THE BRAIN OF THE KENYA NATIVE

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THIS communication is a record of macroscopical and microscopical examination of 100 brains of Kenya natives.

The indigenous population of the Colony is said to be a mixture of Negroid and Hamite stocks. Their physique is poor; that of the Kikuyu, from which tribe 48 per cent. of the material was obtained, has been described by Orr and Gilks as follows:

"The physique of the typical male Kikuyu may be judged from recruiting statistics (Tate, 1917–18). Of the 16,754 men of one district of the Reserve who were called up during 1917 for enrolment in the Carrier Corps, 10,912 were immediately rejected on medical grounds. Following the march of one hundred miles to the depôt at Nairobi, a further 17 per cent. were rejected as physically unfit."

Whether or not this description still holds good for the average native nevertheless, diseases common to other climates are as prevalent amongst the native population as diseases peculiar to the tropics. The high incidence of spirochaetal diseases, yaws and syphilis, must be taken into consideration in any deductions drawn from the findings in this series of brains. Spirochaetal diseases are stated not to affect the central nervous system of Africans, but an investigation just carried out by Dr H. L. Gordon, and my own experience of post-mortem work, do not support this belief for Kenya.

The material used was obtained at autopsies carried out personally in the native hospitals of Nairobi, but does not include cases from the prisons or the Mental Hospital. Only brains that appeared to be normal were used, and were all from adult males. An adult male was regarded as being one of 18 years of age or more. The 100 cases investigated were as follows:

Kikuyu (Bantu)	48
Kavirondo (Bantu)	16
Jaluo (Nilotic)	15
Wakamba (Bantu)	11
Other tribes	10

These 100 brains represent the average native population, but do not include any of the so-called educated class. The educated native is generally the product of the mission schools, and in my experience he is rarely seen on the post-mortem table.

METHODS

On removal of the brain from the body it was weighed without removal of the meninges. It was then suspended by the basilar arteries in 10 per cent. formol saline, care being taken that the brain did not touch the sides or

bottom of the container. Owing to climatic and other local conditions, it was impossible to fix the brain by injection of the carotid arteries.

The preparation of microscopic specimens was as follows. After sectioning, the tissue was carried through the various grades of alcohol, cleared in xylol, and embedded in paraffin wax. Sections were cut at 25μ, taken through xylol and alcohol, to water, and then washed in two changes of distilled water for at least 2 hours. They were then stained for 24 hours, preferably in the dark, in the following solution:

Giemsa's stain	...	...	1·25 c.c.
Methyl alcohol	...	...	1·75
Distilled water	...	...	47·00

On removal from the stain the sections were washed in distilled water and transferred to methyl alcohol containing one drop of 10 per cent. colophonium to every c.c. To obtain even differentiation the sections were kept in constant motion in this solution. They were then passed rapidly through absolute alcohol, placed on slides, blotted and mounted in Gurr's neutral mounting medium. The resulting preparations showed blue-stained nerve cells on a pink background.

WEIGHT OF THE BRAIN

In a series of 389 apparently normal adult male native brains, the average weight was 1276 gm. or 45 oz., the extremes being 1006 gm. and 1644 gm. The weights were taken immediately the brain had been removed from the body with the arachnoid and pia mater *in situ*, and the ventricles full.

Mathews states that the density of the whole brain is 1·037; using this figure the average volume of the native brain is 1230 c.c. In a small series of cases I have estimated the average volume by means of water displacement, and this figure appears to be correct.

The figures given by different authors for the average weight of the brain in white races vary considerably. Shennan gives 1428 gm. as the average of Gray, Cunningham, Luschka, Krause and Neuwerck. If this is the average weight of the European brain, then the average brain of the African native is 152 gm. or 10·6 per cent. lighter.

My post-mortem records suggested that the brain of the native youth is as heavy as that of the adult. Therefore the average weight was calculated by age groups, for those cases in which the age was known, as follows:

Age group Years	No. of cases	Average weight gm.
9–15	29	1301
16–20	74	1279
21–25	87	1270
26–30	69	1264
31–35	24	1262
36–40	13	1256
41 and over	28	1230

From these figures it would appear that the native brain reaches its full weight prior to the age of 18 years, and that there is evidence of decrease after the age of 40.

Some anthropological significance has been attached to the relative weights of the fore-brain and the mid- and hind-brain. Tilney gives the following figures for the human race:

Fore-brain	... ...	86–89 %
Mid-brain	... 1 %	... 11–14 %
Hind-brain	... 10–13 %	

In this series, the average percentages were:

Fore-brain	87·2 %
Mid-brain and hind-brain	12·8 %

These figures for the mid- and hind-brain, as in the case of the whole brain, were obtained from the fresh specimens without the removal of the leptomeninges.

These percentages for the native indicate no significant variation from those of Tilney, but show a uniform reduction in the weight of the different portions of the brain.

THE MACROSCOPIC APPEARANCES OF THE LEFT HEMISPHERE OF 100 BRAINS

General form. Viewed from the side, the upper border of the native brain had a flattened appearance; seen from above the frontal lobes it had a rectangular shape. In the parietal region there was a pronounced increase in width of the brain. The temporal lobes appeared to be narrower than in the European brains used for comparison, and the temporal pole was blunted and turned inwards. All the brains examined showed a pronounced rostrum orbitale. The degree of exposure of the insula varied considerably from brain to brain, being well marked in 34 brains and less marked in 26.

Convolutional pattern. The convolutional pattern differed somewhat from that of the European. Identification of the individual sulci, especially in the frontal region, seemed to me relatively easier in the native.

The *central sulcus* in 14 per cent. of the cases of this series arose on the medial surface of the hemisphere, and in 34 per cent. on the lateral surface. This fissure had not the sinuous course seen in the European, but tended to be straight with poorly developed genua. In 26 per cent. of the cases it reached the Sylvian fissure.

In 22 cases the *lateral cerebral fissure* (fissure of Sylvius) had one ramus absent or represented by a mere indentation of the cortex of the brain. In general the ascending ramus was situated in close proximity to the inferior portion of the precentral sulcus. Posteriorly the Sylvian fissure passed into the parietal lobe, and in 12 of the brains cut through the supramarginal gyrus to end in the intraparietal sulcus.

The *precentral sulcus* in 14 brains was shown as a continuous fissure, and in 17 cases was divided into three portions. It tended to join the Sylvian either directly or through the anterior subcentral fissure.

The *superior* and *inferior frontal sulci* generally were found to arise in the precentral sulcus, and were often seen as small, broken fissures. The *sulcus frontalis medius* (Eberstaller) was well defined; in 43 cases it arose in the precentral sulcus and passed forward usually as a continuous sulcus to end in the fronto-marginal. The *sulcus radiatus* was present in all the brains examined, but the *sulcus diagonalis*, the *sulcus subcentralis anterior*, and the *paramedians* were variable.

The *superior temporal sulcus* was continuous in 76 of the brains, and on the whole started rather far back in the temporal lobe. The *middle* and *inferior temporal sulci* were poorly developed, being seen as small discontinuous fissurettes. The *rhinal sulcus* tended to a straight course, but occasionally was boldly curved.

In 51 of the brains the *intraparietal sulcus* commenced in the post central sulcus. In all brains it rose rapidly towards the upper border to pass backwards, and end in the transverse occipital fissure. In 24 brains it was divided into its component parts.

A *lunate sulcus* is a common finding in the African brain, being present in 70 of the brains of this series. In these 70 it was well developed in 54, and to a lesser degree in 16.

In 10 brains the *calcarine fissure* lay entirely on the medial surface of the hemisphere; in 32 the lateral portion was separated from the rest of the fissure. The *paracalcarine fissure* was, on the whole, poorly developed. It is noteworthy that the parieto-occipital fissure in one brain did not reach as far as the medial border of the hemisphere, while in 23 brains it passed through the arcus parieto-occipitalis to end in the intraparietal fissure.

ANTHROPOMETRY

Measurements of the head of the East African by Dr H. L. Gordon show it to be dolichocephalic, the length/breadth index calculated on 1000 male adults of all tribes being 74·8. The degree of dolichocephaly varies with the tribe under examination, and this must affect the indices of a series of brains derived from different tribes. Nevertheless, indices have been prepared from 12 consecutive brains according to the method of Kappers. The following are the average figures:

Height index	0·462
Occipital index	1·093
Temporal depth index	0·130
Temporal length index	0·749
*Frontal height index	1·594
*Frontal length index	0·251
Callosal index	0·295

* These two indices are Kapper's original ones, i.e. frontal height index = insular perpendicular divided by its distance from the frontal pole, and the frontal length index = distance from the insular perpendicular to the frontal pole, divided by the lateral horizontal.

The indices depending on height measurements are smaller in the native brain than in Kappers' series of Dutch dolichocephalic brains, and yet the degree of dolichocephaly of the native head is anything but marked. Therefore, it is possible to conclude that any failure of development of the native brain is shown in the height. The same conclusion can be drawn concerning the temporal lobe.

MICROSCOPIC APPEARANCES

Bolton, dealing with the subject of cortical measurements, stresses particularly that his measurements are the average of the depths of the laminae in four regions of the convolution, the flat external surface, the fissure lips, the sides of the fissure and the bottom of the fissure. Von Economo, on the other hand, while pointing out that the crown of the gyrus possesses a cortical lamination twice as thick as the floor of the sulcus, does not mention whether his measurements are obtained in the same manner as Bolton's, or whether they are taken only from the flat external surface of the gyrus. The total of his measurements of the laminae in each area lie within the limits given in his "Table of cortical thickness of the crowns of the gyri of the most important areas." It was assumed from this that the measurements given by this author were taken from the crown or flat external surface, and on this assumption the measurements of the native cortex, which are taken from the crown or flat external surface of the gyrus, are compared in Table I with the figures given by Von Economo for the corresponding areas of the European brain. The measurements of the native cortex given in the table are the average for the brains of this series, and in each case the sections were taken from the left hemisphere of the brain. The portion of cortex from which the sections were prepared is shown in figs. 2 and 3.

The average total reduction of the whole cortex as compared with the European in the areas examined is 14·8 per cent.

Woollard states that in the precentral motor area of the brain of the Australian aboriginal the internal granular layer, though reduced in size, is a more marked remnant than in the white brain. In the African, while there is definitely a remnant of this internal granular layer present, it does not appear to be more marked than in the European. On the other hand, the pyramidisation of the cells in this area of the African brain is not so complete. In the motor area there is another significant fact. Betz cells are less conspicuous than in the European; they appear to be fewer in number and are definitely smaller in size. Von Economo gives the measurements for Betz cells as $\frac{60-120\mu}{30-60\mu}$. In the native cortex the size is $\frac{45-90\mu}{25-45\mu}$. Giant pyramidal cells were not found in sections taken from the intermediate precentral area (area 6). The striated appearance which is so noticeable in some areas of the European cortex is not so well shown in the native brain.

The cortical measurements of the native show that, except in the visuosensory area (area 7), the lamina zonalis is in every case greater than in

the European brain, whereas the measurement of the supragranular layer is smaller. This appears to be in keeping with the statement of Kappers:

"The space between the surface and the granular layer originally is an important region for corticopetal impulses. It is not strange that these impulses

Table I. *Cortical measurements*

Area	Laminae	Measurement in mm.	% increase or decrease compared with the European brain
1 (F.E.)	Zon.	0·251	+14
	Supragran.	0·665	−11
	Gran. int.	0·216	−28
	Infragran.	1·049	− 5
	Total	2·181	− 9
2 (F.B.)	Zon.	0·242	+10
	Supragran. + Gran. int.	0·963	−36
	Infragran.	1·625	−14
	Total	2·830	−20
3 (F.A.)	Zon.	0·226	+25
	Supragran. + Gran. int.	1·127	−25
	Infragran.	1·653	−21
	Total	3·006	−21
4 (P.C.)	Zon.	0·231	+ 5
	Supragran.	0·832	−26
	Gran. int.	0·260	−26
	Infragran.	1·136	*
	Total	2·459	−22
5 (T.A.)	Zon.	0·232	+ 5
	Supragran.	0·922	−12
	Gran. int.	0·171	− 5
	Infragran.	1·333	− 5
	Total	2·658	− 7
6 (F.D.C.)	Zon.	0·202*	.
	Supragran.	0·700*	.
	Gran. int.	0·181*	.
	Infragran.	0·944*	.
	Total	2·027	−19
7 (O.C.)	Zon.	0·181	− 5
	Supragran.	0·338	−14
	Gran. int.	0·600	−25
	Infragran.	0·766	+14
	Total	1·886	− 8
8 (O.A.)	Zon.	0·195	+ 8
	Supragran.	0·671	−19
	Gran. int.	0·200	− 0
	Infragran.	0·868	−18
	Total	1·978	−13

The letters in brackets are Von Economo's areas.

* No details of these laminae are given by Von Economo, and the total width of the cortex in these cases is taken from his "Table of cortical thickness."

give rise to a much greater outgrowth of matrix cells of the granular layer in a superficial direction, and thus to the formation of the supragranular cell layers which, in maturing, at the same time acquire a larger size."

In connection with this statement it is interesting to note that the average

measurements of the pyramidal cells of the supragranular layer of the African brain are smaller than in the corresponding areas of the European brain. There has been some evidence in this series of native brains to show that the average size of the pyramidal cells in individual brains bears a direct relationship to the width of the layer in question. It is hoped to investigate this question further.

The increase in thickness of the infragranular layer in the visuo-sensory area is worthy of note.

Cell counts carried out on sections from the different portions of the brains examined failed to show a diminution in the number per unit area, as compared with the brain of the European. Any apparent reduction assumed from inspection of photographs is attributable to the cells being smaller in the native brain, and by the fact that many of the cells are only slightly differentiated. Woollard, on the contrary, found that the closeness of packing, the degree of differentiation and the size of the cells, were much the same in the Australian aboriginal and the European brains.

For the whole brain the average ratio of the supragranular layer to the infragranular layer is 5:8. The average ratio of the figures of Von Economo for the same areas is 6:8.

In an endeavour to check the figures in the foregoing table, measurements according to Bolton's method were carried out on the prefrontal, visuo-sensory and visuo-psychic cortices. The results obtained by this method of measurement, on comparison with Bolton's figures, showed no significant deviation from the results already given.

SUMMARY

1. The average weight of the brain of the Kenya native is 10·6 per cent. or 152 gm. less than the average weight given for the brain of the European.

2. No disproportion was found in the percentage weights of the fore-brain and the mid- and hind-brain in the native.

3. A lunate sulcus was present in 70 per cent. of the brains examined, and there was a tendency to exposure of the insula.

4. The reduction in size of the native brain, as compared with the European, seems to be accounted for mainly by a failure in development in height.

5. The cortex of the native brain was found to be narrower than that of the European. This is true of all the individual laminae in the areas examined, except in the lamina zonalis, and in laminae 5 and 6 of the visuo-sensory area.

6. The pyramidal cells of the supragranular cortex, and the Betz cells of the motor area, are smaller in the native brain than in the European.

7. Cell counts per unit area are the same in the African and European brains.

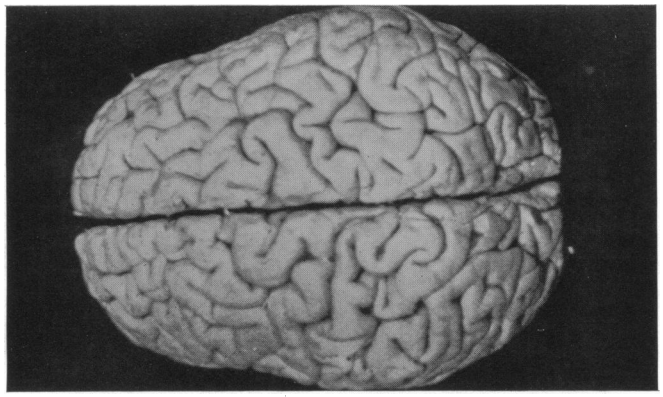

Fig. 1

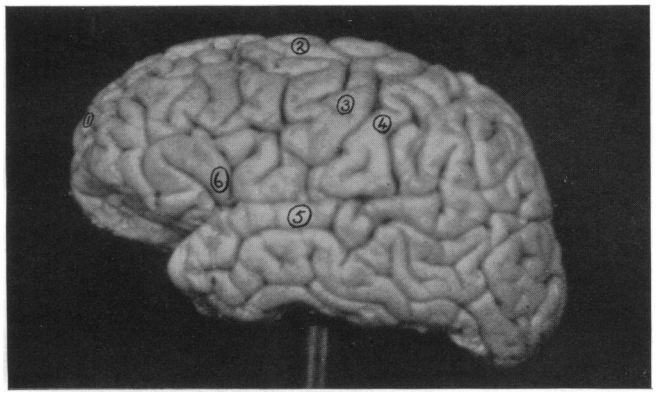

Fig. 2

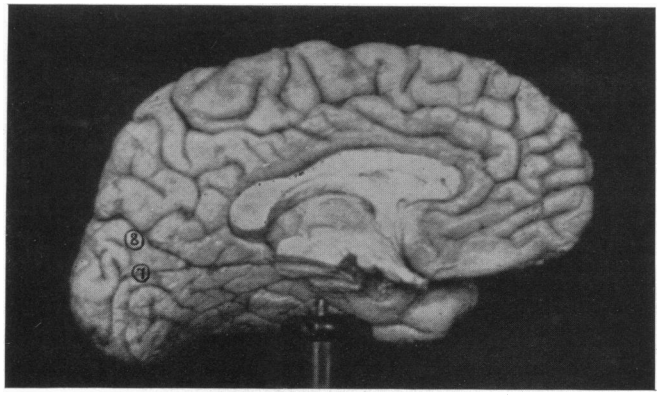

Fig. 3

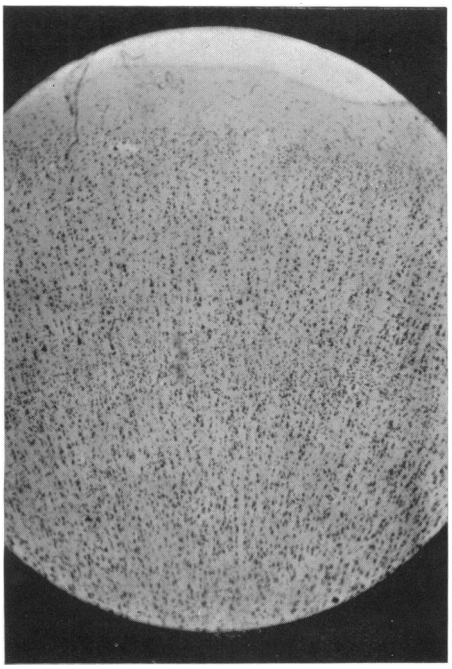

Fig. 4

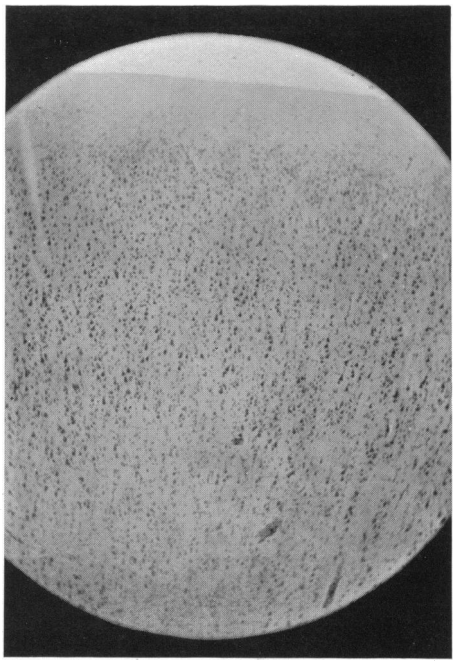

Fig. 5

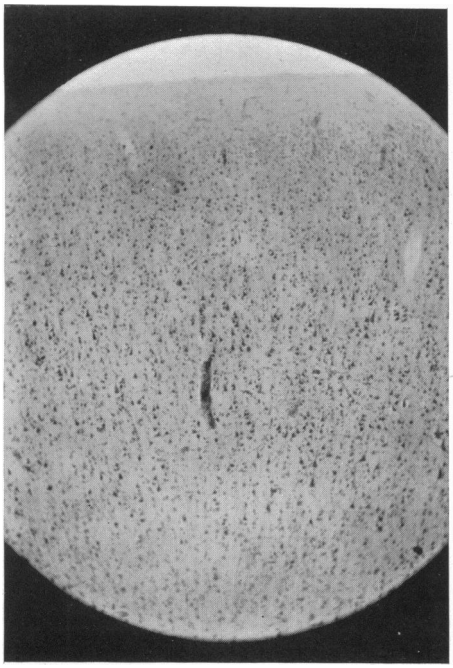

Fig. 6

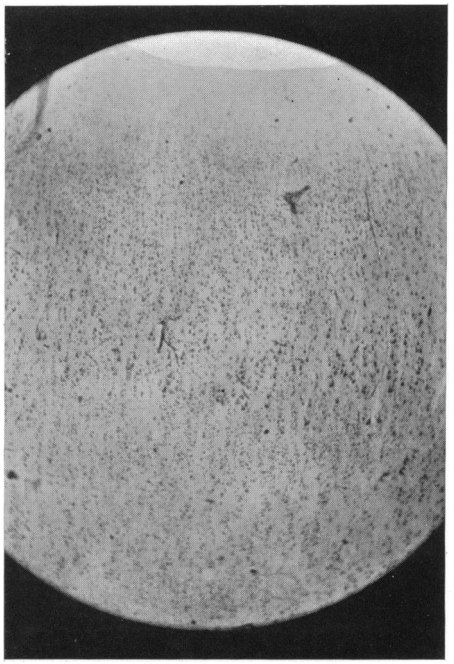

Fig. 7

VINT—THE BRAIN OF THE KENYA NATIVE

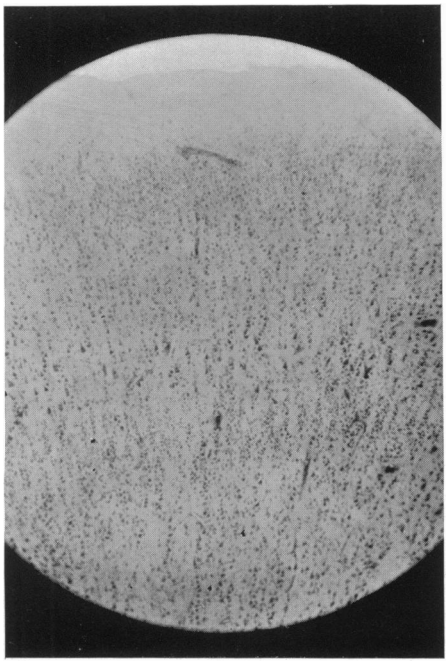

Fig. 8

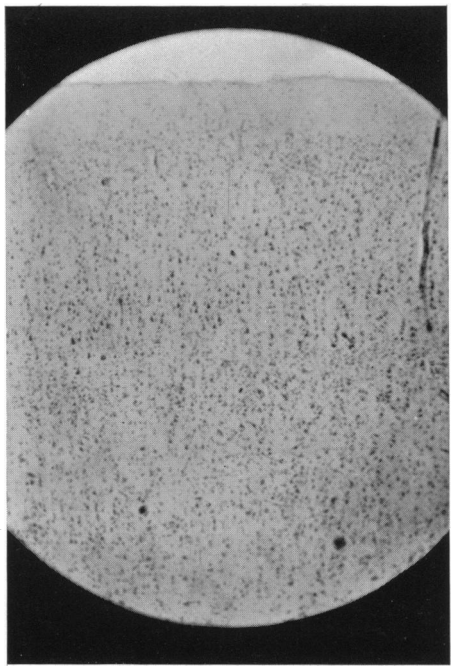

Fig. 9

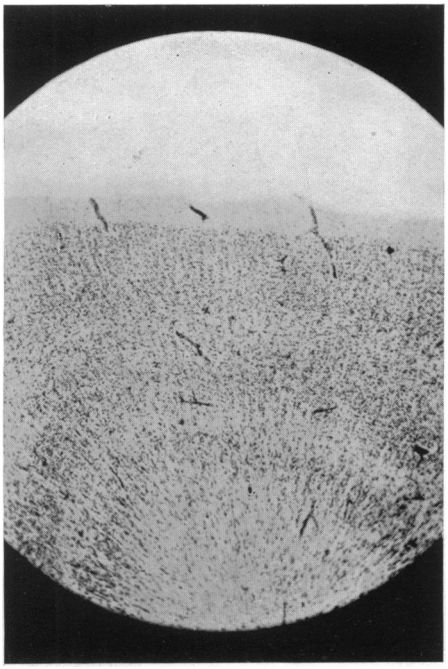

Fig. 10

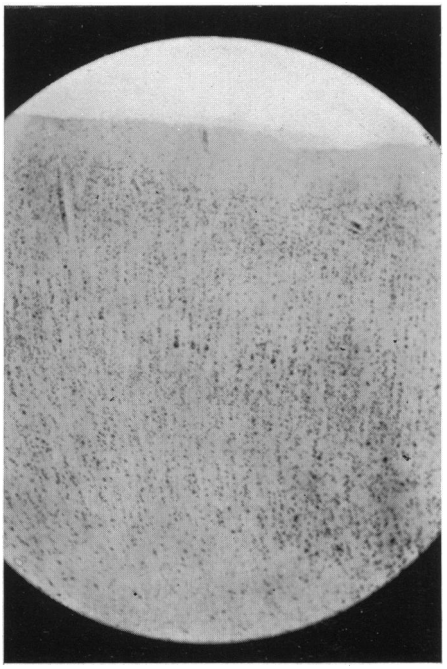

Fig. 11

REFERENCES

BOLTON, J. S. (1903). "The histological basis of amentia and dementia." *Archives of Neurology*, vol. II.

—— (1914). *The Brain in Health and Disease.* Arnold, London.

GORDON, H. L. (1933). *An Enquiry into the Nature of Amentia in the East African.* (In the Press.)

KAPPERS, C. U. ARIENS (1929). *The Evolution of the Nervous System in Invertebrates, Vertebrates and Man.* Haarlem: Bohn.

—— (1931). "The development of the cortex, and the function of its layers." *J. Mental Science*, vol. LXVII.

MATHEWS, A. B. (1925). *Physiological Chemistry.* 4th ed. London: Baillière, Tindall and Cox.

ORR, J. B. and GILKS, J. L. (1931). *Studies of Nutrition. Medical Research Council, Special Report Series*, No. 156.

SHENNAN, T. (1927). *Post-mortem and Morbid Anatomy.* 2nd ed. London: The Scientific Press.

TILNEY, F. (1928). *The Brain from Ape to Man.* London: H. K. Lewis.

VON ECONOMO, C. (1929). *The Cytoarchitectonics of the Human Cerebral Cortex.* Oxford Medical Publications.

WOOLLARD, H. H. (1929). "The Australian aboriginal brain." *J. Anat.* vol. LXIII.

—— (1931). "The growth of the brain of the Australian aboriginal." *J. Anat.* vol. XLV.

EXPLANATION OF PLATES I–III

PLATE I

Fig. 1. Typical Kenya native brain viewed from above.
Fig. 2. Lateral aspect of the same brain.
Fig. 3. Medial aspect of the left hemisphere of the same brain.

PLATE II

Fig. 4. Area fronto-polaris of a native brain. Area 1 in fig. 2. ×32.
Fig. 5. Area frontalis agranularis of a native brain. Area 2 in fig. 2. ×32.
Fig. 6. Area pre-centralis of a native brain. Area 3 in fig. 2. ×32.
Fig. 7. Area post-centralis of a native brain. Area 4 in fig. 2. ×32.

PLATE III

Fig. 8. Area temporalis superior of a native brain. Area 5 in fig. 2. ×32.
Fig. 9. Area pars triangularis of a native brain. Area 6 in fig. 2. ×32.
Fig. 10. Area striata of a native brain. Area 7 in fig. 3. ×32.
Fig. 11. Area peristriata of a native brain. Area 8 in fig. 3. ×32.