Anatomy. — *The frontal fissures on the endocranial casts of some Predmost men.* By C. U. ARIËNS KAPPERS.

(Communicated at the meeting of May 25, 1929).

In preceding communications I described the fissures on the frontal lobes of Pithecanthropus and of some inferior paleolithic or Neanderthal men. In this paper I shall deal with those fissures, as far as they are visible, on the endocranial casts of some superior paleolithic men especially those of Predmost, who by some authors are considered as belonging to the solutrean period, by most others to the preceding or aurignacian period.

MATIEGKA [1]), as well as SZOMBATHY and SALLER, considers them as being more or less related to the Cro-Magnon race.

Whatever may be the exact relationship of the Predmost race with other superior paleolithic races, all these races, are considered as not being related to Neanderthal men.

It is generally accepted that during and after the last or Würm glacial period the latter had become extinct.

Only few authors suppose that even up to our time offsprings or variations of the Neanderthalrace may occur in the Australian aboriginals. Most of the present human paleontologists share BOULE's view that this race though it may have been still partly contemporary — at least in France — with the early or aurignacian superior paleolithic men and with the negroids of Grimaldi, gradually disappeared and that our continent was then populated with races that were physically as well as mentally very different from the Neanderthalrace. Though some authors suppose that transitions between these races occur, BOULE emphatically states "aucun type humain actuel ne saurait être consideré comme un descendant direct, même modifié, du type de Neanderthal" (l.c. p 246).

For the somatic characteristics of the superior paleolithic races in general I refer to the descriptions in different text books and papers on this subject. As far as concerns their mental superiority I may mention that by their mural paintings, ivory and horn sculptures and clay modellings they show a much higher culture than the Neanderthal race, while by their evident totemism as appears from their art and by their refined death cult, strongly contrasting with the lack of burial or very simple burial (La Chapelle, La Ferrassie, Moustier) of Neanderthal men, they showed elaborate conceptions.

The origin of the superior paleolithic men is unknown. It may be stated however that in contrast to the rather uniform skeletal type of Neanderthal men the superior paleolithic race represent different races. So the

[1]) MATIEGKA, The skull of the fossil man Brno III and the cast of its interior. Dr. ALEŠ HRDLIČKA, Anniversary volume published by the anthropological institute of Charles University, Prague, 1929.

negroid relics of Grimaldi are very different in their physical status from the skeletons found in other superior paleolithic strata and also among the later reindeer men different races may be distinguished : the Cro-Magnon type being different from the Chancelade type that was even supposed to be related to the Eskimos (TESTUT, SOLLAS) [1]), en opinion controverted by KEITH [2]).

More or less contemporary with the Cro-Magnon race of France were the men whose relics are found in Moravia, some near Madlec (Lautsch), three near Brünn, four near Predmost, where MASCHKA and ABSOLON discovered their skeletons.

It is of this people that I examined the endocranial casts, since casts of other superior paleolithic skulls were either not accessible or do not show distinct fissural impressions.

Like the endocranial casts of modern and Neanderthal men those of the upper paleolithic period show great variations in the degree of fissural expression. So among Neanderthal men the impressions on the Moustier and La Chapelle cast are not nearly as distinct as e.g. on both sides of the Düsseldorf cast and on the left side of the La Quina cast. Apparently the degree of fissural expression is not generic but rather individual and perhaps influenced by age, or by different conditions of the meninges and intrameningeal fluid.

An advantage of the Predmost casts is that the fissures on the frontal lobes are fairly well expressed and that no less than four endocranial casts of this people were at my disposition.

The casts examined were of the Predmost skulls III, IV, 9 and 10. I am much indebted to Profs. ABSOLON and SUK for procuring me these casts.

They are practically mesencephalic (Predmost III ♂ : 75.6 ; IV ♀ 74.2 ; 9 ♂ 75.2 ; 10 ♀ 78.6) their average length-width index being 75.9. The *endocranial* indices of my cast of Combe Capelle is even less (72.4), the *cranial* indices [3]) of the Cro-Magnon and Chancelade men are 73.7 and 72. Madlec 70.9, Brünn I, II, III : 72.4 ; 67.6 ; 70.2, (MATIEGKA, l.c.).

The endocranial index of the Neanderthal men shows also great variations, but the average is higher than with superior paleolithic casts.

So while the *La Quina* woman was distinctly dolichencephalic (73.8 (ANTHONY [4])), the *Moustier* cast has a length-width index of 76, the *Düsseldorf* and *La Chapelle* [5]) man, according to ANTHONY, are 78.3 and 78.8. The index of the Rhodesia cast is also 78.8. According to my own measures the Düsseldorf man has even a somewhat greater endocranial index viz. 79.6 equal to that of the *Gibraltar* man (79.5) which according to ANTHONY [4]) has even an index of 81.6,

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[1]) See BOULE Les hommes fossiles; MASSON & Cie, Paris, 1921, (p. 296).

[2]) KEITH: Man, Dec. 1925 p. 186.

[3]) Only the skull of Placard is nearly subbrachycephalic (BOULE l.c. p. 289).

[4]) ANTHONY. l'Encéphale de l'homme fossile de la Quina. Bull. et Mém. de la Soc. d'Anthropologie de Paris. 1913.

[5]) BOULE et ANTHONY. l'Encéphale de l'homme fossile de la Chapelle aux Saints l'Anthropologie. Vol. 22, 1911.

Among the *Krapina* skulls brachencephalic indices are found, and the endocranial cast of PODBABA is certainly brachencephalic (I tax this to be about 84.5).

The small endocranial index of the Predmost seems mostly due to a greater length, rarely to a decrease in width.

The Predmost casts are remarkable for their greater general and occipital height indices, while also their frontal lobe is less sloping than in Neanderthal men.

The temporal length has increased, the temporal depth decreased.

Endocran. Indices [1]	Pithecanthropus	Piltdown rec. KEITH	Inf. paleolithic men			Sup. paleolithic men		Average inf. paleolithic men	Average sup. paleolithic men
			Rhodesia	La Chapelle	La Quina	Combe Capelle	Predm. III (IV) 10		
General height	0.400	0.498	0.450	0.480	0.465	0.507	0.516	**0.465**	**0.513**
Occipit. height	0.938	1.465	1.110	0.990	1.10	1.502	1.455	**1.07**	**1.467**
Temporal depth	?	0.137	0.142	0.153	0.153?	0.121	0.144	**0.149**	**0.138**
Temporal length	0.753	0.711	0.766	0.773	?	0.743	0.787	**0.769**	**0.772**
Frontal length	0.344?		0.332?	0.306?	?	0.350		0.319	(0.350)
Frontal height	0.422?		0.450?	0.437?	?	0.450?		0.444	(0.450)

The capacity of the Predmost casts [2] examined is 1568 ccm (Predmost III), 1308 ccm (IV), 1432 ccm (9) and 1430 ccm (10). The capacities of other superior paleolithic cast are 1415 (Combe Capelle), 1590 ccm (Cro-Magnon) and 1530 ccm (Chancelade ; LEE and PEARSON). Their average capacity (1476 ccm) does not differ much from that of the Neanderthal men although the race itself was considerably taller (180 cm Predmost, 182 cm Cro-Magnon) [3]) than the Neanderthal race (160 cm BOULE), where a maximum capacity of 1600 ccm is found. Thus, while the cephalization in Neanderthal men may have been slightly larger than in our present race (DUBOIS) [4]) it was in the superior paleolithic men of Cro-Magnon and Predmost the same as with present races.

The casts examined show the peculiarity that their frontal lobe is rather blunt at its ventral part, more so than most Neanderthal casts (fig. 1).

The *rostrum orbitale* probably was well pronounced. Only a part of it is expressed in N°. IV and N°. III (see the adjoining plate). In N°. 9 and 10 most of it fails as the whole orbital part of the skull was lacking here. In the cast of Combe Capelle the rostrum however is well developed.

[1]) Cf. ARIËNS KAPPERS. Indices for the anthropology of the brain etc. These Proceedings, Vol. **30**, 1927.

[2]) As none of these casts is fully complete the capacities mentioned are a little too small.

[3]) Only the Chancelade man establishes an exception, having a length of 150 cm.

[4]) See DUBOIS, Proceedings of the Kon. Akademie van Wetenschappen, Vol. **23**, 1921.

A lunate sulcus is nowhere obvious. N^{0}. III is remarkable for showing a fairly deep recession right in front of the lambda suture which though less

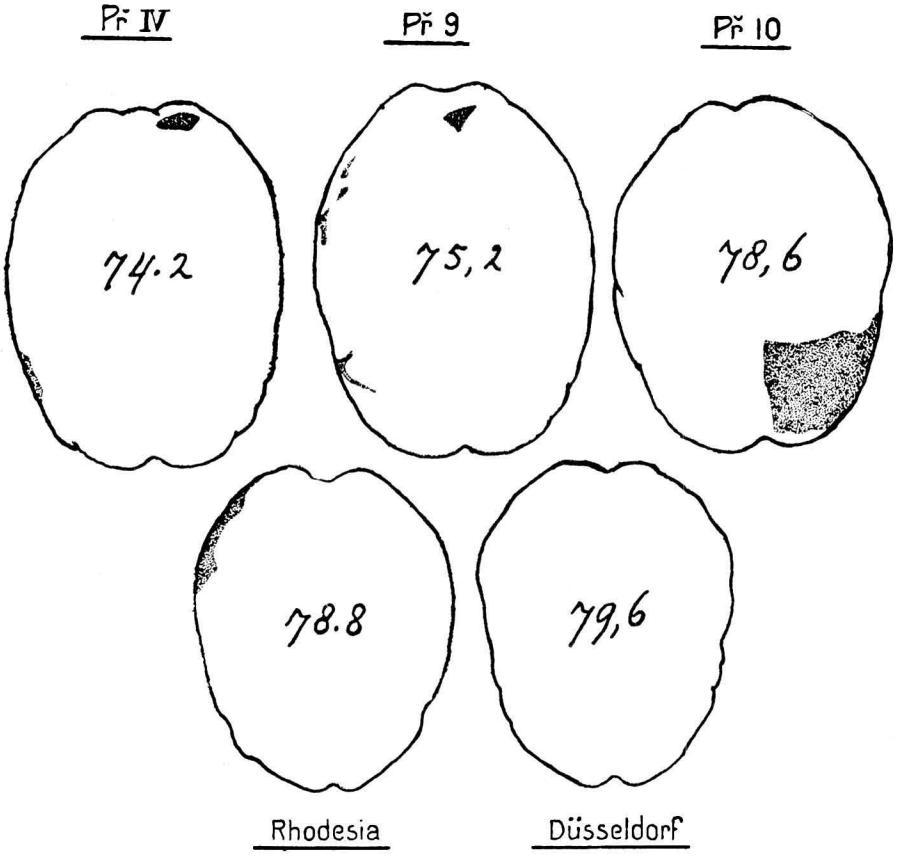


Fig. 1. Horizontal tracings of three superior paleolithic casts (Pr. IV, 9 and 10) and two inferior paleolithic casts.

sharp reminds us of the condition occurring in the Rhodesian Neanderthal men (also occasionally found in recent men).

These indentations, however, have nothing to do with lunate sulci as I already emphasized in one of my former papers but apparently are due to a thickening or deeper position of the posterior edge of the parietal bone in comparison with the upper edge of the occipital squama [1]).

Only on the left occipital lobe of Predmost III ♂, at a distance of about 1.1 cm behind the lambda suture a deepening of the occipital lobe is observed that perhaps may be an indication of a sulcus lunatus. A similar

[1]) For the different factors that may act a part in these and other variations of the skull I refer to BOLK's paper: Over de verschillende soorten van schedelmisvorming bij den mensch. Verslagen van het Genootschap voor Natuur-, Genees- en Heelkunde, Jan. 27, 1915, Amsterdam.

indication is seen on the left occipital lobe of Predmost 10, also at a distance of about 1.3 cm behind the lamba suture.

On *the frontal lobes* the indications of the *superior frontal sulcus* (11) are rather poor. The best expression of it is seen on the left hemisphere of Predmost III ♂ where the anterior part of this sulcus is indicated by three fissurets (fig. 2). On the right hemisphere of this cast similar fissurets occur (see plate). On the other casts this sulcus is still less pronounced.

All the casts show the tendency of the anterior frontal surface to form one or two transverse fissures at the ventral end of the superior frontal sulcus, thus establishing a parallel bridging convolution (*p*) extending between the fronto-marginal sulcus (9) and the medio-ventral edge of the hemisphere. These *fronto-parallel convolutions* (*p*) are most obvious in frontal or semi-frontal aspects (see plate) and are probably correlated with the greater bluntness and increase of the frontal pole (cf. fig. 1).

I also found this parallel convolution clearly expressed in recent European and Mongolian brains.

The *midfrontal sulcus* (7), so clearly indicated on both sides in the ape man and on several hemisphere of my Neanderthal casts, is well indicated only in Predmost IV (both hemispheres) and III (left hemisphere). Nowhere can I trace it to a precentral sulcus (5). This may be correlated with the fact that the precentral sulcus itself is rarely distinct. Traces of it occur in the Predmost IV specially on the left hemisphere. But even here a distinct connection of the midfrontal sulcus with that trace fails (see fig. 2).

On the left hemisphere of Predmost IV the midfrontal sulcus has a connection (7*c*) with the inferior frontal (4), equally seen in Predmost 9 (right hemisphere), and indicated perhaps by *c'* on the right hemisphere of Predmost IV and on the left of Predmost 9. On the latter, the midfrontal is only expressed by discontinuous pieces.

In Predmost III (l.) the midfrontal (7) is connected by a transverse fissure with the superior frontal fissure (11).

In none of the casts does the ventral end of the mid frontal sulcus show a direct continuation into the fronto-marginal (9).

The *frontalis inferior* (4) is very distinct and rather classic in its form on the *left hemisphere of Predmost IV*, where the origin only of this groove from the precentralis, fairly constant in recent brains, fails, probably on account of the failing impression of the lower part of the precentral sulcus. Tracing its course on the left hemisphere of this cast from behind its connection (7*c*) with the midfrontal is evident.

Behind this connection, between 7*c* and 5, a small but distinct dimple is observed, which may represent an intermediate fosset (8) (c.f. this relation with the same in the La Quina casts left hemisphere, where a

dorsal branch of 4 also extends, though for a short distance only, in the direction of 7 and where also a fosset 8 occurs behind this branch).

Continuing in frontal direction and inclining to the ventral margin of the

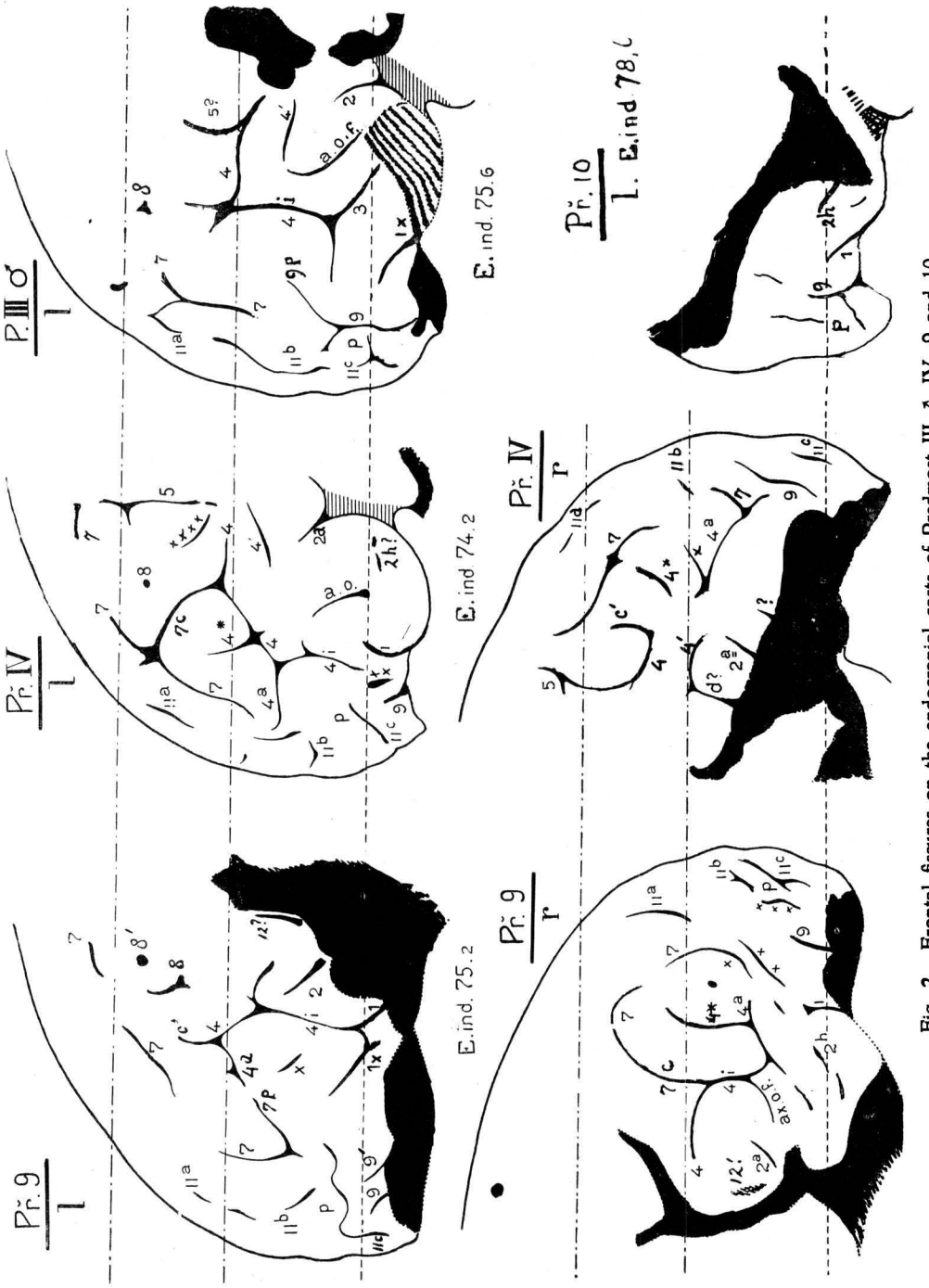


Fig. 2. Frontal fissures on the endocranial casts of Predmost III ♂, IV, 9 and 10.

lobe, the inferior frontal (4) in Predmost IV (l.) shows a second branch (4 *) in dorso-caudal direction. Then the sulcus divides in two branches. One branch, the ramus inferior (4*i*) runs downward, ending immediately in front of the subfrontal sulcus (1). The other branch, the ram. anterior (4*a*), proceeds into the direction of the medial margin, crossing the anterior part of the midfrontal sulcus.

Apparently the ram. anterior is well developed here and even passes the midfrontal which I never saw on casts of Neanderthal men, where the ramus anterior s. frontalis inferioris is usually poorly pronounced and not as long.

Also on the *right hemisphere of Predmost IV* the inferior frontal sulcus is well expressed and a connection with the precentral sulsus (5) is indicated. A ramus inferior however is not expressed on the right lobe and the ramus anterior (4*a*) is discontinuous with the main part of 4. Frontally this branch dichotomizes but the dichotomy may as well represent a connection with the midfrontal sulcus (7).

An analogous condition is observed on the left side of Predmost 9, where a small ramus anterior (4*a*) of the inferior frontal nearly connects with a ramus posterior (7*p*) of the midfrontal sulcus (7).

A pecularity on both hemispheres of Predmost IV is the presence of a sulcus (4') underneath the hindpart of the inferior frontal and parallel to it, a feature which I also occasionally observed in Dutch and Chinese brains. One might call this groove a *frontalis inferior accessorius*. It is also indicated on Predmost III ♂. When this accessory groove is present in actual brains it is sometimes difficult to say which (4 or 4') should be considered as the primary inferior frontal sulcus.

On *the left hemisphere of Predmost III* ♂ the caudal part of the inferior frontal sulcus is much the same as on the left lobe of Predmost IV.

The rest of this fissure (4) is different, being represented on Predmost III only by an inferior branch (4*i*) that apparently finishes in a *sulcus axialis operculi orbitalis* (3), extending frontally about as far as does the subfrontalis (1 *), that has rather a great horizontal extension on this side of the Predmost III ♂.

A ram. anterior s. frontalis inferioris is not indicated, on the left hemisphere of Predmost III ♂. This simple form of the inferior frontal sulcus reminds us of the condition found on the right side of the Rhodesian casts. It also occasionally occurs in recent brains.

In front of the descending branch of the inferior frontal however a posterior branch (9*p*) of the fronto-marginal sulcus (9) points in the direction of the frontalis inferior thus marking an approach to a connection between the fronto-marginal (9) and the inferior frontal (4).

As the fronto-marginal sulcus (9) belongs to the system of 7 this relation is more or less analogous to what is seen on *the left hemisphere of Predmost 9*, where the midfrontal sulcus (7) has a posterior branch (7*p*) that almost reaches the short anterior branch (4*a*) of the inferior frontal sulcus. The inferior branch (4*i*) is well developed on the left hemisphere

of Predmost 9 and reminds us of the relation on the La Quina cast, where it also connects with the subfrontal (1).

On *the right hemisphere of Predmost 9* the relations of the inferior frontal sulcus are very different from the left. In one respect they resemble those in Predmost IV (l.), in so far as 4 has a distinct connection (7*c*) with the midfrontal.

Besides in front of this an ascending branch occurs (4 *) reminding us of 4 * in Predmost IV (l.). Of the anterior branch of the inferior frontal only an indication exists (4*a*). On this lobe of Predmost 9 the inferior frontal sulcus has two distinct ventral branches of the character of a *s. axialis operculi frontalis (a.o.f.)* ending between 2*a* and 2*h*, the ascending and horizontal anterior branches of the fossa Sylvii, limiting a distinct operculum frontale (vide infra).

A *sulcus axialis operculi frontalis* is also indicated on the left hemispheres of Predmost IV and III ♂.

The *fronto-marginal fissure* (9) is indicated on all the casts, being most evident in Predmost III, where this fissure shows a dichotomy, the posterior branch of which (9*p*) runs in the direction of the frontalis inferior (4). Between the anterior branch of the fronto-marginal sulcus, not specially numbered in fig. 2, and the lower part of the superior frontal (11*c*) the *fronto-parallel convolution* (*p*), mentioned above, extends between the stem of the fronto-marginal sulcus and the medial wall of the hemisphere.

As already stated above a similar convolution (*p*) between 11*b* and 11*c* is observed on the left hemispheres of Predmost IV, 10 and 9 and also on the right hemisphere of the latter (see plate). This is a remarkable feature in all these Predmost casts. Similar relations are observed in recent brains but not till now in Neanderthal casts. As stated above the occurrence of this convolution *p* may be correlated with the blunt form of the ventro-frontal margin of the frontal lobe (fig. 1), and at the same time may be an expression of a greater growth in this region, also expressed in modern brains by the tendency of the ventro-medial edge of the frontal lobe to form transverse foldings on the anterior lateral as well as on the anterior medial part of the superior frontal convolution.

The *s. subfrontalis* (1) is best expressed on the left hemisphere of Predmost IV, the only one where the whole operculum orbitale is well preserved. In all the other hemispheres a smaller or larger part of the operculum orbitale is failing or not well expressed (III♂). On the left of Predmost 10 that part in which this sulcus runs is also preserved.

In Predmost IV the sulcus has a semicircular course, the dorsal end of which turns backwards as is also slightly indicated on the right hemisphere of Predmost 9. On the left hemisphere of the latter the subfrontal fissure connects with an additional groove in front of it (1 ×).

In Predmost III ♂ and 10 the subfrontal sulcus (1× and 1) runs more horizontally than it does in the two other casts.

As far as concerns the *rami anteriores fossae Sylvii* this much can be said with certainty that there is more evidence of them than in the Neanderthal casts. Notwithstanding the imperfect state of the opercular region in most casts, there is an indication of such branches in all casts.

On the *right lobe of Predmost 9* there clearly are two branches: a horizontal (*2h*) and an ascending branch (*2a*). Whether on the *left hemisphere of Predmost IV* two rami anteriores are indicated is doubtful. The most distinct one (*2a*) is the ascending branch. I doubt whether the small dimples *2h* ? on the left lobe of Predmost IV are due to a sulcus.

On the *left hemisphere of Predmost 10* of which only the lower part of the frontal lobe is preserved an indication of a ramus anterior horizontalis f. Sylvii may exist (*2h*). The region of *2a* fails on this side.

In the other hemispheres most of the operculum fails and only one of these branches is indicated. It is very dificult to say whether this is a single ramus anterior f. Sylvii, or a ramus anterior ascendens f. Sylvii, e.g. on the left hemispheres III ♂ and 9. On the right hemisphere of Predmost IV the conditions are difficult to explain in consequence of the failing of the larger part of the opercular region. Here three fissures (*d* ?, *2a* and ?) are observed underneath the frontalis inferior accessorius (*4'*). The most caudal one is a ventral branch of the frontalis inferior accessorius and might be a diagonal sulcus (*d* ?).

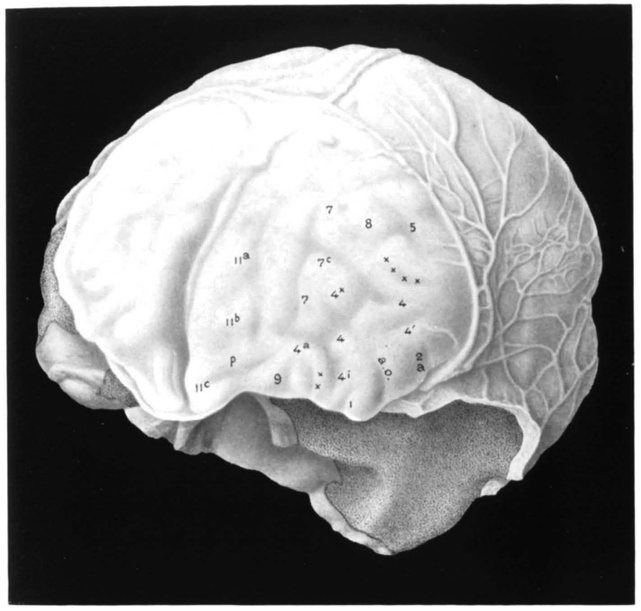
The second one, *2a*, probably is an impression of a ram. anterior ascendens f. Sylvii, as on the right side of Predmost 9. What the small dimple (?) is I do not know. I have seen, however, horizontal branches running as high up the convexity in recent brains.

Altogether it is striking that indications of frontal Sylvian branches are more pronounced here than on Neanderthal casts, and that, in one vase at least (Predmost 9, right hemisphere), probably also in two other cases (Predmost III and IV), also a f. *axialis frontalis* is indicated.

It is strange that no indication of an inferior continuation of the precentral sulcus is visible here nor a distinct vestige of a subcentralis anterior. The only impression that reminds me of the latter is 12 ? in Predmost 9 (right hemisphere).

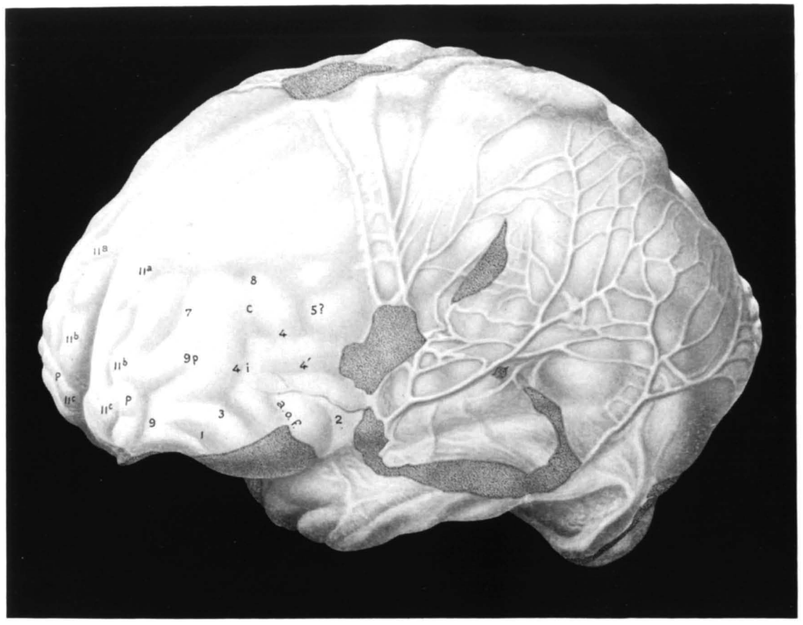
Also is it wholly impossible to say any thing about the ventral end of the centralis, although the central sulcus according to MATIEGKA (l.c.) is indicated on Brünn III, where also the inferior and midfrontal sulci are reported to be evident.

The *orbital sulci* were probably well developed in Predmost men, but as in these casts most of the orbital surface is failing little can be said of this. Only on the left side of Predmost IV, the frontal half of BROCA's



Semi-frontal aspect of the endocranial cast of Predmost IV.

Frontal aspect of the endocranial cast of Predmost 9. Note the fronto-parallel convolutions (*p*) on both sides.



Approximately lateral aspect of the endocranial cast of Predmost III ♂.

scissure en *H* is well expressed and independent of the very pronounced s. subfrontalis (1 ; see fig. 2).

Resuming my results I may say :

1⁰. that the Predmost casts show few impressions of the superior and midfrontal sulci, specially caudally, while impressions of the precentralis are very faint or fail. A subcentralis anterior is nowhere indicated with certainty, nor even a part of the centralis.

2⁰. The inferior frontal system is well expressed. In addition to its ramus inferior a ramus anterior is strongly developed in Predmost IV (on both sides). In Predmost 9 it is indicated on the left hemisphere and tends to connect with the midfrontal. The ram. anterior s. frontalis inferioris seems to be better developed than in any of the Neanderthal men.

3⁰. A constant feature in all the Predmost casts examined, is the occurrence of a fronto-parallel convolution between 11*b* and 11*c*, running parallel to the ventral margin of the frontal lobe, as is often observed in recent brains.

4⁰. Indications of the rami anteriores f. Sylvii are observed on all hemispheres. On one hemisphere, Predmost 9 (right side) and perhaps on Predmost IV (left side), where the whole or most of the opercular region is present, both rami may be indicated, on the other hemispheres only one. On the left lobe of Predmost 10 this may be a horizontal ramus, in Predmost IV (right side) an ascending branch. In III and 9 (left side) it is difficult to say whether the branch indicated is an anterior ascending one or a single ramus anterior. A single ramus anterior f. *S.* may occur in Predmost 9 (left side).

5⁰. A s. axialis operculi frontalis is indicated in Predmost III (*l.*) and 9 (*r.*), probably also in IV (*l*).

The better development of the ramus anterior s. frontalis inferioris, the more frequent impressions of anterior branches of the fossa Sylvii and the evidence of a sulc. axialis operculi frontalis give these casts a more differentiated aspect than the Neanderthal casts, from which they also differ in having greater sagittal height and temporal length indices and smaller temporal depth indices.

By these features the Predmost casts approach those of recent men.

Finally, I want to express my thanks to our scientific artist Mr. CHR. VLASSOPOULOS for his accurate drawings, reproduced on the adjoining plate.