seems to be morphologically a part of the superior precentral sulcus. The centre point of the radiation is the point of meeting of many arteries, and it lies on the line of vascular demarcation between the anterior and middle cerebral arteries.

The triradiate form of the combined sulci frontalis superior and praecentralis superior occurs in twenty-six hemispheres. They can be picked out so easily from the figures that there is no need to state them.

A continuous precentral furrow brought about by the confluence of the three precentral sulci occurs in nine hemispheres of the forty-one (S.2.R., S.3.R., S.4.L., S.5.L., S.7.L., S.8.L., S.10.L., S.11.R., and C.3.L.). Cunningham found a continuous precentral sulcus in only 9·3% of the hemispheres examined by him.

The Sulcus Praecentralis Medius

As Cunningham says, this is not a constant sulcus, and the term is not always applied to the same fissural element. In C.2.R. and C.2.L. this small sulcus lies between the two precentral sulci. It appears to be derived from two sources. The lower part of it appears to be derived from the posterior part of the horizontal element of the sulcus praecentralis inferior and the upper part from the sulcus praecentralis superior. The only other hemisphere in which this sulcus occurs as a separate unit is S.8.R. This hemisphere is of interest, for it would appear to show that the whole of the sulcus praecentralis inferior above its vertical limb has separated off. In this way the posterior part of the horizontal segment of the sulcus is confluent with that part which has been put forward as homologous with the upper end of the sulcus arcuatus. A somewhat similar appearance is seen in S.I.L.

On both sides of R.C.S.703.5. the posterior part of the horizontal element of the sulcus praecentralis inferior is branched and complicated. This branching is the sulcus praecentralis medius, and the specimen clearly illustrates the derivation of that sulcus from the inferior precentral sulcus. Other hemispheres, for example, Q.2640.R., show a similar arrangement of the sulci.

The Sulcus Frontalis Inferior—Following the order taken by Cunningham, we shall now deal with the sulcus frontalis inferior. The inferior frontal region of these brains has been the most difficult to unravel. In the first place because in many of them there has been a considerable degree of distortion making the selection of landmarks impossible, and in the second place because the pattern of the sulci differs so considerably from that shown in the brain of the Southern Chinese. In the brain of the Chinese one certainly finds variability of pattern, but there are few brains where one cannot distinguish the sulcus frontalis inferior with a fair degree of certainty. Cunningham found fourteen varieties of the sulcus in fifty-seven hemispheres, but if it was broken up into parts he had no doubt of their identity, for he says :—" When Sernoff speaks of the sulcus frontalis inferior as being occasionally completely absent, he, no doubt, refers to those cases in which it is broken up into its several parts ".

Of the hundred Chinese hemispheres, the drawings of which I have examined at the moment of writing, there are all manner of varieties ; but there is not one in which a sulcus frontalis inferior is not present in such a form that anyone conversant with cerebral anatomy would fail to identify it. In the Australian there are many hemispheres where identity is very uncertain. In place of an arcade, whether complete or broken, surrounding the inferior frontal gyrus, there are radiating sulci extending outward and upward toward the sulcus frontalis medius. We may take Q.1905.R. (Plate 28) as an example, for here the cerebrum was well fixed. The sulcus frontalis medius, lying along the line of vascular demarcation between the major arteries, is well defined ; but in place of a folding in the usual line of the inferior frontal sulcus there are sulci radiating out and joining with the sulcus frontalis medius. To a lesser extent the same type of features are seen in Q.1487.R., S.2.L., Q.2640.L., S.11.L., and Q.2788.R.

The only method of giving a comprehensive picture of these hemispheres is to classify them in accordance with the degree of the capacity of identifying the sulcus.

Group 1

The sulcus frontalis inferior arises from the sulcus praecentralis inferior below the level of the horizontal part of that sulcus. From this it proceeds forwards until it reaches a point immediately above the anterior ascending limb of the fissure of Sylvius. Here it turns slightly downwards, and ends by bifurcating into two branches, which spread out widely from each other and form a terminal transverse piece of the furrow. The lower of the two branches resulting from this bifurcation cuts into the pars triangularis.

This is given almost in Cunningham's own words. There are also present the sulci radiatus and outer limb of the sulcus fronto-marginalis to which this sulcus may become conjoined. It is not necessary to subdivide the group for these features.

There are seven hemispheres in the group (C.3.L., S.7.R., S.7.L., S.6.R., Q.2788.R., A.954.L., and S.12.R.).

In *C.3.L.* the inferior frontal sulcus arises fairly high up on the sulcus praecentralis inferior. Its course is then exactly as described in accordance with the grouping. Anteriorly it is confluent with the sulcus radiatus, and there are also short branches extending into the middle frontal gyrus.

In *S.7.L.* the condition is very similar to C.3.L. The only differences being that the sulcus arises at a lower level from the sulcus praecentralis inferior, and that the upper arm of the sulcus radiatus is superficially confluent with the sulcus frontalis medius.

In *S.7.R.* the sulcus frontalis inferior is confluent with the sulcus praecentralis inferior through the sulcus diagonalis.

In *S.6.R.* the sulcus praecentralis inferior is confluent with the sulcus diagonalis This hemisphere is somewhat distorted.

In *A.954.L.* the condition is made somewhat complex by the union of the sulcus praecentralis inferior with the sulcus inferior transversus or sulcus subcentralis anterior.

In *S.12.R.* the anterior arm of the sulcus frontalis inferior has become detached in the pars triangularis, but otherwise the pattern conforms with the grouping.

In *Q.2688.R.* the pattern of the arterial areas helps in the identification of the sulci. The sulcus frontalis inferior is separated from its terminal branch in the pars triangularis, and has become confluent with the anterior part of the sulcus frontalis medius ; and through this with the sulcus fronto-marginalis of Wernicke. It is to be noted that the sulcus frontalis inferior lies wholly within the area of the inferior frontal branches of the middle cerebral artery. Anteriorly, where the sulcus is confluent with the sulcus frontalis medius, the area of arterial supply has more nearly approached the area of the anterior cerebral artery. This will be dealt with more fully when we come to deal with the other hemispheres showing the blood supply.

Group 2

The features are the same as in group 1 *except that the sulcus frontalis inferior is not confluent with the sulcus praecentralis inferior, but is confluent with the sulcus diagonalis.*

There are four hemispheres in the group (C.3.R., A.954.R., S.10.L., and Q.1905.L.).

C.3.R. shows a very diagrammatic pattern of the sulci of the frontal lobe. The sulcus frontalis inferior assumes a form almost exactly as described by CUNNINGHAM. The sulcus arches over the anterior ascending limb of the fissure of Sylvius and ends in a branching whose lower arm enters the pars triangularis. The sulcus radiatus is rudimentary. The sulcus frontalis medius is a very clearly defined sulcus which is confluent posteriorly with the horizontal arm of the sulcus praecentralis inferior. The sulcus diagonalis lies parallel with the sulcus praecentralis inferior and lies between it and the anterior ascending limb of the fissure of Sylvius.

In *A.954.R.* the pattern of the sulci is very similar to that seen in C.3.R. The sulcus frontalis inferior is confluent behind with the sulcus diagonalis. Anteriorly it is more extensive, being confluent superficially with the sulcus radiatus. The condition in S.10.L. and Q.1905.L. is essentially the same as in A.954.R.

Group 3

The sulcus frontalis inferior is clearly defined and is entirely separate from both the sulcus diagonalis and the sulcus praecentralis inferior.

There are eleven hemispheres in this group (C.2.R., C.2.L., S.5.L., S.11.R., S.8.L., S.9.R., S.2.R., R.C.S.703.5.R., R.C.S.703.5.L., S.3.L., and C.4.R.).

It will suffice to deal with one or two typical cases and leave the figures as sufficient description for the remainder. Brains S.2. and S.3. were considerably distorted and their interpretation is therefore somewhat doubtful.

C.2.R. (Plate 32) is an important hemisphere of the type which CUNNINGHAM used to arrive at his conclusion that the sulcus frontalis inferior was homologous with the sulcus rectus of the apes. The sulcus frontalis inferior commences immediately below the horizontal arm of the sulcus praecentralis inferior bearing a relation to that sulcus which is superficially very similar to the relation between the sulcus arcuatus and the sulcus rectus. It arches over the anterior ascending limb of the fissure of Sylvius and gives rise to a strongly developed anterior branching whose lower arm passes into the pars triangularis. In front of this the sulcus frontalis inferior is continued into the sulcus radiatus of EBERSTALLER. KAPPERS, in discussing the frontal fissures of Neanderthal Man, agrees with the conception of KOHLBRUGGE (1909) that the whole of the sulcus including the connexion with the sulcus radiatus should be regarded as the sulcus frontalis inferior. The connexion is, however, not constant. KAPPERS remarks that " the continuation of the system in nasal direction seems to be typical specially of recent men as appears from a comparative study of anthropoids, Pithecanthropus, Neanderthal and recent men ". In the Australian the sulcus radiatus is confluent with the inferior frontal sulcus, or what may represent it, in eighteen cases, separate in twenty cases, and non-definable in three cases.

In *S.11.R.* the anterior end of the sulcus frontalis inferior is continuous through the anterior part of the sulcus frontalis medius with the sulcus fronto-marginalis of Wernicke.

Other types of variation occur in the other hemispheres of this group which can be seen from the figures. These variations seem to be fortuitous and in the present state of our knowledge are not capable of interpretation.

GROUP 4

The sulcus frontalis inferior can be distinguished, but it is not well defined as a continuous sulcus. There are short detached sulci to represent it. This region seems to be less complicated than in the Chinese.

There are eight hemispheres in the group (S.1.R., S.1.L., S.3.R., S.4.L., S.12.L., S.13.R., S.13.L., Q.1487.R.).

In *S.1.L.* there is a triradiate sulcus lying immediately above the anterior ascending limb of the fissure of Sylvius. The two posterior arms constitute the sulcus diagonalis, the anterior horizontal arm represents the sulcus frontalis inferior. Anteriorly, the terminal piece of this sulcus is represented by a detached sulcus, and anterior to that again the sulcus radiatus is a short and detached sulcus.

In *S.1.R.* the pattern of the sulci is as simple as on the left side. Here, however, the sulcus radiatus is attached to the anterior piece of the sulcus frontalis inferior.

The remaining six hemispheres are essentially similar to S.1.R. and S.1.L.

Group 5

In this group it is impossible to define the sulcus frontalis inferior. There are present sulci radiating out towards the sulcus frontalis medius, so that the pattern assumes a different appearance to that usually seen in the human brain.

There are eleven hemispheres in the group (Q.1905.R., Q.1487.R., Q.2788.R., S.6.L., S.8.R., S.11.L., S.5.R., S.2.L., Q.2640.R., S.4.R., and S.10.R.).

Before discussing these hemispheres, it is necessary to draw attention to Kappers's (1929, *b*) description of the sulcus frontalis medius in his work on the frontal fissures in Neanderthal man. I am substantially in agreement with his views from which the following quotations are made.

In referring to Eberstaller's statement that the sulcus frontalis medius does not join the precentral, but only begins (usually by a transverse piece) quite a distance in front of it (see in this series S.9.R., A.954.R., and others) he says :—" It is different in Neanderthal men. In all my casts its connexion with the precentral (mostly the inferior) seems to exist. On the La Quina left hemisphere it connects in Keith's Gibraltar cast and in recent men."

In his interpretation of Dusseldorf Neanderthal man and La Chapelle R. (*see* his fig. 1), the connexion of the sulcus frontalis medius with the sulcus praecentralis inferior is clearly portrayed, as is also the fact that the sulcus frontalis inferior is rudimentary. Whether this interpretation of the sulci in Neanderthal man is correct or not, it is very impressive that it so closely accords with the conditions seen in Q.1905.R., S.6.L., S.4.L., S.5.R., Q.2788.R., and other hemispheres.

Kappers goes on to say :—" Concerning anthropoids I must confess that this fissure is very often described (recently again by Mingazzini (1928)) as S. frontalis inferior. This is caused by the fact that the frontalis inferior in anthropoids may fail, or—on account of its steep course in those animals—is not recognized as such, and the sulc. medius, often connected with the precentral reminds one of the frontalis inferior of men."

My agreement with Kappers on this point is best emphasized by referring to figs. 68, 82, and 90 of Mingazzini. In his fig. 68 the sulcus rectus, lying axially in the frontal keel, is labelled as the sulcus frontalis inferior.

The whole question of the homology of the frontal sulci will be continued at the end of this section on the frontal lobe.

Q.1905.R. (Plate 28)—The sulcus praecentralis, apparently confluent with the sulcus diagonalis, divides into the short posterior branch of the horizontal part, and a longer anterior branch which extends upwards and forwards to the line of vascular demarcation between the middle and anterior cerebral arteries. The sulcus frontalis medius is confluent with this anterior branch ; it extends forwards to become confluent with the sulcus fronto-marginalis of Wernicke. There are indications, from its mode of branching, of three parts to this arcade lying horizontally across the frontal lobe. The two posterior parts comprise the sulcus frontalis medius proper, the anterior part is the sulcus fronto-marginalis. In many of the hemispheres these three parts may be distinguished as separate elements (Q.1487.L., S.5.L., etc.). There are no sulci between the sulcus frontalis medius and the fissure of Sylvius which can be recognized as the sulcus frontalis inferior. The sulcus frontalis inferior lies wholly within the vascular areas 17 and 18 in every hemisphere in which I have examined the arterial supply. The anterior part of the sulcus frontalis medius lies on the vascular line of demarcation. Compare Q.1487.R. (Plate 29) with Q.1905.R. The upper boundary of the vascular area 18 is the anterior part of the sulcus frontalis medius, and both from its cortical relations and its arterial relations this sulcus must represent the sulcus rectus of the apes, but not in its entirety, because the sulcus fronto-marginalis of Wernicke—the axial sulcus of the frontal keel—likewise fulfils the criteria of homology with the anterior part of the sulcus rectus in its cortical and arterial relationships. In Q.1487.R. the arcuate sulcus over the anterior ascending limb of the fissure of Sylvius is a rudimentary sulcus frontalis inferior.

In Q.2788.R. (Plate 30) almost identical conditions are seen, and, where differences exist, the arrangement of the arterial fields permits of the identification of the sulcal elements without need for detailed description. It must be remembered that this brain was flattened antero-posteriorly and so the drawings of the lateral surface must be compared with those of the antero-lateral aspects.

The remaining hemispheres of the group are sufficiently described by comparison with those already described and in the description of the grouping.

The occurrence and percentage of the groups of the sulcus frontalis inferior are shown in Table XI, contrasted with one hundred Chinese hemispheres. There is clearly a great difference between the Chinese and the Australian in this region. The sulcus frontalis inferior seems to indicate in the Australian that the areas 44 and 45 of Brodmann have not developed to a sufficient extent to cause the deeper folding of this sulcus as expressed in Cunningham's statement :—" In rather more than half of the hemispheres examined (50·8%) the furrow was equally deep throughout, and not interrupted by annectant gyri ". Whilst the question of homologies will be discussed later, it will emphasize the difficulty of accepting Cunningham's view that the sulcus rectus is homologous with the sulcus frontalis inferior to point out that, if the sulcus frontalis inferior is to be regarded as a primitive sulcus, one would expect to find it more definitely present in the brain of the Australian aboriginal. Also the condition of the frontal lobe in this race supports Kappers's view that the continuation of the inferior frontal system in a nasal direction seems to be typical especially of more modern brains, as appears from a comparative study of anthropoids, Pithecanthropus, Neanderthal, and recent men. Finally, whilst Cunningham's arguments in favour of this homology from topographical and form relationships seemed to be sound, the works of Elliot Smith, Brodmann, Campbell, and others show that the inferior frontal sulcus must be a new sulcus forming the upper limit of new frontal areas. In addition to the work which has been done since

CUNNINGHAM's time, the value of the arterial supply as a confirmatory method seems to have been established.

TABLE XI—CLASSIFICATION OF THE S. FRONTALIS INFERIOR

Australian (41)

Group . . .	1		2		3		4		5	
	R	L	R	L	R	L	R	L	R	L
Sydney . .	3	1	0	1	3	3	3	4	4	3
Queensland	0	1	0	1	0	0	0	1	4	0
Cambridge .	0	1	1	0	2	1	0	0	0	0
Amsterdam . .	0	1	1	0	0	0	0	0	0	0
R.C.S. . . .	0	0	0	0	1	1	0	0	0	0
Totals .	3	4	2	2	6	5	3	5	8	3
% . . .	7·4	9·8	5·0	5·0	14·5	12	7·4	12	19·5	7·4
Southern Chinese (100)	22	27	4	7	16	14	4	1	4	1

CUNNINGHAM

It is not possible to determine the occurrence of this grouping from CUNNINGHAM's figures, but from his percentages it is clear that the majority of his hemispheres would be placed in the first three groups (*see* CUNNINGHAM (1898), p. 261).

The Sulcus Frontalis Medius

In this description of the frontal lobes it is assumed at the commencement that there are the three horizontal tiers comprising the superior, middle, and inferior frontal sulci ; but, as the description proceeds, it will be pointed out that there is a very definite tendency for the sulci to run in a more oblique direction from below upwards and forwards. There is a tendency, in other words, for the sulci to assume the direction taken by the areas of BRODMANN. Finally, after the hemispheres have been described from the more conventional standpoint, the problem of the general arrangement of the sulci will be discussed with the object of suggesting a more elastic and variable pattern to give a better appreciation of the frontal lobes.

CUNNINGHAM, whilst conforming his description to the definition of EBERSTALLER, remarks for his collection, after classifying it in much the same way as I have done for the Chinese and Australian brains, that " the degree of variability of this sulcus, as established by this method, is very bewildering. In the sixty-nine hemispheres examined, I have met with no less than twenty-seven different varieties of the middle frontal sulcus." I can confirm this for the Australian brains. Despite this, the definition of EBERSTALLER is here used to act as the basis for a classification to facilitate study and description. EBERSTALLER's description, taken from CUNNINGHAM, is as follows :—" In its typical form the middle frontal furrow appears generally as a sagittally directed sulcus, which begins in a transversely placed short sulcus, midway between the anterior central convolution and the orbital border, and ends in a similar transverse branch immediately above the orbital border. This furrow shares the peculiarity of a hinder transverse branch, with the upper and lower frontal furrows only ; in the case of the latter the transverse branches receive the special names of the upper and lower praecentral furrows."

I find that the system thus defined by EBERSTALLER consists of three elements. Anteriorly, there is the sulcus fronto-marginalis, which itself consists of inner, outer, and horizontal posterior parts ; and posteriorly, a more horizontally disposed sulcus which is frequently broken into anterior and posterior pieces. In accordance with KAPPERS's system of numbering, the posterior transverse piece is numbered " 6 ", the two posterior segments " 7*a* " and " 7*b* ", and the sulcus fronto-marginalis " 9 ". These different parts of the sulcus frontalis medius enter into a number of fortuitous connexions with neighbouring sulci. For example, the sulcus fronto-marginalis may be separate, it may communicate with the anterior end of either the superior or middle frontal sulcus ; and, in the Chinese, there are numerous examples of its connexion with the sulcus frontalis inferior through the sulcus radiatus. The classification here used has been determined by the degree of confluence of the elements of the sulcus.

GROUP 1

The sulcus frontalis medius is in one piece running from its posterior transverse element to the sulcus fronto-marginalis.

There are nine hemispheres in the group (22·0%) (R.C.S.703.5.R., R.C.S. 703.5.L., C.2.L., Q.1905.R., Q.1905.L., S.6.L., S.7.R., Q.2640.R., and A.954.L.).

R.C.S.703.5.R. (Plate 35)—In this hemisphere EBERSTALLER's description is exactly illustrated. The posterior transverse piece lies immediately anterior to the horizontal part of the sulcus praecentralis inferior ; following this there is a continuous sulcus passing forwards as far as the rostral keel. Small branches indicate the possible division of the main stem of the sulcus into two parts ; and, finally, at the point where the sulcus is joined to the sulcus fronto-marginalis there is a connexion with the most anterior part of the sulcus frontalis superior " 11*d* ". The sulcus frontalis medius is so diagrammatically displayed in this hemisphere that it acts as a useful basis for the description of the frontal sulci.

R.C.S.703.5.L. is very similar to its fellow. There are, however, certain differences. The transverse piece is apparently separated off and there are connexions with the superior frontal sulcus. The three parts of the sulcus fronto-marginalis are well defined. Both the horizontal part of the sulcus praecentralis inferior and the posterior part of the sulcus frontalis medius are united with the sulcus frontalis superior. It is probably from such specimens as this that COLE arrived at the conclusion, from a study of the cortical relations, that the upper end of the sulcus arcuatus is sometimes represented in the sulcus frontalis superior.

C.2.L. (Plate 32) again shows the pattern of the sulci in almost exact agreement with EBERSTALLER's description. The only question, of minor importance, is whether the transverse piece is the separate element lying between the horizontal part of the sulcus praecentralis inferior and the sulcus frontalis medius.

Q.1905.L. (Plate 28)—The posterior part of the sulcus frontalis medius is joined to the sulcus frontalis superior. It is very similar to C.2.L.

Q.1905.R. (Plate 28)—In this hemisphere the arterial areas were determined. It will be seen that the line of vascular demarcation between the anterior and middle cerebral arteries practically coincides with the line of the middle frontal sulcus. The sulcal pattern of the inferior frontal gyrus is unusual. There is no inferior frontal sulcus ; and the region is occupied by sulci radiating out towards the sulcus frontalis medius. In the figure showing the infero-lateral aspect of the brain there appear to be the two anterior limbs of the fissure of Sylvius. I am inclined to believe, however, that the upper one is the anterior horizontal limb and not the ascending limb ; the second and lower arm on the orbital surface is a sulcus cutting the orbital operculum similar to those shown in S.5.R.

In the remaining four hemispheres of this group (S.6.L., S.7.R., Q.2640.R., and A.954.L.) the features already described are plainly seen in the figures. In Q.2640.R. the pattern of the sulci is very similar to that seen in Q.1905.R. In S.6.L. the sulcus frontalis medius is confluent posteriorly with the vertical arm of the sulcus praecentralis inferior. In S.7.R. the posterior end of the sulcus frontalis medius (middle part) ends in a complexly folded group of sulci representing both the sulcus fronto-marginalis and the anterior end of the sulcus frontalis superior.

It is obvious from these examples that, although the sulcus frontalis medius is well defined, there is such a wide range of possible secondary connexions that with CUNNINGHAM it is agreed that the variations are bewildering. One feels, however, that the difficulty is to a great extent removed if we consider the sulcus fronto-marginalis as a separate element. Taking the frontal views of all the brains figured in review, the sulcus fronto-marginalis, comprising the inner sulcus fronto-marginalis of Wernicke, the outer sulcus fronto-marginalis of Eberstaller, and the posterior horizontal stem, presents a similarity in form and position in all. It appears to be one of the most constant sulci in the brain. Furthermore, any series of anthropoid brains will present a picture so similar to that of the Australian aboriginal that, considering the cortical and arterial relations, there can be little doubt that the sulcus fronto-marginalis is homologous in all anthropoid forms.

GROUP 2

The posterior part of the sulcus frontalis medius is separate ; the anterior part is confluent with the sulcus fronto-marginalis.

This group contains four hemispheres (10%) (S.1.R., S.2.R., S.4.L., and A.954.R.).

In *S.1.R.* the posterior part of the sulcus frontalis medius is superficially confluent with the horizontal part of the sulcus praecentralis inferior. Anteriorly, it is separated from the anterior part by a superficial gyrus, the anterior portion of the sulcus frontalis medius is, itself, confluent with the sulcus fronto-marginalis. The frontal view of the brain shows these features best. It is questionable whether the part which is called the anterior part does not represent the so-called horizontal part of the sulcus fronto-marginalis in its entirety.

This hemisphere is of importance in so clearly defining this sulcus passing into the frontal keel, because it is this sulcus which is regarded by me as the homologue of the sulcus rectus of the apes. The fronto-marginal part of it represents that portion of the sulcus rectus which lies within area 10, the posterior section is that part which lies on the line of vascular demarcation between the anterior and middle cerebral arteries and is related to area 9 of Brodmann.

In the other three hemispheres of this group the pattern of the sulci is practically identical with S.1.R. There are minor differences : for example, in S.2.R. the posterior part of the sulcus frontalis medius is confluent with the horizontal arm of the sulcus praecentralis inferior posteriorly and with the anterior element of the sulcus frontalis superior anteriorly ; in S.4.L. the two parts of the sulcus frontalis medius are separated by a submerged gyrus; and in A.954.R. it is questionable whether this hemisphere belongs to group 1 or whether the elongation of the horizontal part of the sulcus praecentralis inferior represents in part the posterior part of the sulcus frontalis medius.

Group 3

The two parts of the sulcus frontalis medius (proper) are confluent ; the sulcus fronto-marginalis is separate.

There are six hemispheres in the group (14·6%) (C.3.R., C.3.L., C.2.R., S.8.L., S.6.R., and S.3.R.).

The features of this grouping can be seen to the best advantage from the frontal aspect of the brain. In all six hemispheres the sulcus fronto-marginalis is clearly defined. In C.2.R. this sulcus is somewhat more complicated than in others on account of secondary connexions with sulci in the superior frontal gyrus.

There is no need to describe the hemispheres individually as the features have already been seen from the previous groups. The only points of interest are :— in C.3.R. the posterior end of the sulcus frontalis medius is confluent with the horizontal arm of the sulcus praecentralis inferior, producing a large arcuate sulcus lying concentrically with the sulcus frontalis inferior. The arrangement suggests that the same factors are operative in determining the form of both frontal sulci in such forms as this. Somewhat similar conditions are present in many of the hemispheres : in C.2.R. there is the somewhat unusual condition in which the posterior end of the sulcus frontalis medius lies above the horizontal part of the sulcus praecentralis inferior, in S.8.L. the anterior end of the sulcus frontalis medius is confluent with the sulcus radiatus, in S.3.R. the posterior end of the sulcus frontalis medius is confluent with the horizontal arm of the sulcus praecentralis inferior.

Group 4

The two parts of the sulcus frontalis medius and the sulcus fronto-marginalis are all separate from one another.

This condition is found in fifteen hemispheres (36·6%) (Q.1487.R., Q.1487.L., S.13.L., S.2.L., S.12.L., S.12.R., S.5.R., S.5.L., S.7.L., S.3.L., S.10.R., S.10.L., S.9.R., C.4.R., and S.1.L.).

The pattern of the sulci in this group is somewhat variable, but its main features can be made out in the figures, so that there is no need to enter into a description of them. We might refer, however, to Q.1487.R. Here the three separated parts are clearly seen in the figure of the frontal view. It will be noticed that the sulci have an oblique direction passing from behind forwards and upwards. The middle frontal elements are confluent with superior frontal elements. This oblique direction is the same as that taken by the cortical areas of Brodmann and by the arteries. I am at present writing a full description of the cortical arterial supply and in that have noted that the anterior cerebral branches to the superior frontal region become more and more oblique in their direction as the evolution of this region proceeds. In the Cercopithecidae the arteries pass almost directly laterally on reaching the dorsal border ; in the higher apes there is a definite posterior inclination and in man this is accentuated.

Group 5

This is a heterogeneous group. It is difficult to recognize with certainty the various sulci and it seems better, therefore, to record the group pictorially for future use.

There are seven hemispheres in the group (17%) :—Q.2788.R., Q.2788.L., S.4.R., S.8.R., S.13.R., S.11.R., and S.11.L.

The two sides of S.11 are better regarded as doubtful on account of the distortion of the hemispheres.

Q.2788 (Plate 30) illustrates on both sides the difficulties of interpretation. On the right side it is impossible to conform the hemisphere to any conventional pattern of superior, middle, and inferior frontal sulci, although there are elements at each level which may be so interpreted. On the left side there are two almost continuous sulci running antero-posteriorly ; the question as to how much of each is to be regarded as superior, middle, and inferior frontal is a purely arbitrary one.

It is of interest here to note that in this series of Australian brains the sulcus frontalis medius can be recognized in 83% of the hemispheres. Kappers, discussing the endocranial casts of Neanderthal Man, states :—

> " It is very remarkable that the mid-frontal sulcus, whose existence in present races is only so recently realized and which is mostly broken into pieces in the Javanese, while Sernoff could state its occurrence in only 17% of his Russians, is such a constant and continuous groove in Neanderthal men, where nobody can doubt its existence, and where also Anthony rightly described its occurrence in the La Quina cast, and equally observed its relation to the fronto-marginal fissure. Keith found this connexion even indicated on his Australian cast."

In Table XII the percentage occurrence of the grouping of the Australian is contrasted with that of the Chinese. It is felt that in the present state of our knowledge these figures are not of great significance ; but it is interesting to find that a continuous sulcus frontalis medius is more common in the Australian.

TABLE XII—CLASSIFICATION OF SULCUS FRONTALIS MEDIUS

Group	1		2		3		4		5	
	R	L	R	L	R	L	R	L	R	L
Sydney	1	1	2	1	2	1	4	8	4	1
Queensland	2	1	0	0	0	0	1	1	1	1
Cambridge	0	1	0	0	2	1	1	0	0	0
Amsterdam	0	1	1	0	0	0	0	0	0	0
R.C.S.	1	1	0	0	0	0	0	0	0	0
Totals	4	5	3	1	4	2	6	9	5	2
%	10	12	7·5	2·5	10	5	15	22	12	5
Southern Chinese (100)	6	5	8	4	6	7	17	16	13	18

The Sulcus Frontalis Superior

This is generally regarded as a continuous sulcus passing from the sulcus praecentralis superior to the frontal pole. It is a sulcus which, although we may regard it as a topographical unit, must be considered as a series of distinct morphological parts. In its primitive form it consists of separate elements, each of which is related to different cortical areas and should, therefore, be looked upon as distinct from one another. The conception of a single horizontal sulcus is derived from the form seen in the most highly developed brains, where it is brought into being by a compensatory folding resulting from the expansion below it. Its distinct elements become clear when it is studied from lower to higher forms.

MINGAZZINI, in all his figures in which the sulcus is depicted, shows the most posterior element as a component part of the sulcus praecentralis superior to which it is joined to form a triradiate sulcus. The parts of the superior frontal sulcus are numbered in the figs. 11*a*, 11*b*, 11*c*, and 11*d*. The first (11*a*) is a sulcus within area 6 of BRODMANN ; the second (11*b*) lies in a position which appears to be the line of demarcation between areas 6 and 8 ; the third (11*c*) lies between areas 8 and 9 ; and, finally, the fourth (11*d*) is sometimes present as a small sulcus in area 10 which may be absent or obscured by confluence with the sulcus fronto-marginalis. Each of these elements is also related to a separate branch of the anterior cerebral artery. I have already pointed out that the usual conception of three horizontal tiers of sulci in the frontal lobe tends to obscure the fundamental morphological construction of the sulci. This is well illustrated in these elements of the superior frontal sulcus, for they are not horizontally, but obliquely disposed. They run from behind forwards and inwards and tend to overlap one another in echelon. These facts were patent to both CUNNINGHAM and EBERSTALLER, but not having the work of BRODMANN to guide them they could not be aware that this direction of the elements is the general direction of the cortical areas of BRODMANN. CUNNINGHAM's statement is as follows :

> " In direction they are oblique, and the posterior end of each is placed on the outer side of the anterior extremity of the one behind, whilst the other extremity approaches close to the mesial border of the hemisphere. EBERSTALLER has also observed this mode of arrangement of the complete pieces of the first frontal furrow in those cases where its continuity is disturbed by the presence of superficial annectant gyri."

In virtue of the fact that the sulci on the medial surface of the frontal lobe are more broken in the Australian aboriginal, it is of interest to classify the sulcus frontalis superior in terms of confluence or separation of the elements. In this grouping the element 11*d* is not considered.

GROUP 1

The sulcus frontalis superior is separated into three or more pieces by gyri connecting the superior and middle frontal gyri.

Various combinations occur and it is not always possible to define the different elements exactly.

The group comprises twenty-one hemispheres (51%) : — R.C.S.703.5.L., Q.1487.R., Q.1487.L., S.9.R., S.5.L., Q.2788.R., S.1.R., S.8.L., S.8.R., S.6.L., S.6.R., S.1.L., S.2.R., S.2.L., S.4.R., S.3.R., S.11.R., S.11.L., S.13.L., C.3.L., S.12.R.

It is unnecessary to describe each one in detail. It will suffice to refer to certain individual hemispheres to illustrate types of variation.

In *Q.1487.R.* (Plate 29) the obliquity of the elements of the sulcus frontalis superior is well shown. In this hemisphere these elements appear to receive contributions from the sulcus frontalis medius. A similar type of arrangement is found in S.9.R. and other hemispheres. In *Q.2788.R.* (Plate 30) the distribution of the arterial areas in relation to the sulci is shown. The arteries supplying the areas 24, 25, and 26 reach the dorsal surface in the anterior part of the areas and then run obliquely downwards and backwards on the lateral surface of the hemisphere. The pattern of the sulci is very irregular, but nevertheless the different parts of the sulcus frontalis superior can be distinguished. These enter into connexions with detached parts of the sulcus frontalis medius. Similar types of variation and pattern are seen in the other hemispheres of the group.

GROUP 2

The sulcus frontalis superior is broken in two pieces.

There are different combinations of union of the sulci ; in some cases 11*a* and 11*b* are joined, with 11*c* separate ; in others 11*a* is separate, with 11*b* and 11*c* joined.

There are also different combinations of the union of superior frontal elements with middle frontal elements. Most of these combinations appear to be fortuitous and of little morphological value so far as one can judge. The individual hemispheres will not be described.

There are ten hemispheres in the group (24·4%) :—R.C.S.703.5.R., C.2.R., A.954.L., C.4.R., Q.2640.R., Q.2788.L., Q.1905.L., S.7.L., S.10.L., and S.13.R.

Group 3

The sulcus frontalis superior forms a continuous sulcus lying parallel with the medial border of the hemisphere.

There are nine hemispheres in the group (22%) :—Q.1905.R., C.2.L., A.954.R., S.4.L., S.5.R., C.3.R., S.3.L., S.10.R., and S.12.L.

The features of this group are clearly seen in the figures and will not be described.

Whilst it must be admitted that the separation into these groups is somewhat arbitrary, and that two independent workers might alter the grouping to a certain extent, the figures of the Australian percentages are somewhat striking. On the medial surface it was shown by a similar method of grouping that the sulci were more broken in the Australian than in the European and Chinese. The same thing is true of the sulcus frontalis superior. Cunningham found in the European that the sulcus is broken in three pieces in 23% of cases ; in the Chinese it occurs in 30% ; and in the Australian in 51% of cases. In two pieces in the European in 49·2% ; in the Chinese in 25% ; and in the Australian in 27%. In one piece in the European in 27·8% ; in the Chinese in 45% ; and in the Australian in 22%.

Cunningham makes the statement that : " In the negro cerebrum this furrow appears to have a greater tendency to break up into separate parts than in the European ".

This appears to be equally true of the Australian, and it suggests lack of expansion of the frontal lobe.

The Sulcus Subfrontalis of Kappers (1)

Ariëns Kappers has given this name to a small sulcus which might be regarded as the most lateral of the fissures on the orbital surface. It lies below the anterior horizontal limb of the fissure of Sylvius and may extend to a point anterior to the lower end of the sulcus radiatus. Kappers mentions this sulcus in his various papers on the endocranial casts of primitive man. He regards it as the homologue of the sulcus fronto-orbitalis of the apes. In this opinion he is supported by Keith (1931) in his description of the endocranial cast of the Galilee Man. Elsewhere (1930) I have advanced evidence to show that the orbital opercular sulcus of the island of Reil is the homologue of at least the lower part of the sulcus fronto-orbitalis of the apes. The upper part of this sulcus is probably the anterior horizontal limb of the fissure of Sylvius, but it is possible that the upper part has disappeared in man. In the brain of a Gorilla at University College, the sulcus fronto-orbitalis actually enters into the composition of the orbital opercular sulcus. At the same time it is to be noted in this brain that the sulcus fronto-orbitalis gives off an anterior branch which occupies the position of the sulcus subfrontalis in man. It is therefore possible that this sulcus is actually a derivative of the sulcus fronto-orbitalis. From the arterial distribution there appears to be little doubt that the orbital limiting sulcus is the homologue, but, unfortunately, the evidence from cortical structure is not apparent from BRODMANN's work because of the new areas 44 and 45. BRODMANN's fig. 85 shows the sulcus subfrontalis as a sulcus limiting the new areas of the frontal region. For this reason, and from consideration of the arterial distribution, I regard the sulcus subfrontalis as a new sulcus in man. At the same time it is important to insist upon the danger of using the arterial distribution as a final method in the present state of our knowledge. I have used the arterial supply as an auxiliary method of determining homology ; and, while I feel that it indicates the correct homology of the sulcus fronto-orbitalis, the question is so important that it is better to leave it open for the present.

KAPPERS states :—" Furthermore the subfrontal fissure (1) though occasionally well pronounced in the Europeans seems more striking in the Australian, although it is usually described as a part of the orbital fissure ".

It is not necessary to describe the hemisphere in which this sulcus is shown because it is well marked in many of the figures ; and the opinion of KAPPERS concerning it is confirmed in this series so far as the Australian is concerned.

General Discussion and Conclusions

Detailed descriptions of the sulcal patterns of the Australian brain have been given. Throughout the whole examination, drawings of one hundred hemispheres of the Southern Chinese have been continuously consulted and comparisons have been instituted. The comparative information thus obtained has been to a great extent summarized at the end of each section and so this discussion can be curtailed.

The Australian brain was selected, after having examined a large number of Chinese brains, in order to answer the question whether the brain could be used as an index of race ; and also as a problem in pure brain morphology. Taken collectively, the brains of the Australian aboriginal appear from this investigation to differ from the brains of " higher " races of man. It is probable that an individual Chinese brain could be distinguished from an Australian brain ; but much more work must be done before this can be regarded as certain. It seems that the problem of racial difference is a question of the features in the individual. Percentage tables may indicate the lines along which further research is to be conducted ; but will not give the final answer.

Before summing up the different areas of the brain, it is necessary, to avoid misunderstanding, to refer to the terms " lowliness " and " primitiveness ". In many works on the brain these terms have been used as though they were synonymous.

Lowliness, however, indicates a difference in mentality ; and, whilst many of the features of these brains may point to the Australian aboriginal as an inferior race, it is insisted that the question has no place in a purely morphological paper. Primitiveness, on the other hand, deals with the retention of unspecialized characters in the process of evolution ; and the actual retention of primitive characters may provide the possibility of greater evolutionary advance.

This question of retention of primitive characters involves another. In a morphological problem the features examined may be regarded as static, as being features in one moment of time. We try to find the static features which characterize a race, whereas the very features which go to make differences are more probably developmental tendencies and, therefore, dynamic and acting through long periods of time.

The individual features of these brains have been summed up at the end of each section. If we should select any of these features as significant of the Australian aboriginal, individual cases presenting the same features in the Chinese would probably be found. The same may be said to a lesser extent of groups of features. It seems that, so far as individual features are concerned, the words of MALL (1909) still apply :—" In this study of several anatomical characters said to vary according to age and sex, the evidence advanced has been tested and found wanting. It is found, however, that portions of the brain vary greatly in different brains and that a very large number of records must be obtained before a norm is found. For the present the crudeness of our method will not permit us to determine anatomical characters due to race, sex, or genius, and which if they do exist, are completely masked by the large number of marked individual variations. The study has been still further complicated by the personal equation of the investigator. Arguments for difference due to race, sex, and genius will henceforward need to be based on new data, really scientifically treated and not on the older statements."

A review of the hemispheres examined shows that in the lateral occipital region most of the hemispheres fall into two groupings which appear to contrast with one another. Firstly, a well-marked sulcus lunatus is present with horizontal folding of the striate cortex, and secondly, the striate cortex is folded in a vertical direction, frequently associated with a broken condition of the sulcus lunatus. This vertical folding is accompanied by a retreat of the area striata from the lateral surface ; but this retreat must be of a different order from that which occurs in the European races because the particular Australian hemispheres practically all reveal the very primitive form of the intrastriate sulci found in the higher apes in which the whole area of the cuneus is often occupied by the area striata. Furthermore, these cases of vertical folding also reveal a prominent medial operculation which is suggested, in this type, as representative of the inner part of the " Affenspalte " as the sulcus lunatus is of the outer part in those cases where the area striata is horizontally folded. Whilst these two types contrast, the fact that a combination of the two occurs in three hemispheres suggests that they are more closely related. It almost suggests two experimental methods of repacking the striate cortex consequent upon the expansion of the parietal lobe. One tendency—the vertical—might well lead to the European type with absence of sulcus lunatus; the other might equally well tend towards the Chinese. But these groupings of subordinate areas do not give the solution of the racial difference, for I have found some of the best examples of vertical folding in the Southern Chinese hemispheres. So, although the sulcus lunatus when it is seen in the Australian looks fuller and bolder than in the Chinese, the pattern shown cannot at present be regarded as significant of the race. Going further, and examining neighbouring areas, the arcus intercuneatus is clearly more fully exposed in the Australian, and, with it, the development of the praecuneus seems to be definitely less than in the Chinese; but, taking individual cases, an open arcus intercuneatus is sometimes found in the Chinese. The problem is, however, whether one would find in the Chinese the arcus intercuneatus in its primitive form associated with the primitive arrangement of the cuneus and of the lateral occipital region, indicating a whole lack of expansion. Much more work must be done, however, along these lines before a definite answer can be given.

It is not only in the occipital region that definite evidence of lack of development occurs. On the medial surface of both the frontal and parietal lobes the sulci are not folded so deeply in the Australian as in other races. The sulcus cinguli is more broken, and there is an absence of secondary sulci such as the sulcus paracingularis. Again, similar conditions may occur in the Chinese, but not so frequently. In the lateral frontal region the sulcus frontalis superior is more broken; the sulcus frontalis medius—accepting KAPPERS's views—is more often a complete sulcus; the sulcus frontalis inferior does not extend forward in a frontal direction of the extent that it does in the European, and the island of Reil appears to be more fully exposed. It must be repeated, however, that the material used was not perfectly preserved. In the parietal region parallel conditions are observed. The sulcus intraparietalis, using CUNNINGHAM's classification, is more broken than in the Chinese and in the European; the sulci of the parietal lobule are simpler and more clearly defined; and finally the two sides of the brain of the Australian are so definitely asymmetrical, and the ascending limb of the fissure of Sylvius is so clearly a variable sulcus, that, although CUNNINGHAM, GANS (1922), and others have noted an asymmetry, it would appear that there is something distinctive about this disproportion in the Australian. In the Southern Chinese this asymmetry is present, but it does not stand out so clearly as it does in many of the Australian hemispheres.

For the Australian aboriginal, as a whole, it would appear that the new cortical areas are not developed to the extent that they are in higher races. Further, using the criteria outlined above to determine cerebral simplicity, it seems certain that the most fully developed of the Australian hemispheres would look ill-formed and under-developed as compared with a fully developed Chinese brain. But the crux of the problem is whether one would notice a definite difference between the most highly developed Australian and the least developed normal Chinese. The problem must finally be solved for the individual, and it does not appear from this study that a solution has yet been reached.

Finally it is suggested that racial difference is not to be found in individual features or in individual specimens. Any individual brain is an object in one unit of time and so are its individual features. It is static in its nature when subjected to examination after fixation. It is not, then, in individual features, it is perhaps in tendencies that these differences in race will manifest themselves. Each brain in the living is the sum total of the tendencies of its growth both phylogenetically and ontogenetically. It may be that brain differences will become revealed as time differences in growth processes. This hypothesis has also been advanced by Harris (1931) in another manner by suggesting that the differences in the development of the jaws in man are time features dependent upon delays while the brain is reaching its full development.

During the five years in which I have been engaged on this work, I have visited Australia three times to examine the Sydney and Queensland series, Singapore for anthropoid material, Cambridge for the material on which Duckworth wrote many years ago, London for the specimen in the Royal College of Surgeons, Amsterdam to see the specimen referred to in the writings of Kappers, and the Peking Union Medical College to study the collection of Northern Chinese brains, preserved in the Department of Anatomy.

This investigation could not have been carried out without the generous cooperation and help of the authorities in the various Universities and Institutions in which I have worked, and I desire to acknowledge with gratitude the many kindnesses and unstinted assistance I have received from one and all of these authorities in the course of my work. In particular I desire to offer my grateful thanks to Dr. W. L. H. Duckworth, Cambridge, Professor C. O. U. Ariëns Kappers, Amsterdam, Mr. Roger Green, the late Professor Davidson Black and Professor Stevenson of the Peking Union Medical College, Mr. Longmann of the Brisbane Museum, Queensland, and Messrs. Boden Kloss and Chasen of the Raffles Museum, Singapore. To the National Research Council of Australia, under whose auspices this work was commenced, I am deeply indebted for a grant which enabled me to visit Sydney in 1928 in order to examine and report on the collection of aboriginal brains in the Pathological Laboratory of the Lunacy Department of New South Wales. This valuable collection with which the name of the late Dr. J. Froude Flashman will always be associated, for we owe to him its careful preservation and the description of a considerable part of it, was placed at my disposal by Dr. James Hogg, Chief of the Lunacy Department, and to him as well as to Dr. O. Latham, Pathologist to the Department, I am indebted for kind help, whilst I have to thank Professors Burkitt and Stump of the University of Sydney for placing the resources of the Department of Anatomy at my disposal. To Mr. L. Schaffer, the able Technician of the Department, I am indebted for the making of the photographic records. To Dr. A. Abbie of the University of Sydney, I am indebted for help in the preparation of this paper for publication.

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SUMMARY

A description is given of the features of forty-four brains of Australian aborigines, which was undertaken in the attempt to discover the existence of racial features.

The different regions are classified in a more or less arbitrary manner to facilitate comparison with the brains of other races. Many interesting and suggestive facts emerge. In the lateral occipital region the general pattern of the sulci, together with other features, shows two distinct methods of folding of the striate cortex, one horizontal and one vertical. In the horizontal foldings various forms of sulcus lunatus are revealed, whereas in the vertical foldings this sulcus is not so commonly found, but the intrastriate sulci are disposed in an almost stereotyped manner.

The percentage occurrence of the different types differs materially from that of a standard group of one hundred Chinese brains used for comparison. These groupings do not settle the question of racial difference because similar types can be seen in both races.

In the Australian there is clear evidence of a lack of development of the praecuneal, parietal, temporal, and frontal regions, as shown by the general pattern of the sulci and by such conditions as the widely open anterior end of the fissure of Sylvius and the position of the temporal pole.

Characteristic differences between the right and left hemispheres are brought out in the groupings.

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LIST OF BRAINS DESCRIBED IN THE TEXT

Source	Designation	Plate
Lunacy Department, Sydney	S.1	15
	S.2	16
	S.3	17
	S.4	18
	S.5	19
	S.6	20
	S.7	21
	S.8	22
	S.9	23
	S.10	24
	S.11	25
	S.12	26
	S.13	27
Queensland Museum, Brisbane	Q.1905	28
	Q.1487	29
	Q.2788	30
	Q.2640	31
Cambridge Department Anatomy. (W. L. H. DUCKWORTH)	C.2	32
	C.3	33
	C.4	34
Royal College of Surgeons, London	703.5	35
Amsterdam, Central Institute for Brain Research	A.954	36

EXPLANATION OF PLATES

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1. S. subfrontalis.
2*a*. Anterior ascending limb of the fissure of Sylvius.
2*h*. Anterior horizontal limb of the fissure of Sylvius.
3. S. radiatus.
4. S. frontalis inferior.
5*i*. S. praecentralis inferior.
5*a*. Horizontal arm of S. praecentralis inferior (upper part of sulcus arcuatus).
5*m*. S. praecentralis intermedius.
5*s*. S. praecentralis superior.
6. Posterior transverse arm of S. frontalis medius.
7. S. frontalis medius.
9. S. fronto-marginalis.
10. S. cingularis.
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12. S. subcentralis anterior.
13. S. diagonalis.
14. S. centralis.
15*i*. S. postcentralis inferior.
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16. S. paroccipitalis.
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17. S. occipitalis transversus.
18. S. lunatus.
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19. S. calcarinus externus.
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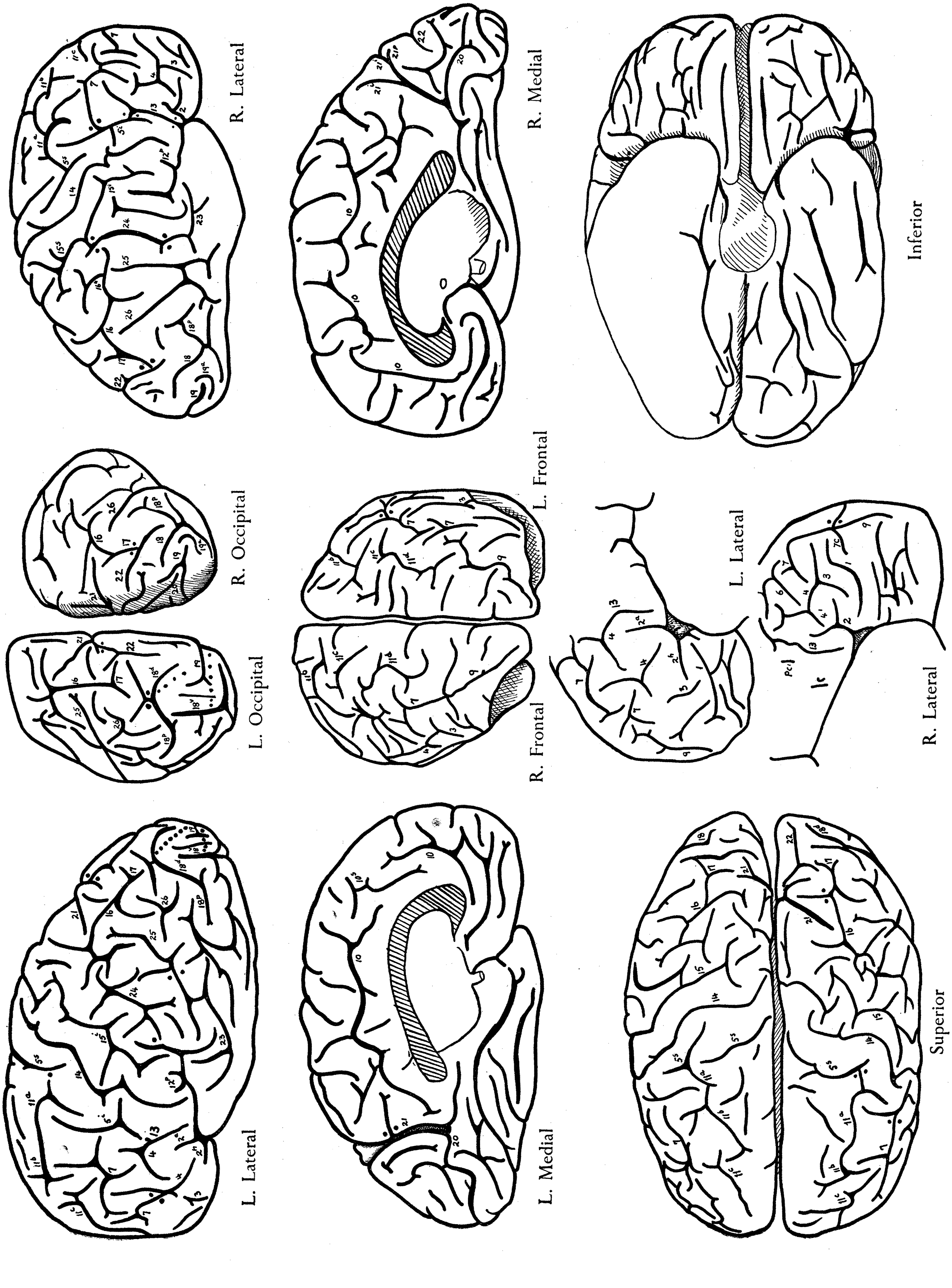
21*i*. Incusura parieto-occipitalis.
21*p*. S. paracalcarinus.
22. S. paramedialis.
22*s*. S. polaris superior.
23. S. parallelus.
24. S. parallelus superior (ascending I of KAPPERS).
25. S. angularis (ascending II of KAPPERS).
26. S. occipitalis anterior (ascending III of KAPPERS).

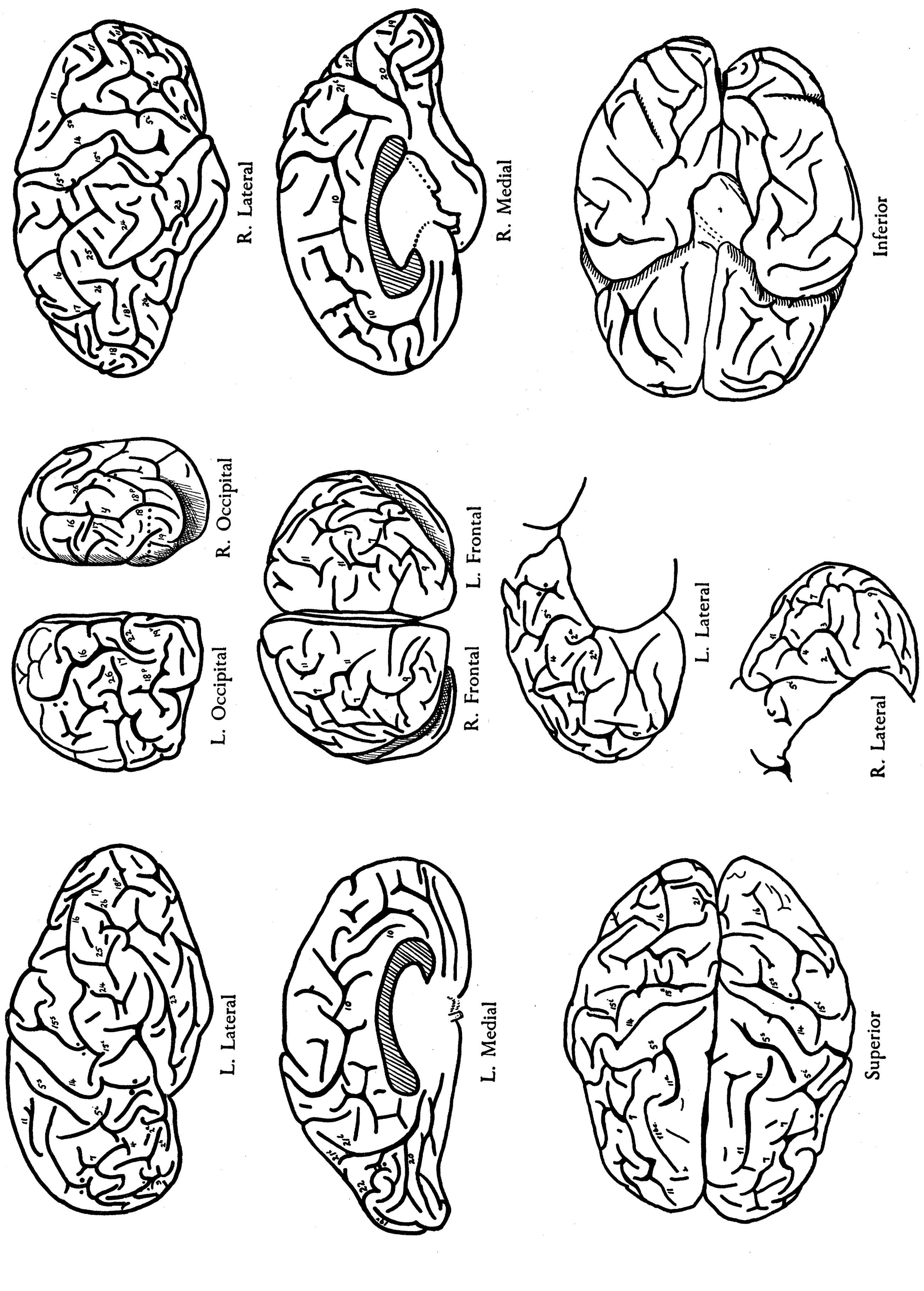
Explanation of Lettering Below the Figures

L. Lateral R. Lateral	Lateral views of left and right hemispheres.
L. Medial R. Medial	Medial views of left and right hemispheres.
L. Frontal R. Frontal	Views of frontal pole of left and right hemispheres.
L.P.-Lat. R.P.-Lat.	Postero-lateral views of left and right hemispheres.
L. Occipital R. Occipital	Views of occipital pole of left and right hemispheres.

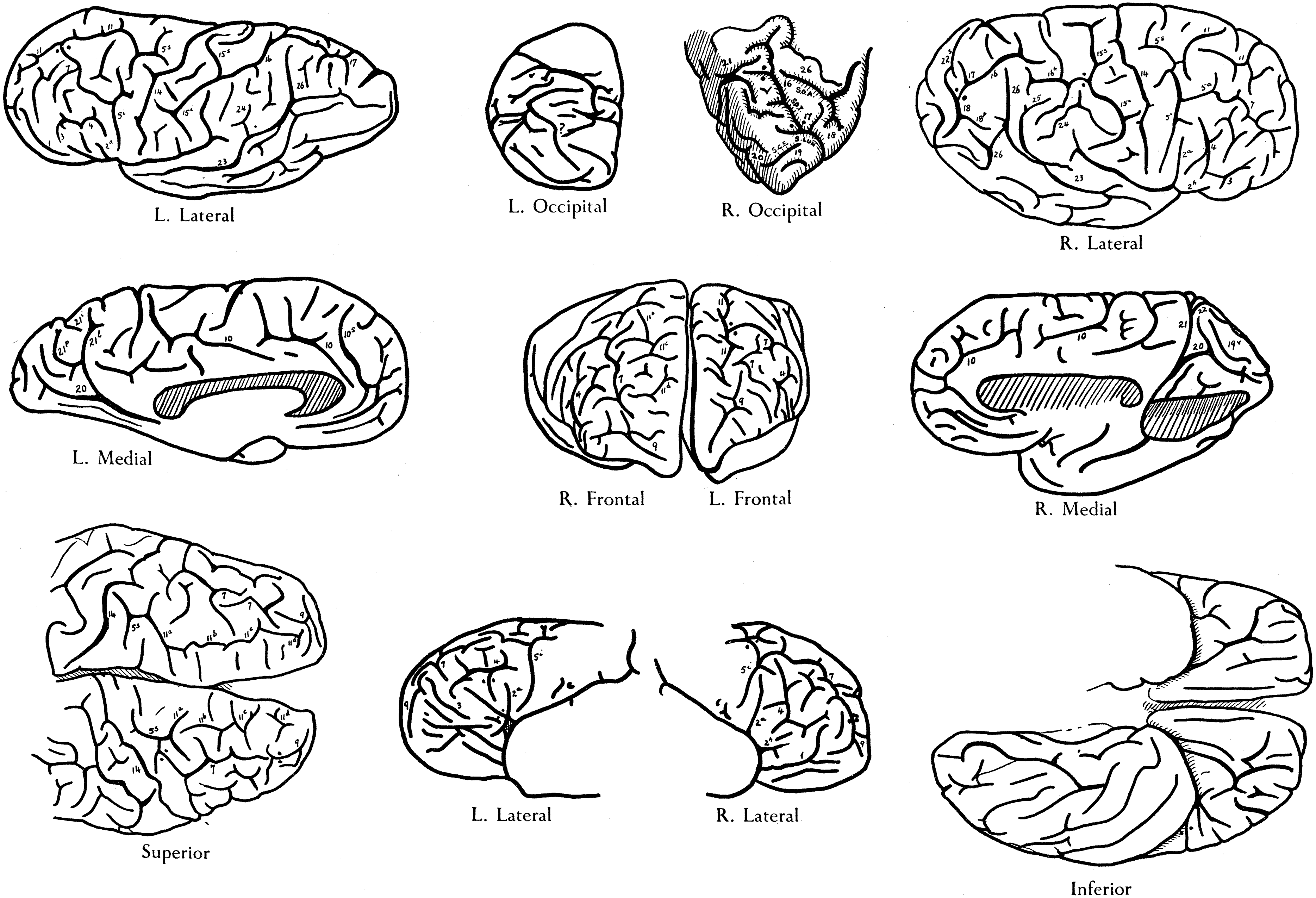
Superior and Inferior. Views of the hemispheres from above and below respectively.



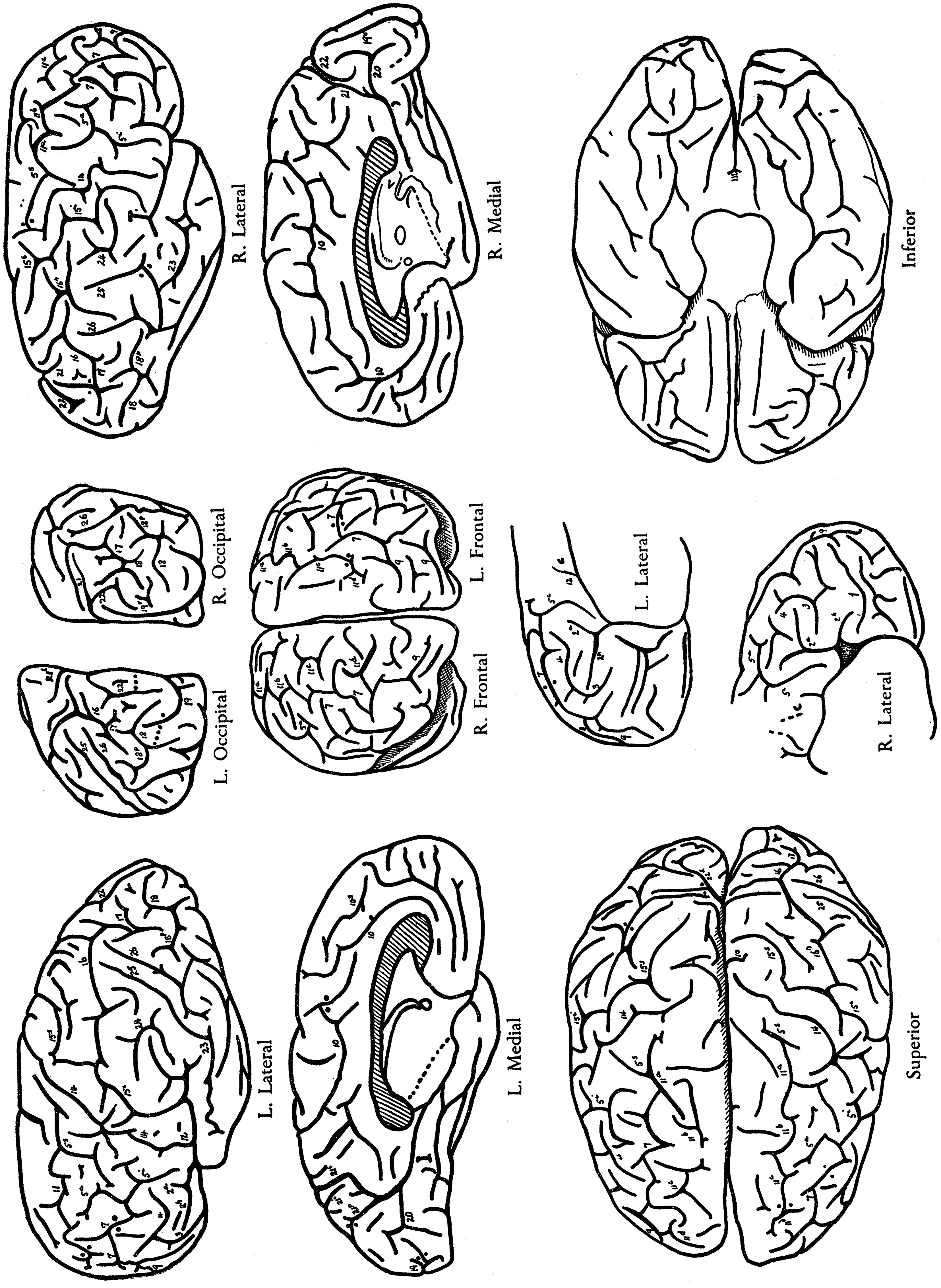
S.1. The brain of "Joey Governor". The right temporal lobe was destroyed by a bullet. The brain is slightly distorted. The drawings are orthogonal projections and are in no way reconstructed.



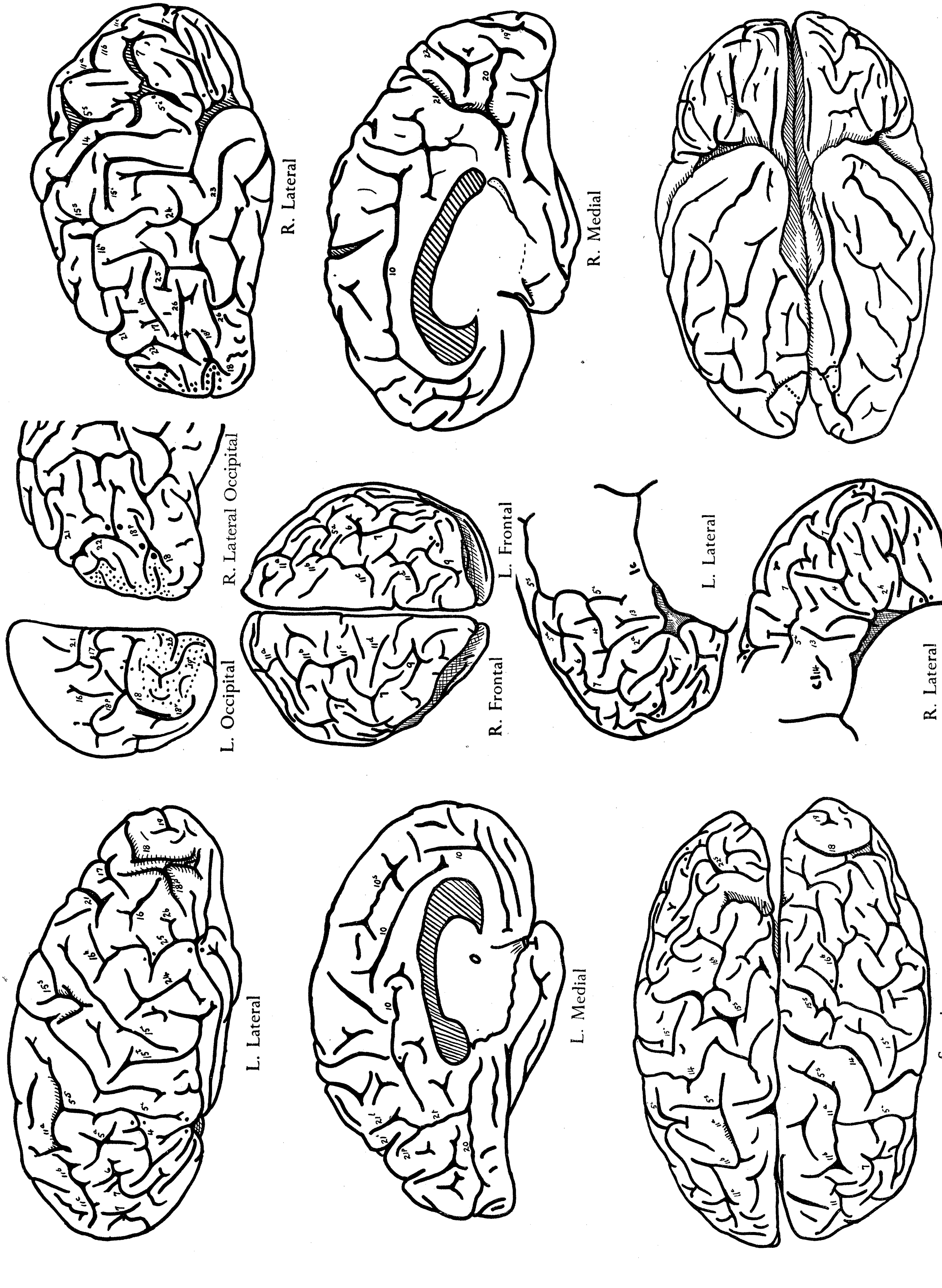
S.2. The brain of "Bob". Obtained in 1884. The brain was much contracted and hardened by preservation. The presence of buried annectant gyri could not be determined. The superficial pattern of the sulci is clear.



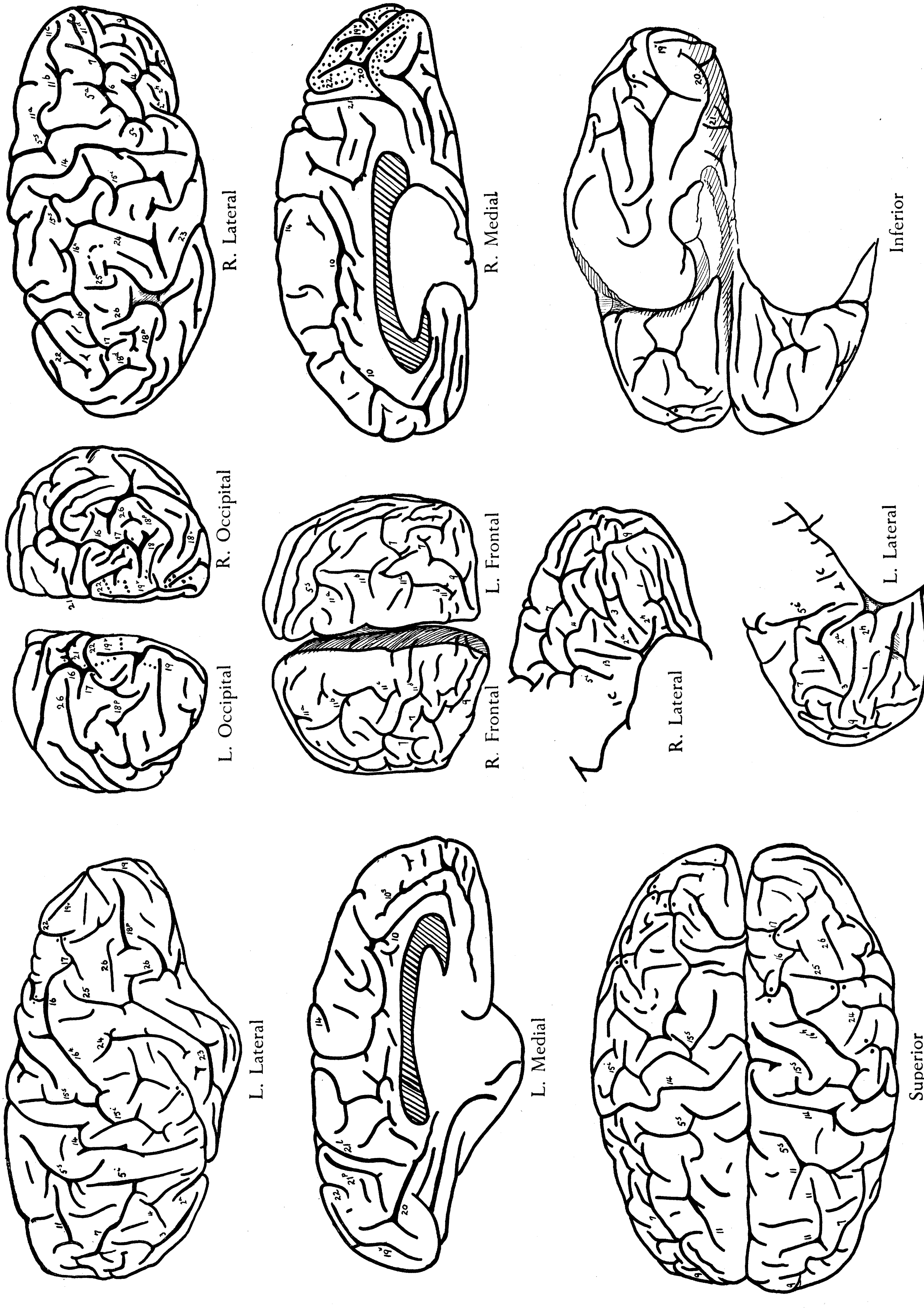
S.3. This brain is also old, it is hard and contracted. The right occipital lobe is somewhat damaged and has become detached along the line of the sulcus lunatus. The drawing is to this extent reconstructed. The pattern of the sulci was clearly definable. On the left side there is some damage in the region of the sulcus lunatus, and so the classification of the sulcus lunatus on this side is a little doubtful.



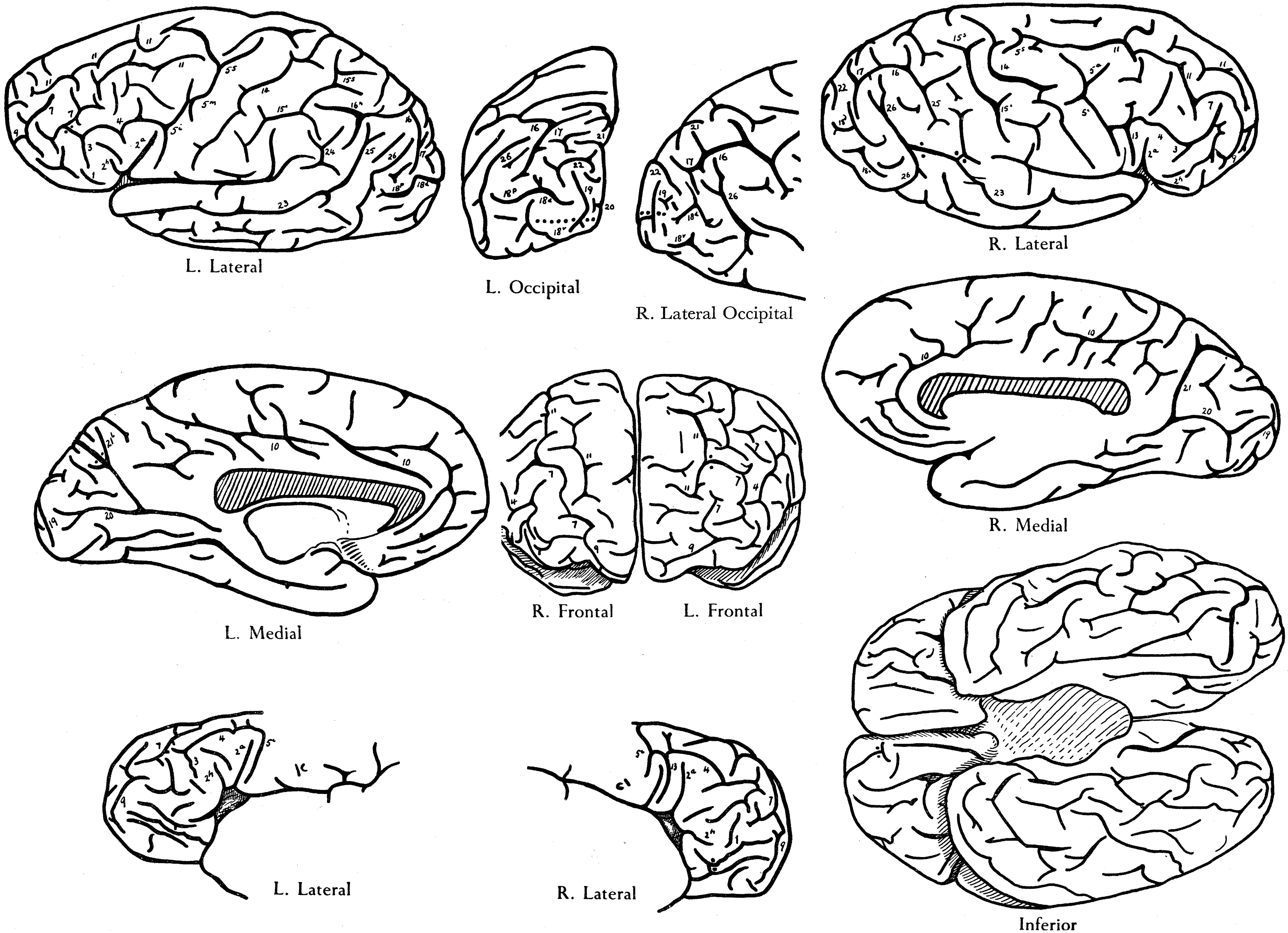
S.4. This brain is slightly contracted and distorted. The only place where there may be some doubt about the disposition of the sulci is on the right lateral occipital region. Attention is drawn to the very primitive pattern of the right medial occipital region.



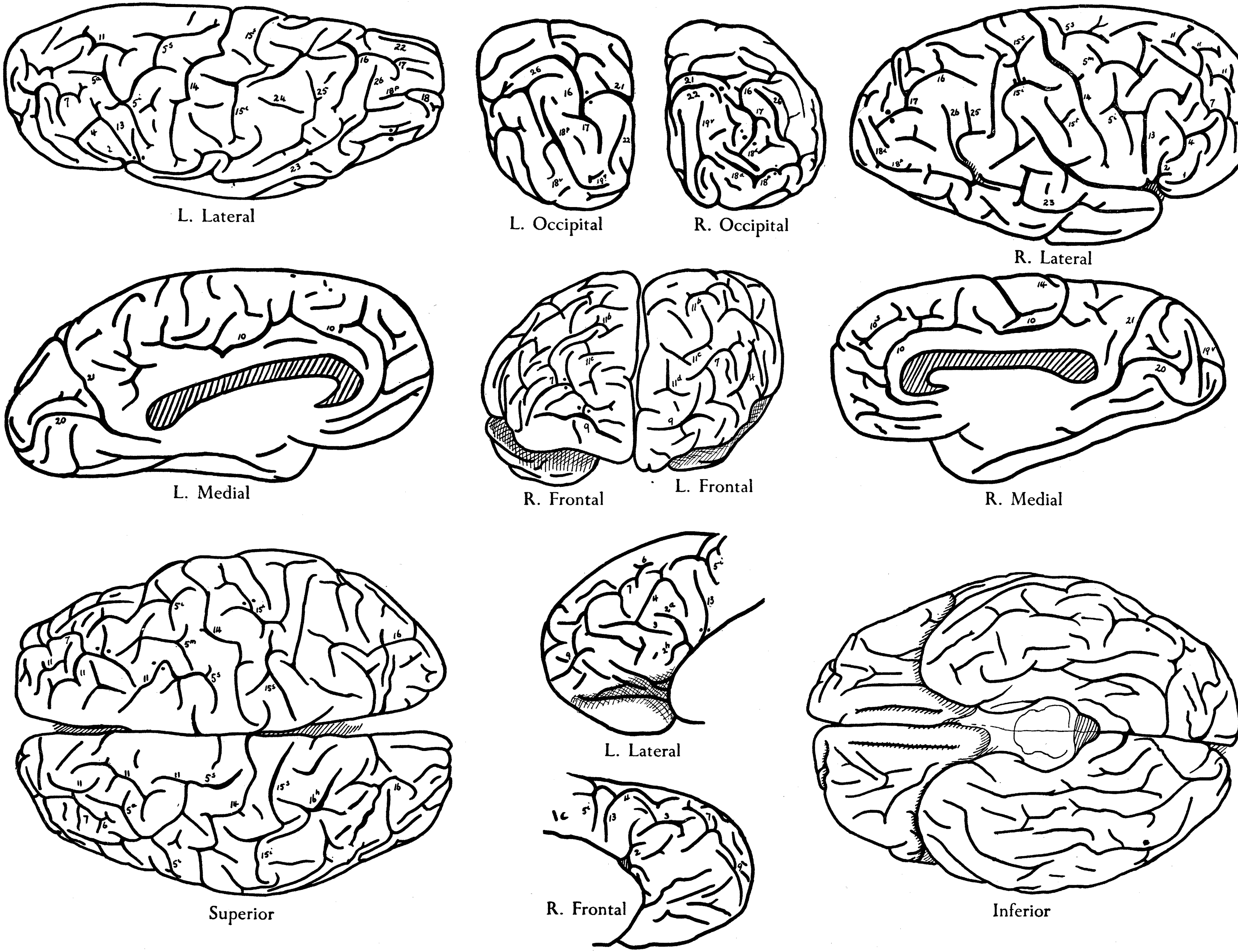
S.5. The brain of "Mick". Photographic reproductions of this brain are shown in FLASHMAN's writings.



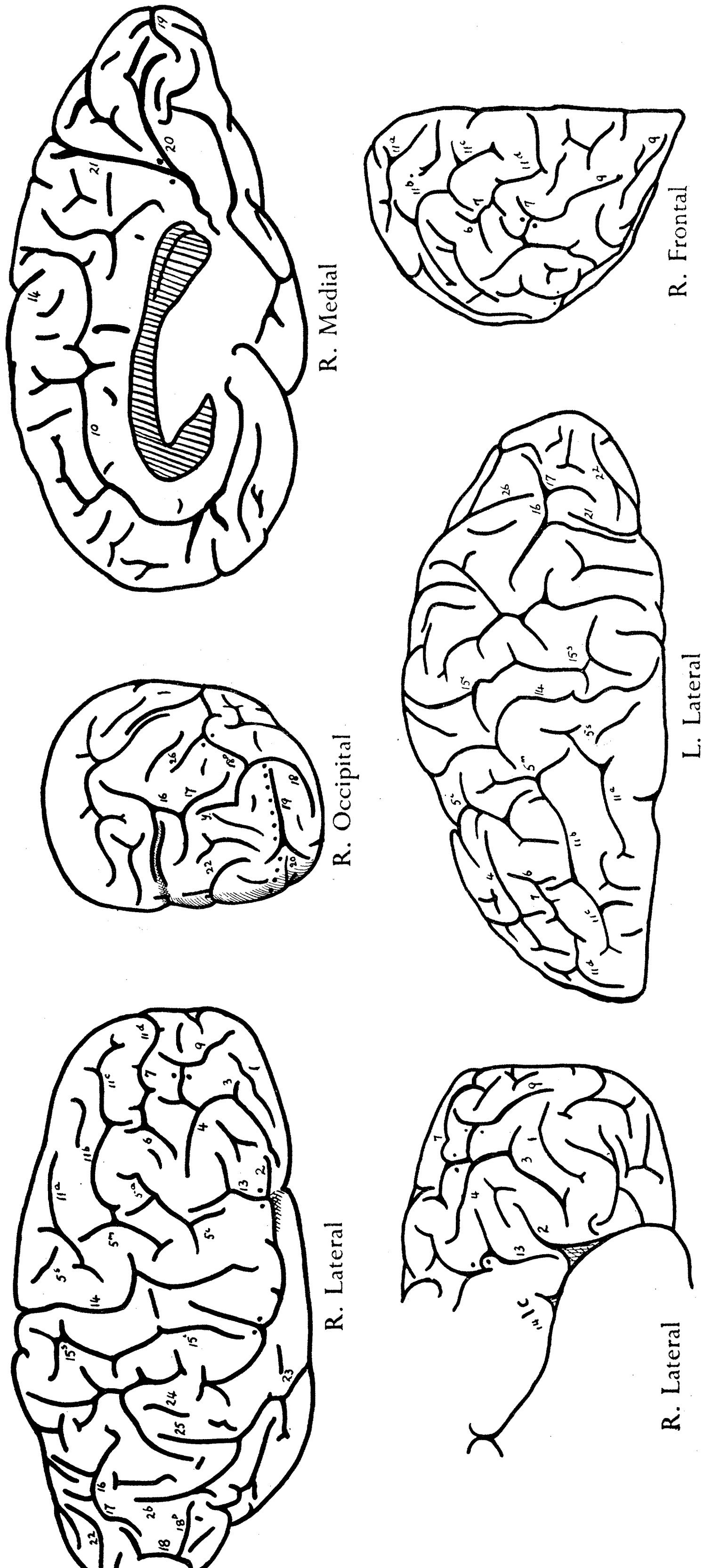
S.6. The brain of "Billy King". Photographic reproductions of this brain are also included in FLASHMAN's work.



S.7. This brain is fairly well preserved, but is somewhat distorted. Handling and some injury throw a little doubt on the form of the sulci of the right lateral occipital region.



S.8. This brain is distorted as shown in the figures of the anterior and posterior aspects. The pattern of the sulci is, however, fairly definite. (*See* photograph, Plate 37.)



R. Medial

R. Frontal

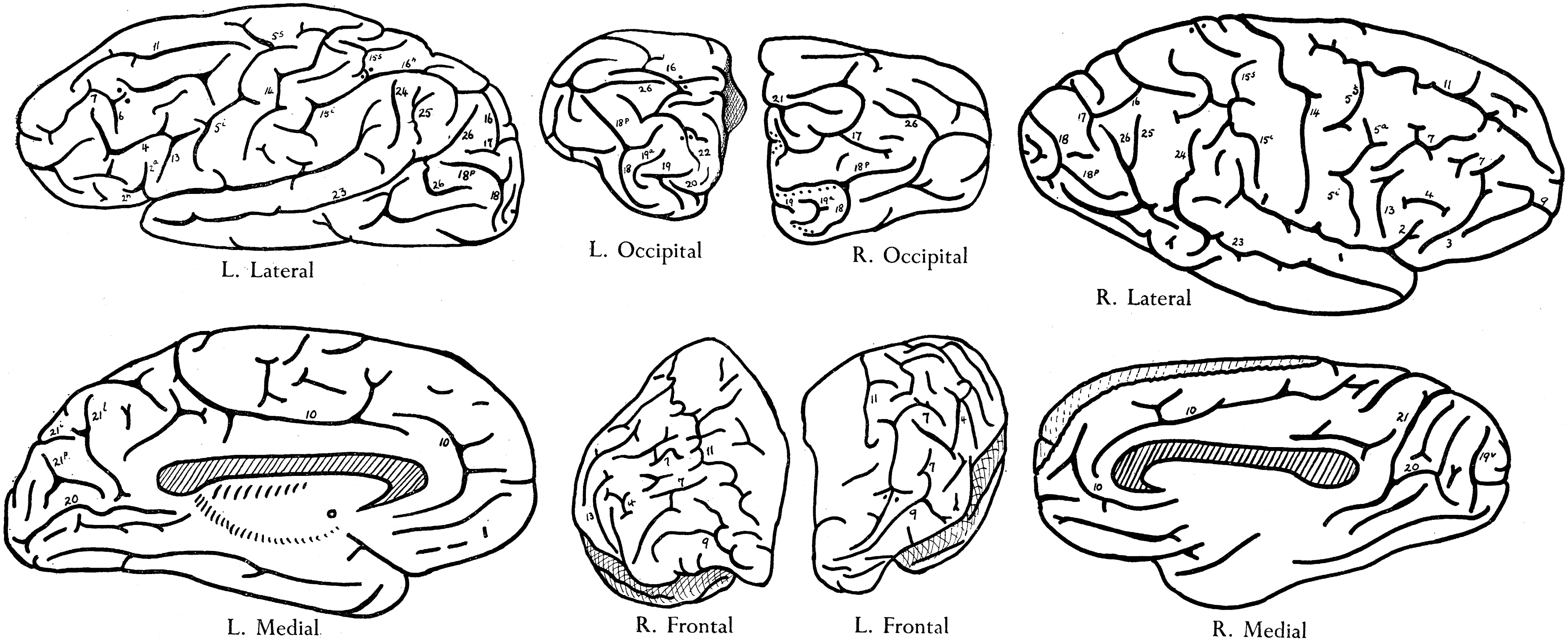
R. Occipital

L. Lateral

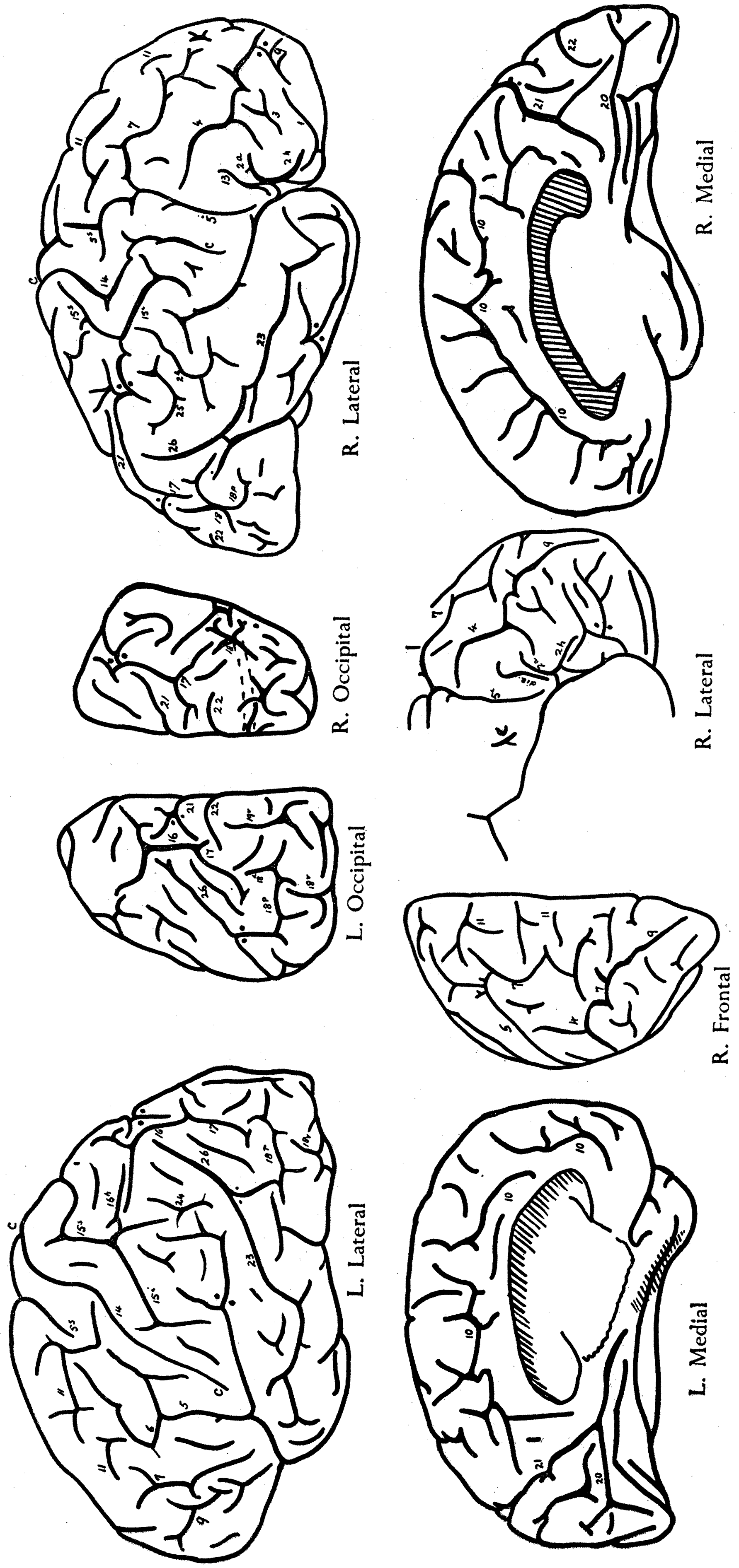
R. Lateral

R. Lateral

S.9. The left hemisphere of this brain is useless; the right hemisphere is well preserved.



S.10. The right hemisphere of this brain has had the superficial layer of the cortex shaved off, and so the drawings show the sulci below the surface. Both hemispheres are very distorted and the drawings are to a considerable extent reconstructed. (*See* photograph, Plate 37.)



R. Lateral

R. Medial

R. Occipital

R. Lateral

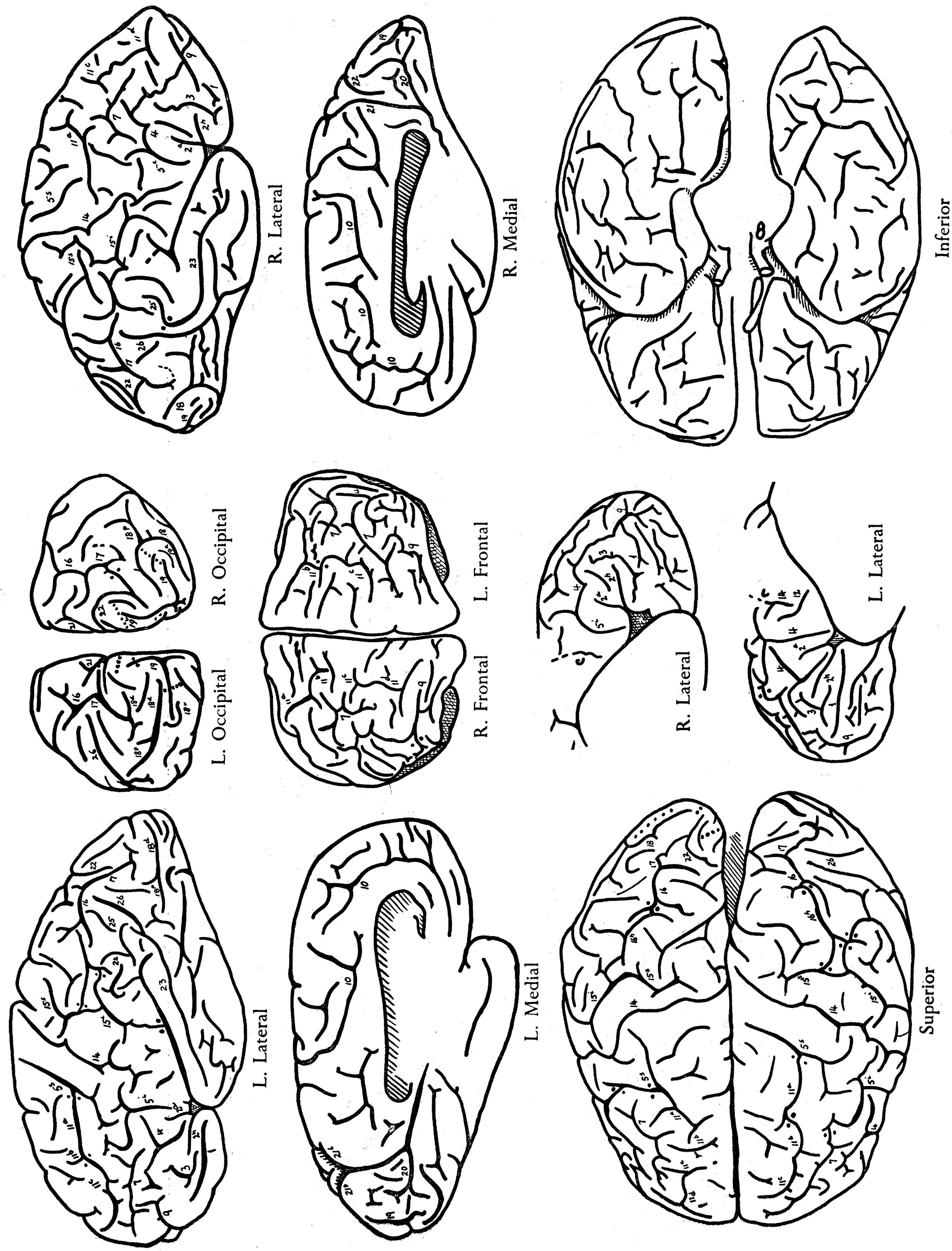
L. Occipital

R. Frontal

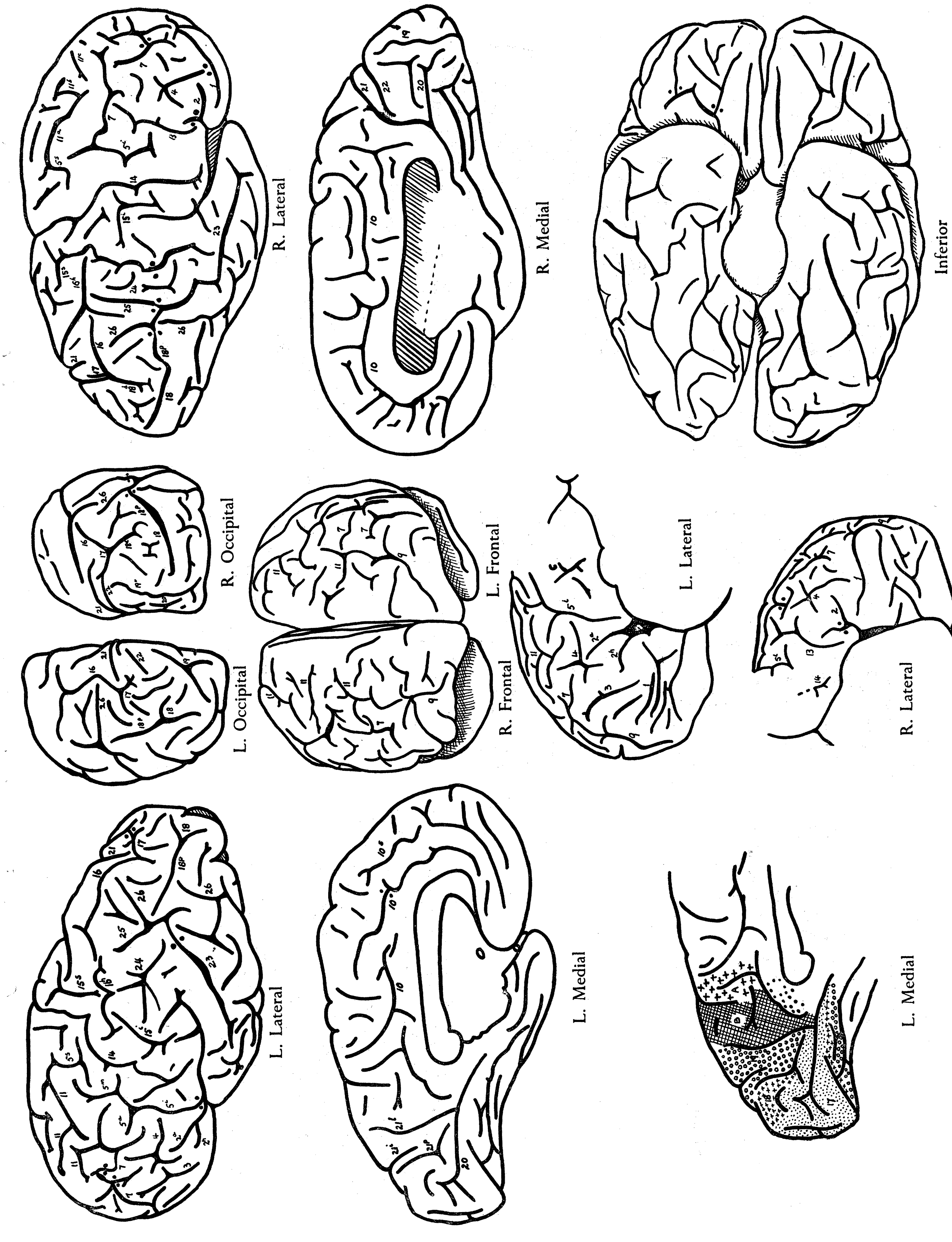
L. Lateral

L. Medial

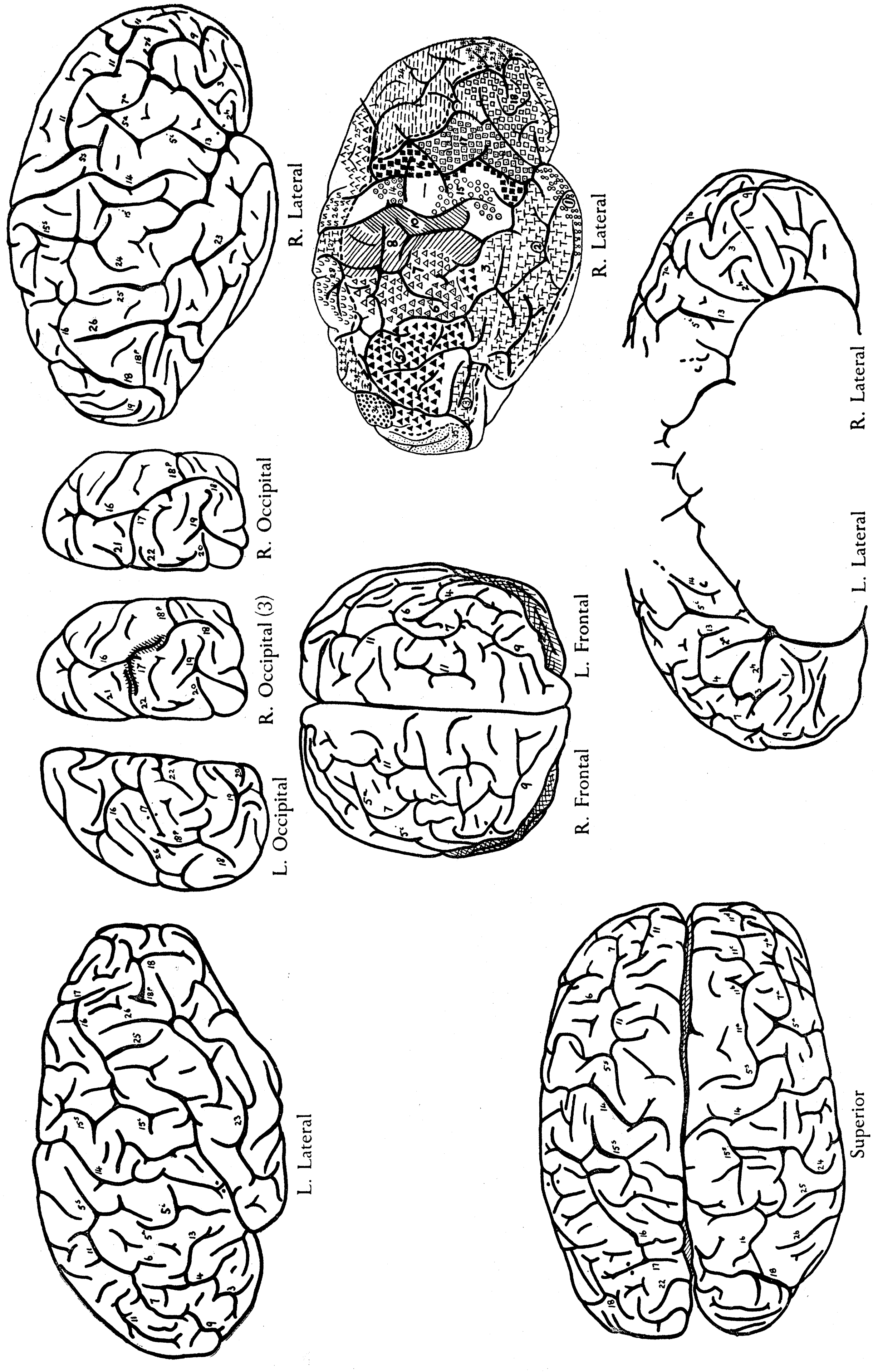
S.11. This brain is considerably distorted; it is, however, well preserved and a fair amount of useful information can be gained from it.



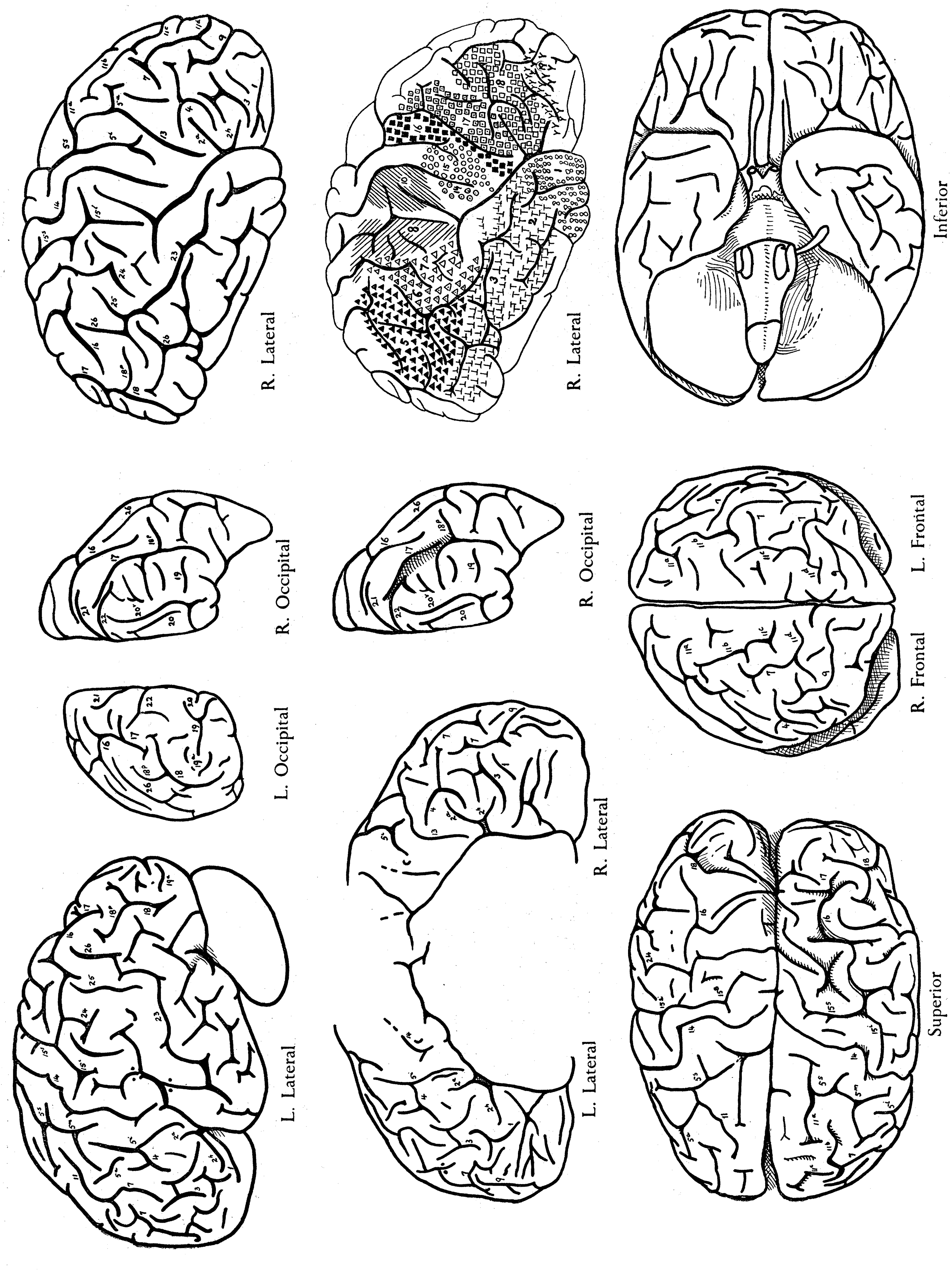
S.12. In fair preservation.



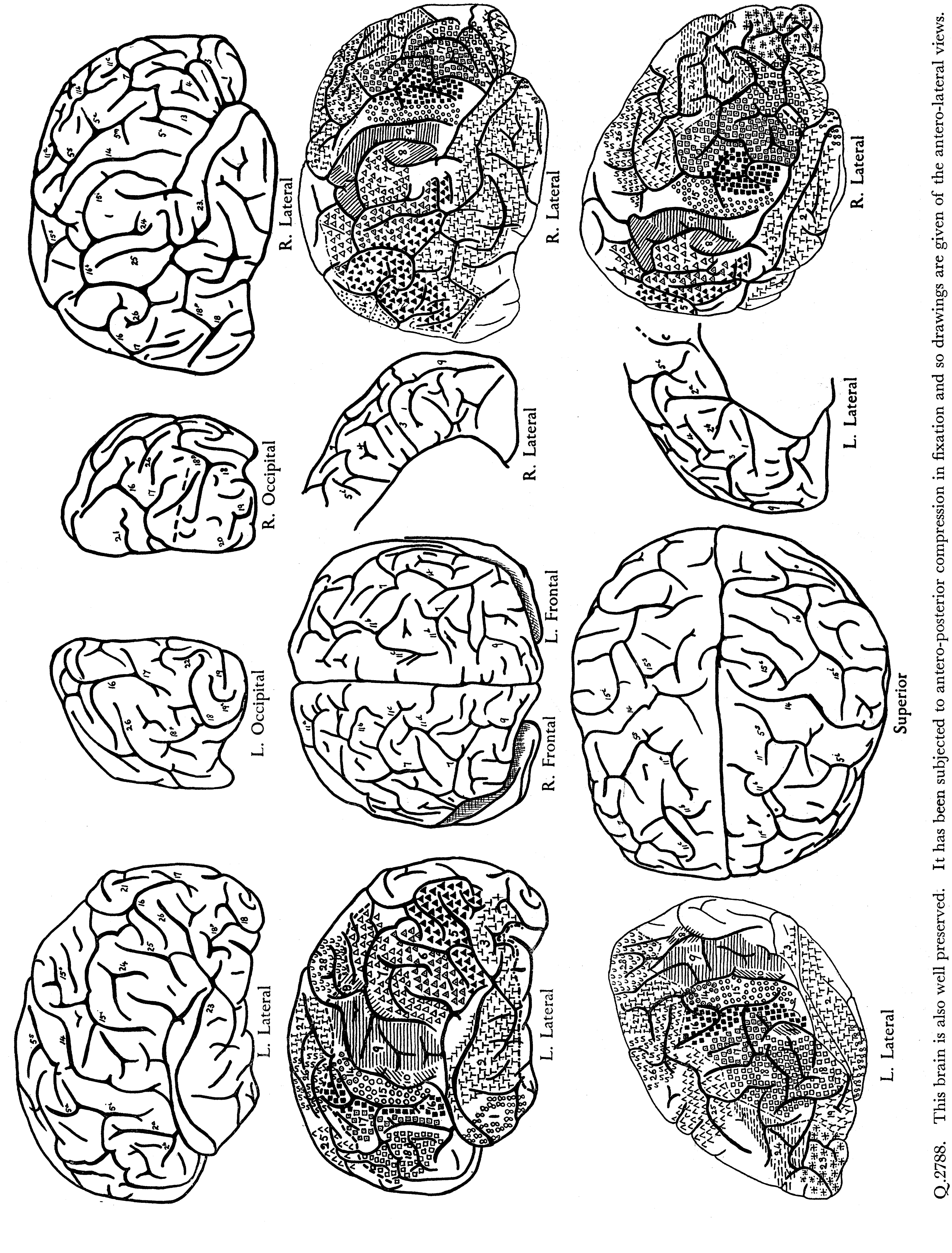
S.13. In a fair state of preservation. (*See* photograph, Plate 37.)



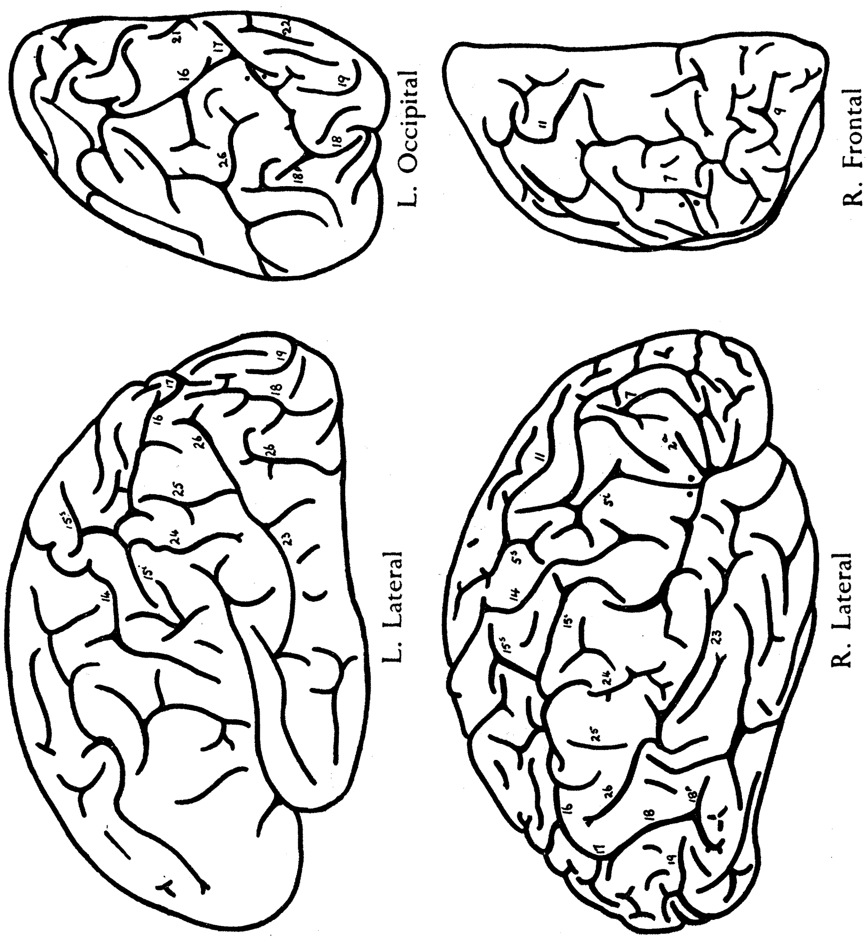
Q.1905. This brain is in an excellent state of preservation. The chart of arterial areas is shown on the plate. A full description of these areas is being given elsewhere. (*See* photograph, Plate 37.)



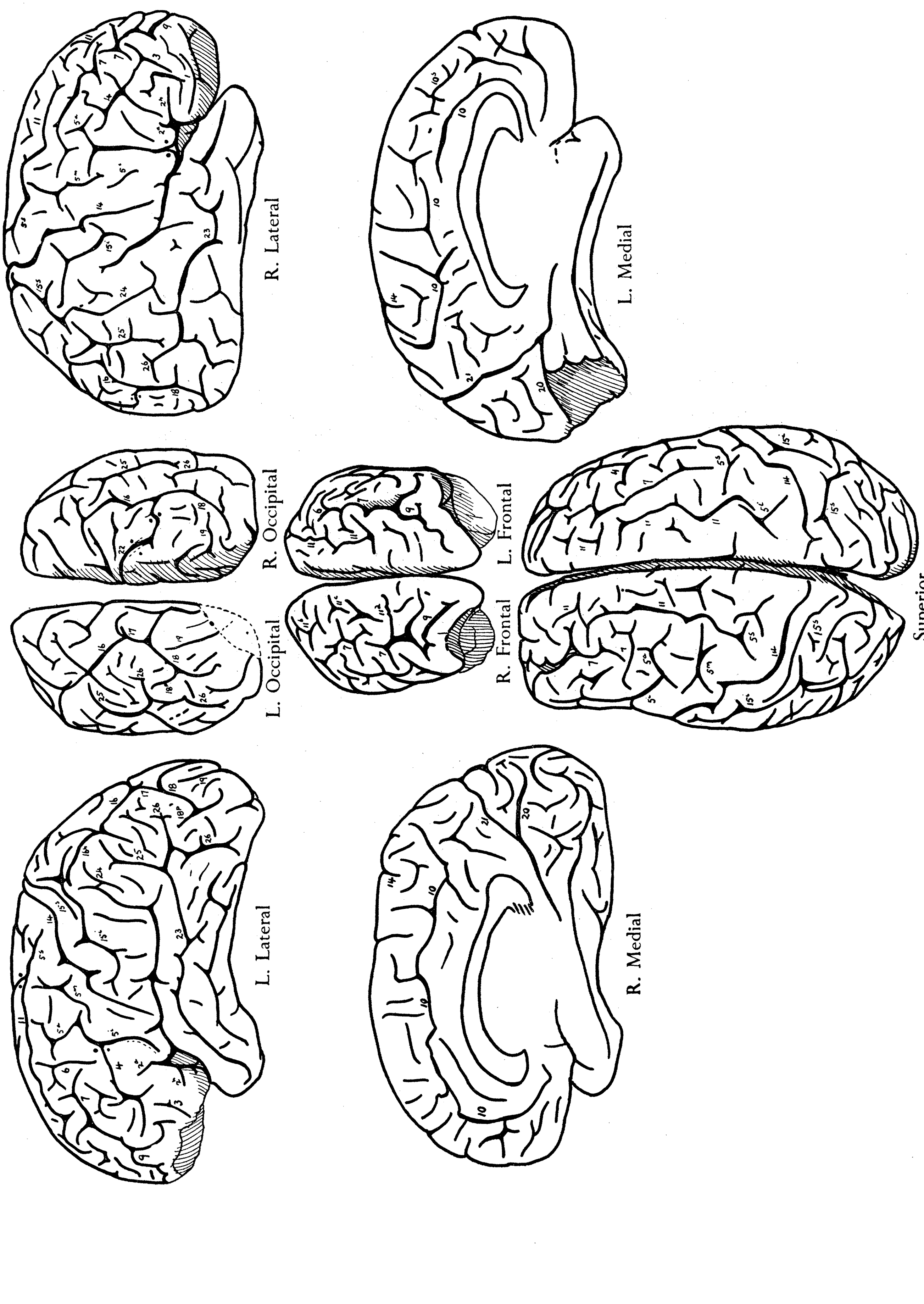
Q.1487. *See* remarks on Plate 28, also photograph, Plate 37.



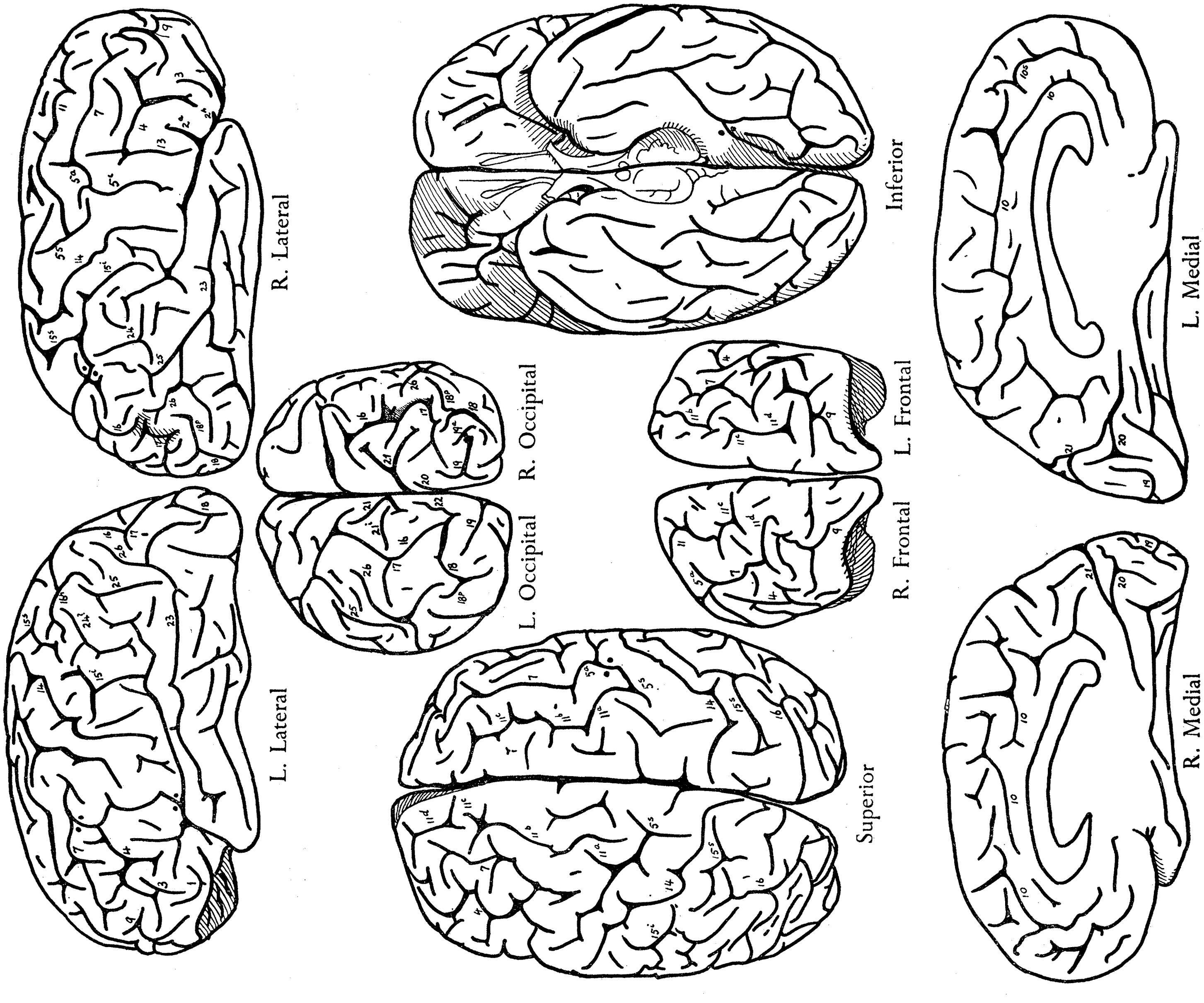
Q.2788. This brain is also well preserved. It has been subjected to antero-posterior compression in fixation and so drawings are given of the antero-lateral views.



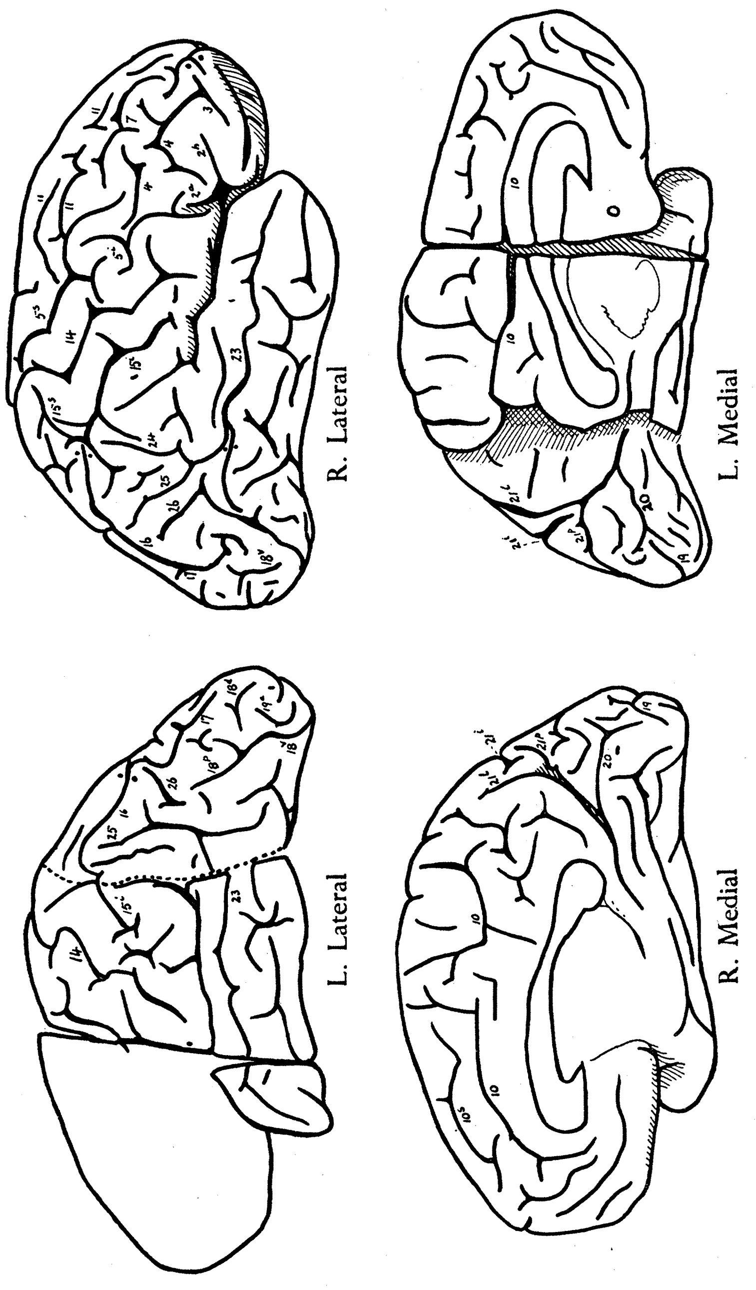
Q.2640. This brain is not in such good condition as the other three Queensland brains. The left frontal lobe was not in a fit state to describe. (*See* photograph, Plate 37.)



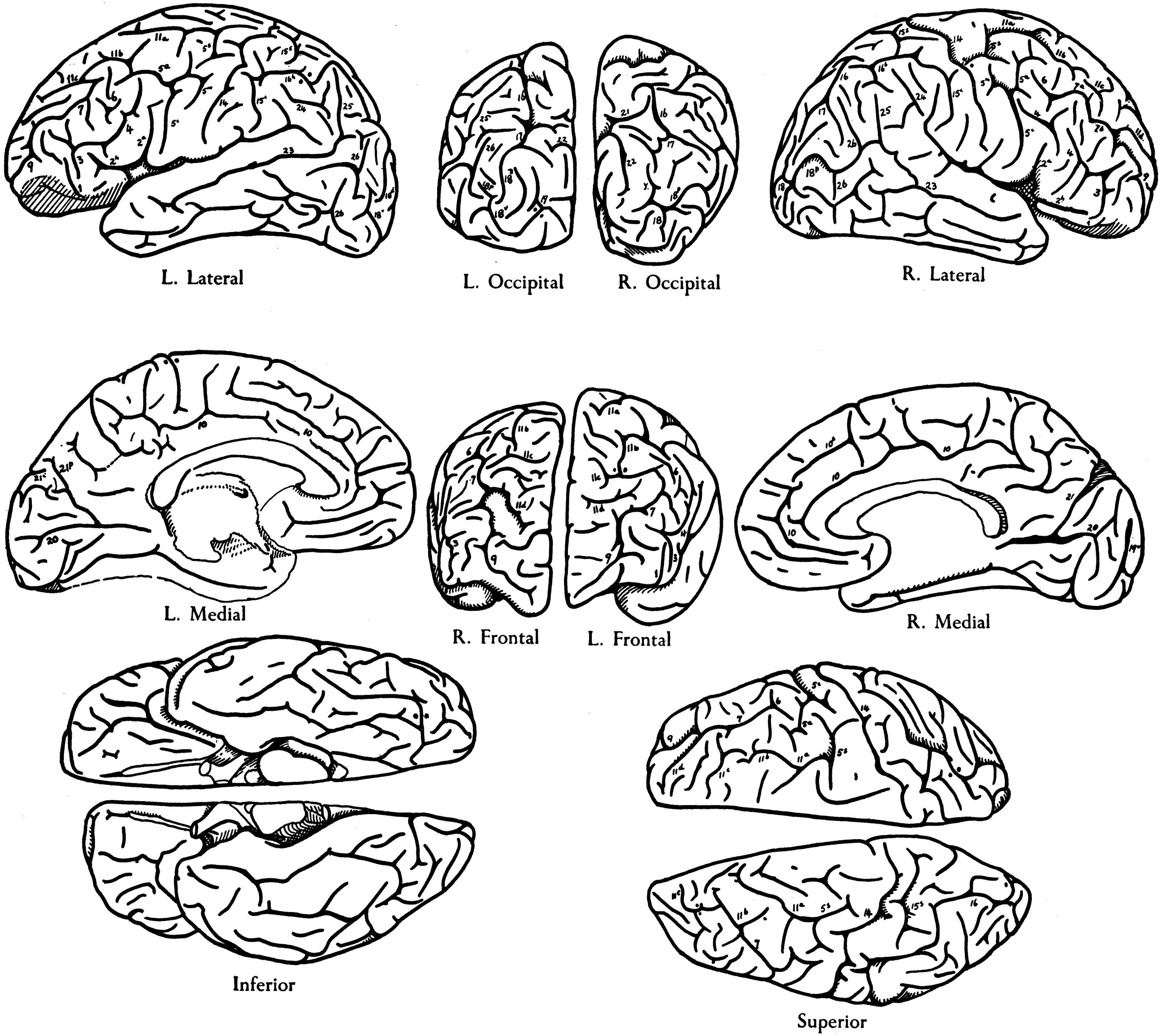
C.2. In good preservation and the sulcal pattern is clear.



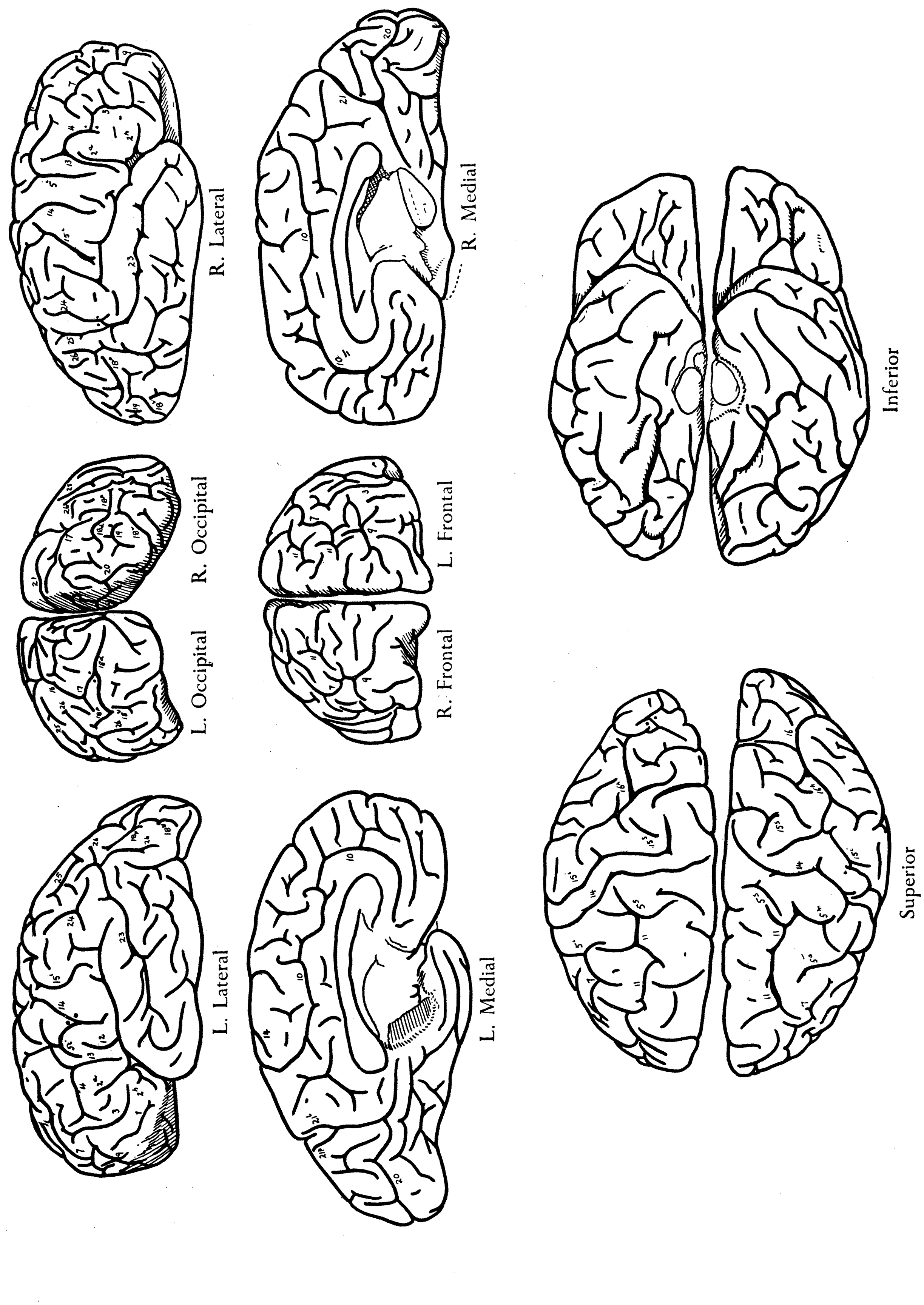
C.3. *See* Plate 32.



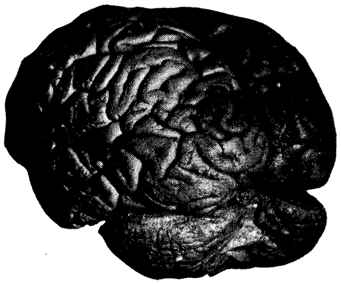
C.4. This brain is not well preserved but a good deal of useful information can be obtained from it.



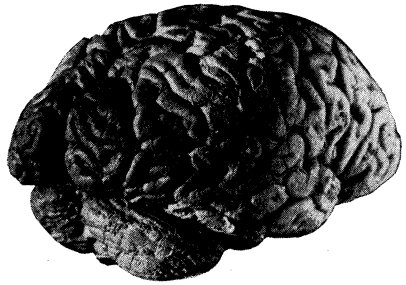
R.C.S. 703.5. This brain is well preserved. It has been depicted by ELLIOT SMITH in his description of the brain of the Tasmanian.



A.954. This brain is in an excellent state of preservation. It is mentioned in some of the writings of KAPPERS. (*See* photograph, Plate 37.)

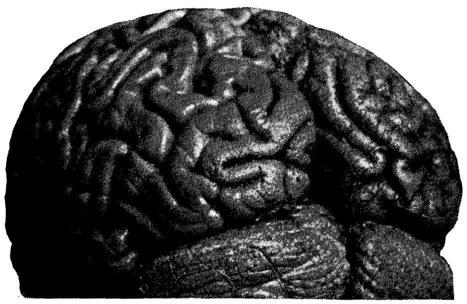


Q.1905. L.P. Lateral



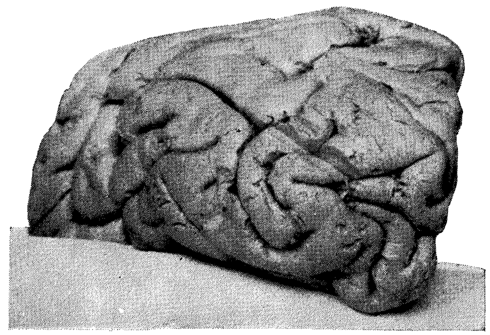
Q.1905. R.P. Lateral

R.P. Lateral. Q.1487

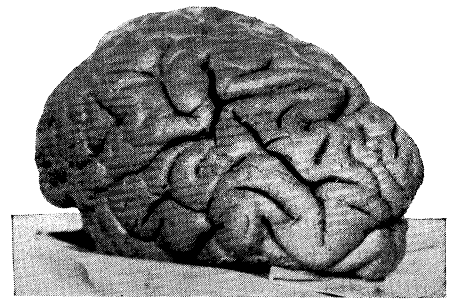


Q.1487. L.P. Lateral

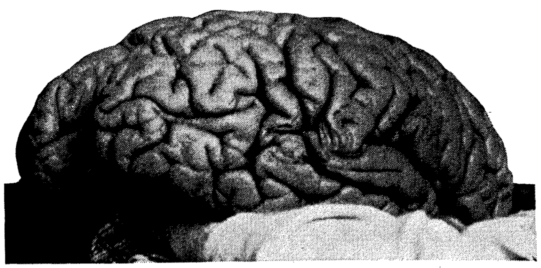
Q.2640. R.P. Lateral



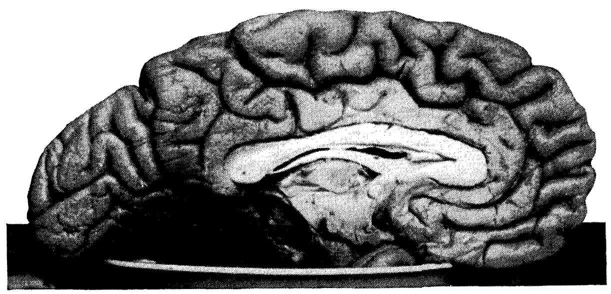
S.10. L.P. Lateral



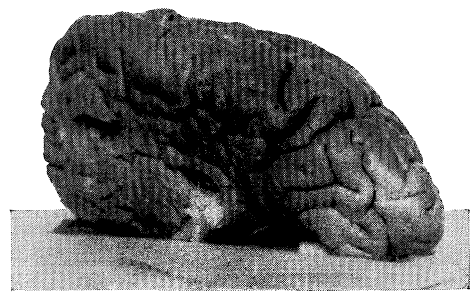
S.13. L.P. Lateral



A.954. R. Lateral



A.954. L. Medial



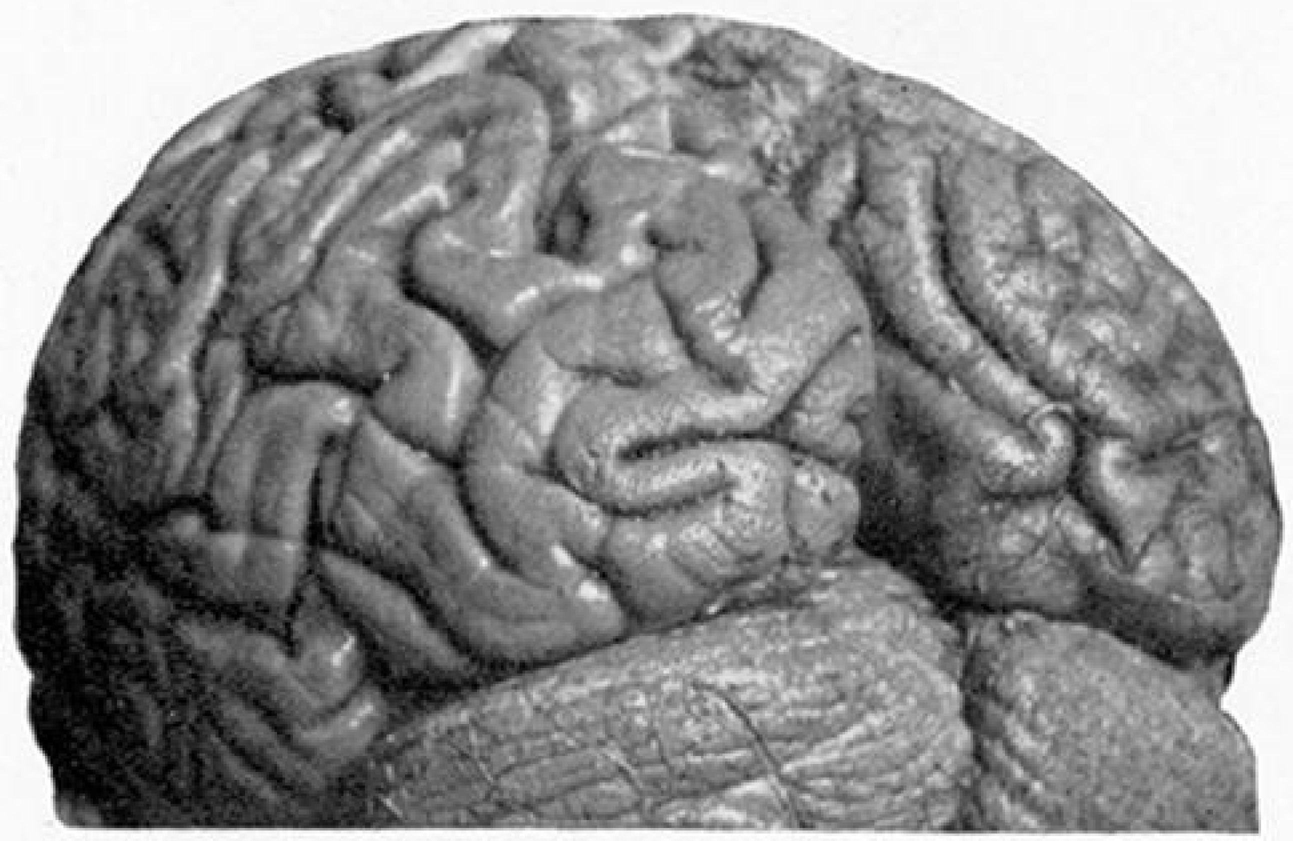
S.8. R. Medial

In this plate eleven photographs are shown of the brains which are reproduced in line drawings in other plates. The photographs are labelled by the brain numbers.

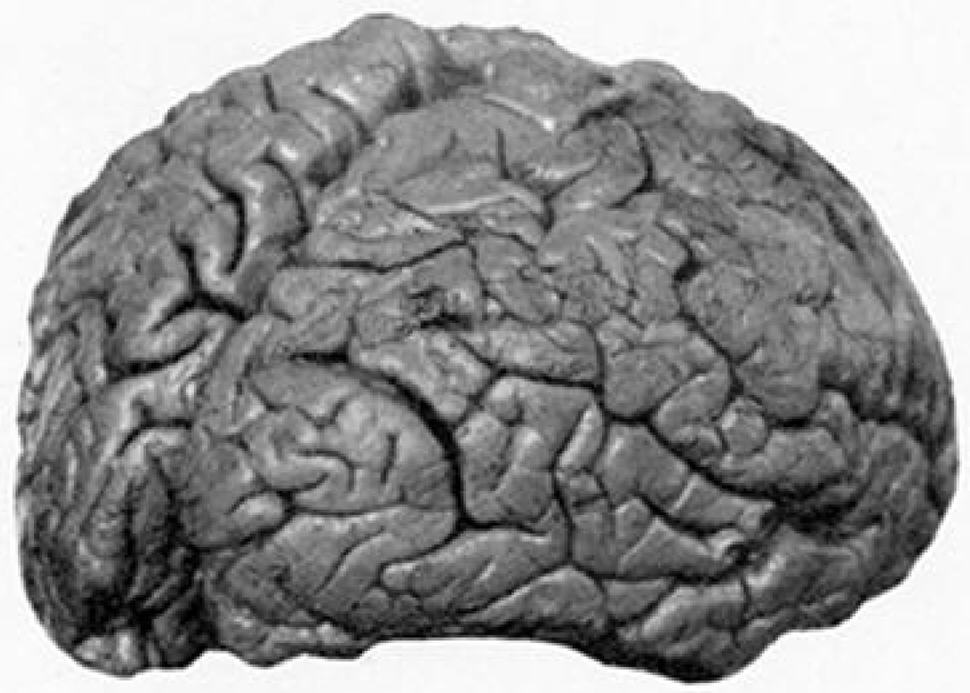
Q.1905. L.P. Lateral

Q.1905. R.P. Lateral

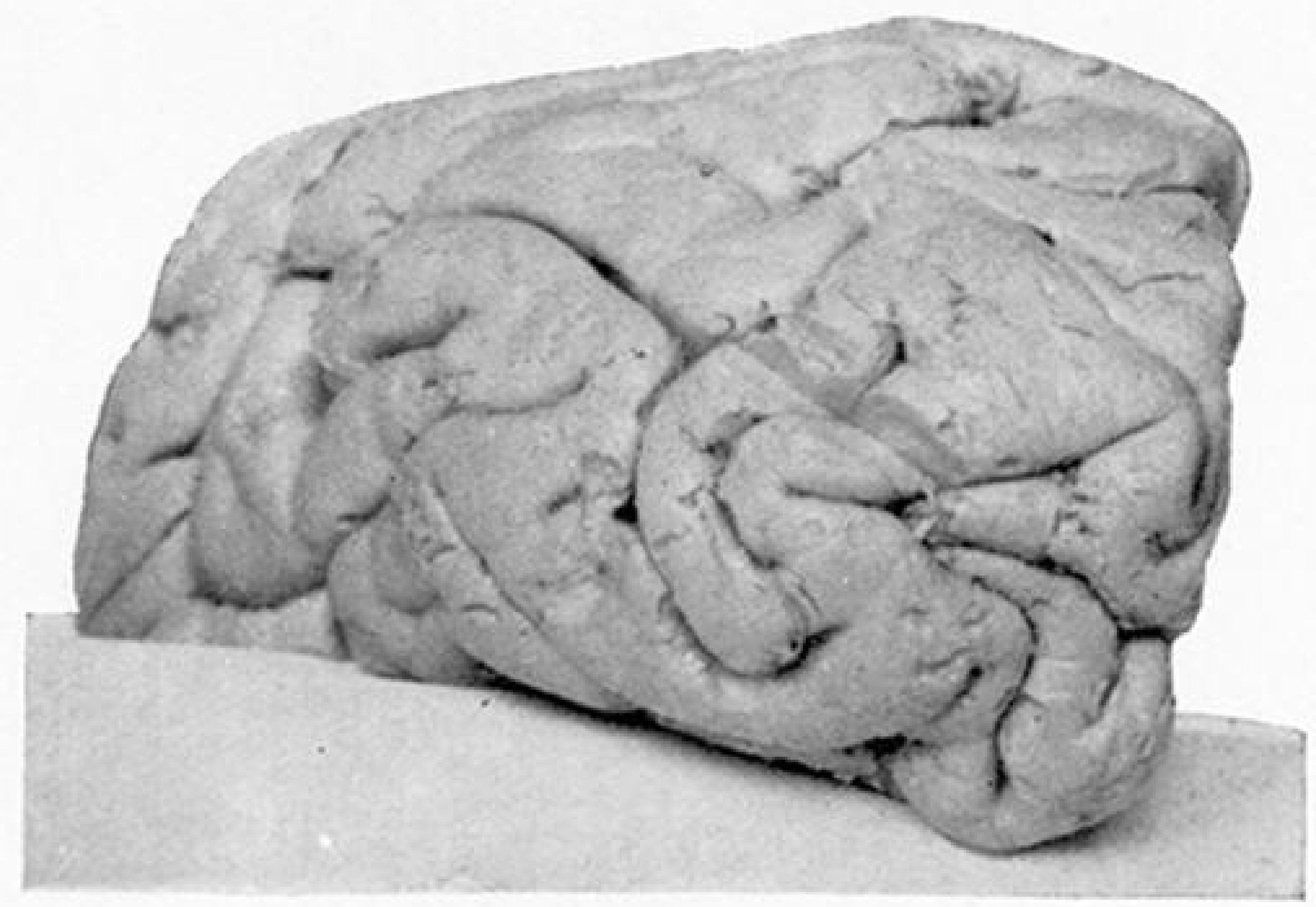
R.P. Lateral. Q.1487



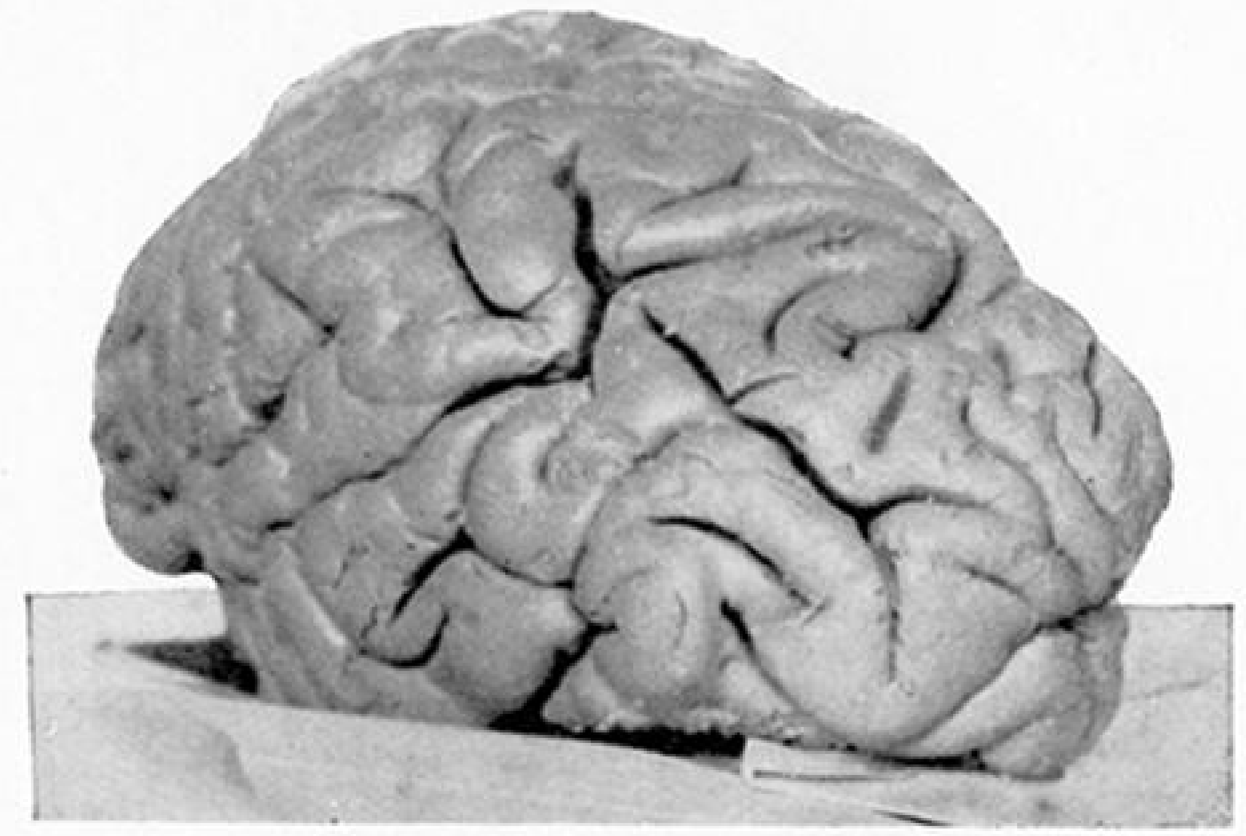
Q.1487. L.P. Lateral



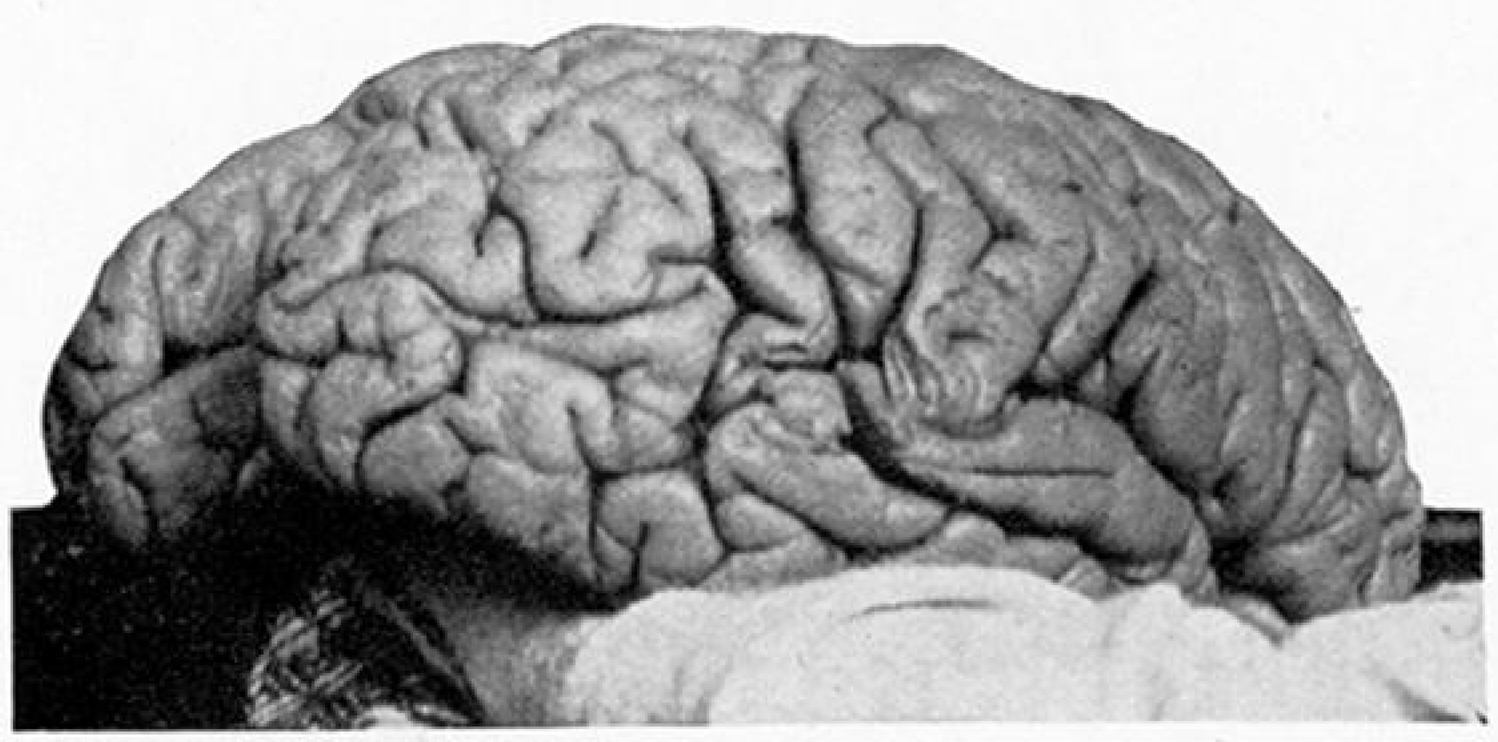
Q.2640. R.P. Lateral



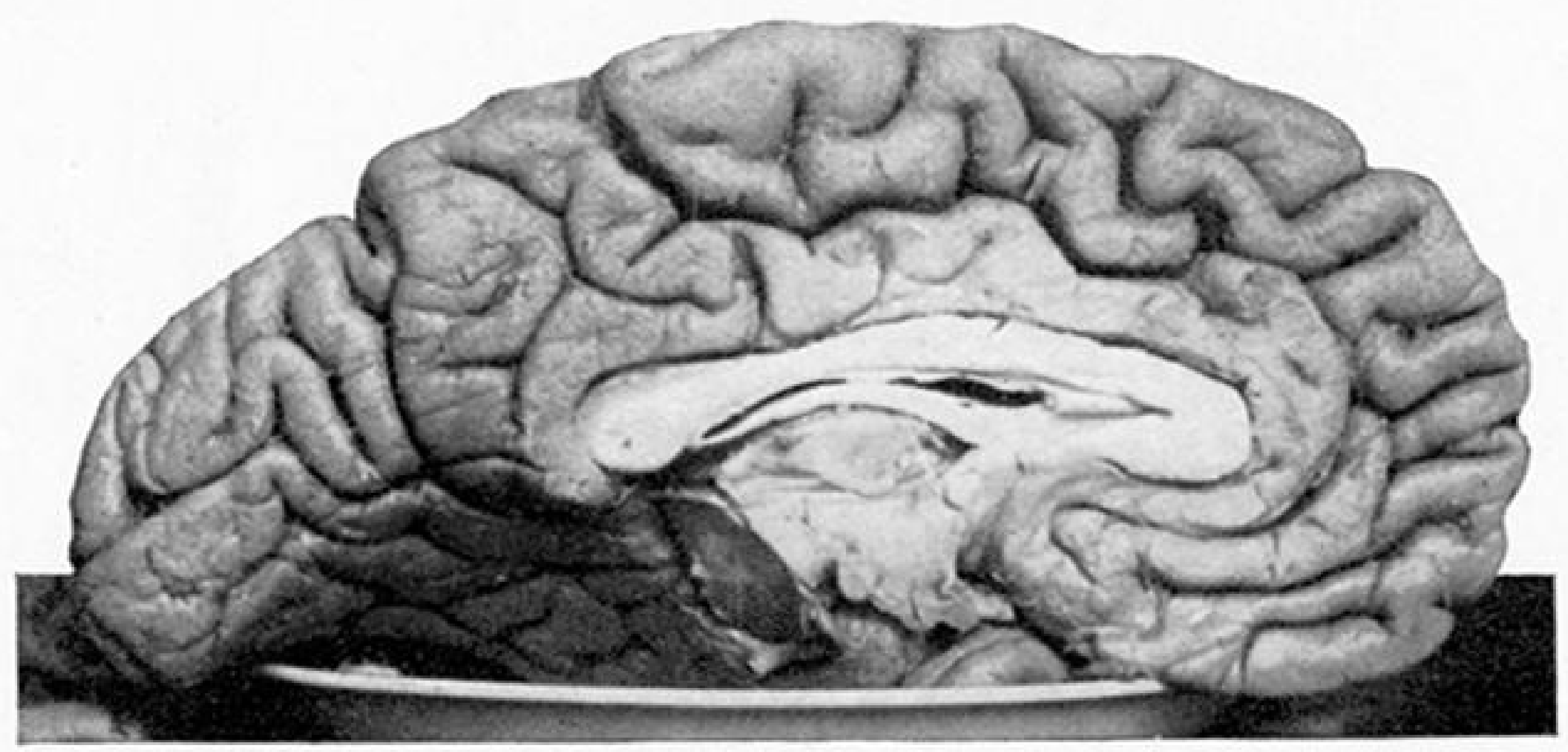
S.10. L.P. Lateral



S.13. L.P. Lateral



A.954. R. Lateral



A.954. L. Medial

S.8. R. Medial

In this plate eleven photographs are shown of the brains which are reproduced in line drawings in other plates. The photographs are labelled by the brain numbers.