

Anatomy. — *Some topographic relations of the orbits in Man and Anthropoids during ontogenesis, especially bearing on the ontogenetic development of the "rostrum orbitale".* By J. ARIËNS KAPPERS.
(Communicated by Prof. H. M. DE BURLET.)

(Communicated at the meeting of October 26, 1940.)

When examining the base of an adult human or anthropoidal skull we see how the two roofs of the orbits protrude more or less into that part of the skull cavity in which the frontal lobes of the brain are situated. Between these roofs a more or less deep space exists at the bottom of which the lamina cribrosa is found. Therefore the anterior part of the base is not flat in a transverse sense either in Anthropoids or in Man. That part of the frontal brain lobes, including the lobus olfactorius, which lies between the orbital roofs is commonly called rostrum orbitale. It will be our aim to discuss in Man and Anthropoids the form and as far as possible the genesis of the space between the orbital roofs in which the rostrum lies.

Looking at the well-known model of the primordial cranium of a human embryo of 8 cm crown-rump length, made by ZIEGLER after HERTWIG, we see how the ala orbitalis forms a nearly flat plate extending at right angles from the septum of the nose, so that the primitive roofs of the orbits practically do not rise above the level of the lamina cribrosa and the base of the skull is nearly flat in a transverse sense. The same is seen in the frontal section through the head of a human embryo of about two months old reproduced in figure 1. The section is not quite perpendicular to the aequatorial plane, so that the right side of the embryo, to the left in the figure, with which we will deal only, is cut more backward than the left side. The septum nasi protrudes above the level of the roof of the nose cavity and, what is not the same thing here, above the bottom of the fossa cranii, forming the crista galli at the anterior end of the skull base. On the left side of this crista in the figure the base of the skull, i.e. the roof of the orbit, slopes slightly laterally and upwards to the ascending wall of the brain cavity, being still nearly flat. Nothing is yet to be found of an elevation of the roof of the orbit protruding into the brain cavity.

No indication is seen of an *U*- or *V*-shaped space between the roofs of the orbits, in which in the adult stage the rostrum orbitale lies.

We now compare this section with figure 2, showing a frontal section through a senile human skull sawn perpendicularly to the lamina cribrosa,

through the forepart of the crista galli. In this way the two sections to be compared are as homotopic as possible.

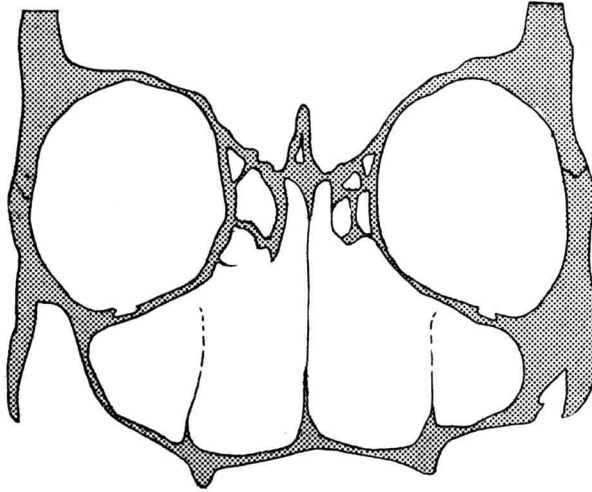


Fig. 2. Frontal section through senile human skull.

We chose this adult skull because in this specimen the pit beside the crista galli in which the olfactory bulbs are situated and the whole *U*-shaped space between the roofs of the orbits were so pronounced that one could speak of a real fossa interorbitalis encephalicus in which the rostrum orbitale lies.

Apart from some very similar relations in the two sections, we observe also a remarkable difference.

First we will point out the most important, quite similar relation between the position of the orbit as a whole towards the cavum nasi in the two sections. Connecting in thought the centres of the orbits, as done by BOLK, we see that this line in the two skulls not only runs beneath the upper border of the crista but even a little underneath the roof of the cavum nasi. BOLK, using a frontal section through the skull of a neonatus, laid great stress on this point, saying that also in this respect the adult human skull maintains its fetal features. He used for comparison a new-born and an adult skull. That we find the same state of affairs in a so much younger skull corroborates his point of view.

Passing to the differences which exist between the two sections, we may first call attention to figure 3, showing a frontal section through the skull of a human fetus of about the 8th month perpendicularly to the lamina cribrosa. A remarkable difference with regard to the young embryonic as well as to the adult skull, appears in the vertical height of the orbit relatively to that of the cavum nasi. In comparison with the two months old embryo, the vertical height of the orbit is increased very much relatively to that of the nose cavity. The line, however, connecting the centres of the two orbits would have the same position with regard to the tectum nasi.

This implies that the roof of the orbits has grown upwards, while the bottom has grown downwards. In this way the roofs are beginning to protrude into the cavum cranii, forming between them the *U*-shaped valley

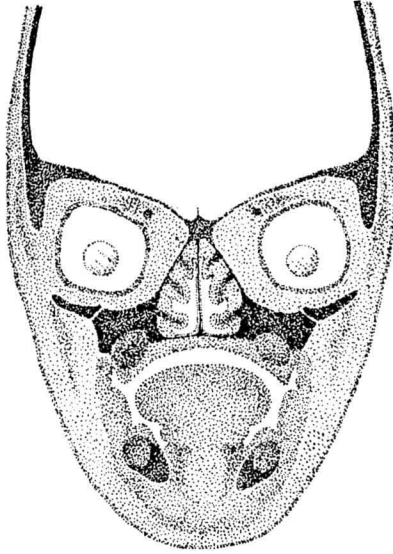


Fig. 3. Frontal section through head of human fetus aged 8 months.

in which the rostrum orbitale lies instead of the flat plate existing in the younger embryo. Later on in the ontogeny the nose cavity grows downwards, as is well known, and beside it and underneath the orbits are then formed the maxillary sinuses. That is why in the adult skull the relation between the height of the orbit and that of the cavum nasi on this level nearly reaches again the early embryonic value. Thus the protrusion of the orbital roofs in adult Man which does not exist in early embryonic development, is primarily due to a vertical enlargement of the orbit relatively to the nose in a fetal stage of development. However, the relative position of the centres of the orbits to the tectum nasi remains the same during development and therefore the position of the orbits in adult Man, being quite lateral to the nose cavity, is an ontogenetically conservative one.

Passing now to the Anthropoids it is well known that in the adult stage the *U*- or *V*-shaped "valley" between the orbits gives the impression of being much deeper here than in Man.

To get some information about the position of the orbits relatively to the nose in very young, fetal stages of development in Anthropoids is very difficult owing to the lack of material. Descriptions of anthropoid embryos are very rare and as far as we know sections through such embryos were never published. In 1885 DENIKER dissected a fetus of Gorilla and one of Gibbon and gave a very elaborate and thorough description of the whole

and the parts. As far as the whole of its features were concerned, the Gorilla fetus was at the same stage of development as a human fetus of the 5th—6th month. The Gibbon fetus was older and probably in its last intra-uterine month. About the frontal bone of the young Gorilla DENIKER says:

"La lamelle de l'os frontal, formant par sa face inférieure la voûte de l'orbite, est excessivement mince; elle n'est point encore bombée vers la cavité crânienne comme chez les gorilles même très jeunes. Par suite de cette disposition, la lame criblée de l'éthmoïde, encore cartilagineuse, se voit très nettement, tandis que, dans les crânes même les plus jeunes, elle est enfoncée profondément entre les frontaux et à peine visible."

This last statement, where he deals with the relation in Gorilla infants, may be slightly exaggerated, but what he says about the conditions in his Gorilla fetus is clearly visible in his figure of the skull base. The frontal part of the base, upon which the frontal part of the brain is situated, is very flat indeed and has not at all the shape which it has in postnatal stages. Here also the orbits are situated laterally to the nose cavity. Therefore nothing of a rostrum is seen on his figure taken from the lateral side of his endocranial cast of the Gorilla fetus.

Speaking of the skull of his Gibbon fetus, he says:

"La lame criblée cartilagineuse a la forme ovoïde... les deux os frontaux se touchent presque en arrière et en avant de la lame criblée; chez le Gibbon adulte, ils vont se souder en cet endroit, et c'est à peine si l'on apercevra la lame criblée, enfoncée entre les deux os qui deviendront très bombés".

Looking at DENIKER's figure of the skull base of the Gibbon fetus, we see that the anterior part is somewhat more "bombé" than in the fetus of Gorilla and not quite so flat. Yet, there is still a very great difference in this regard in comparison with the adult stage. That it is still more flat in the Gorilla is probably due to the lesser age of the latter.

In figure 4, we show an X-ray photo of the skull of a Gorilla fetus, present in the collection of the museum of the Anatomy Department of the University of Amsterdam, the exterior of which was formerly described by BOLK. This specimen must have lived till the end of pregnancy. The orientation in the photogram is not far from the Frankfurt plane being perpendicular to the plate.

Here the orbital roofs are already vaulted, so that the formation of an orbital keel has begun, but it is curious to see how the line connecting the centres of the two orbital aditus would not run far above the brain base and the roof of the nose, quite contrary to the state of affairs in most adult Anthropoids, especially in Gorilla (see figure 6). This also resembles quite human conditions.

Descriptions of the primordial crania of Primates other than Anthropoids are rather rare. In 1902 FISCHER published and described a model of the primordial cranium of a *Cercopithecus cynomolgus* embryo of 25 mm crown-trunk length. His figure clearly shows that both alae orbitales are remarkably flat, so that here also the orbits were lying towards the sides of the lateral nose walls and a rostrum orbitale must have been still absent.

FISCHER himself says about this region: "Die vordere Partie der Ala orbitalis (also damit auch die Cartilago spheno-ethmoidalis) ist völlig eben, liegt auch etwa in einer Flucht mit der Lamina cribrosa, genau wie beim menschlichen Embryo, während bei den meisten erwachsenen Affen das Dach der Augenhöhle (Frontale) sich so stark gegen das Gehirn vorwölbt, dass die Siebplatte in eine tiefe Spalte zu liegen kommt." In a later article this author describes the model of the same specimen once more together with that of a *Semnopithecus maurus* embryo of 53 mm crown-trunk length. Speaking about the ala orbitalis he says here: "Sie ist als eine mächtige Platte entwickelt, die sich von der Lamina cribrosa und den Sphenoïdbalken aus als Dach der Augenhöhle seitlich ausspannt. In ihrer Form und Lage stimmen Affe und Mensch völlig überein, weichen aber von andern Säugern ab." The solum suprasedale of Reptiles, after GAUPP the homologon of the ala orbitalis, is a flat plate which rises in an oblique position laterally to the median plane, whereas in Primates the position became nearly horizontal. Further on FISCHER says that in the *Macacus cynomolgus* embryo the upper sides of the alae lie in one plane with the lamina cribrosa, whereas in *Semnopithecus* the latter is already somewhat sunken between the orbital roofs. This also appears from the figures with which he illustrates his article. The difference between the two monkeys on this point, in our opinion, may be caused by the fact that the embryo of *Semnopithecus* was somewhat older, thus approaching the adult relations.

From these facts it appears that in the younger fetal stages of many, if not all, Primates the topographic position of the orbits relative to the nose cavity is the same: the plane through the orbital axes lies beneath the subcerebral part of the nose roof, in other words: the orbits are situated beside the nose cavity, and there is no rostrum orbitale, the skull base being nearly flat.

To get a more objective idea of the topographic position of the orbital roofs in our own postnatal material we studied quasi-frontal sections through the skull base.

To avoid a further destruction of our skulls of a great many Anthropoids and Men of different ages which for other purposes had been sawn along the median plane, we made frontal figures with the aid of MARTIN's diagraph of the inner wall of the skull cap and the skull base on the level of the posterior border of the lamina cribrosa of one half of the skull, the skull being oriented with the Frankfurt plane perpendicular to the drawing paper. After we had in this way got the relations on one side of the skull, the whole outline of the inside of the skull on this level could be easily reconstructed, supposing that the skull was symmetrically built. A so far occipital level was chosen, and not for instance the level of the frontal border of the lamina, because of the soon receding frontal bone in the Anthropoids. Starting our drawing in the mid-line on this level and in this orientation, we soon should reach the fronto-lateral side of the skull cap with the point of the diagraph without touching the orbital roofs at all.

The drawback of our method is that the point of greatest height of the orbital roof above the roof of the nose is not always fixed in the figure. This disadvantage was removed by projecting that point in the level of our drawing by means of the diagraph. It was not necessary to note also the median point of the nose roof on this more frontal level, because in this orientation the part of the roof between the two levels was almost perpendicular to the drawing-paper.

In figure 5 we give the drawing of an infantile and an adult specimen of all genera of Anthropoids, excepting Siamang. Of adult Man only we give two figures to show the possibility of individual variations in this

region. It appears that the outline of the inside of the cavum cranii at this level in Man has a much greater extension than in the Anthropoids, the part of the frontal lobes above the orbital roofs being absolutely much

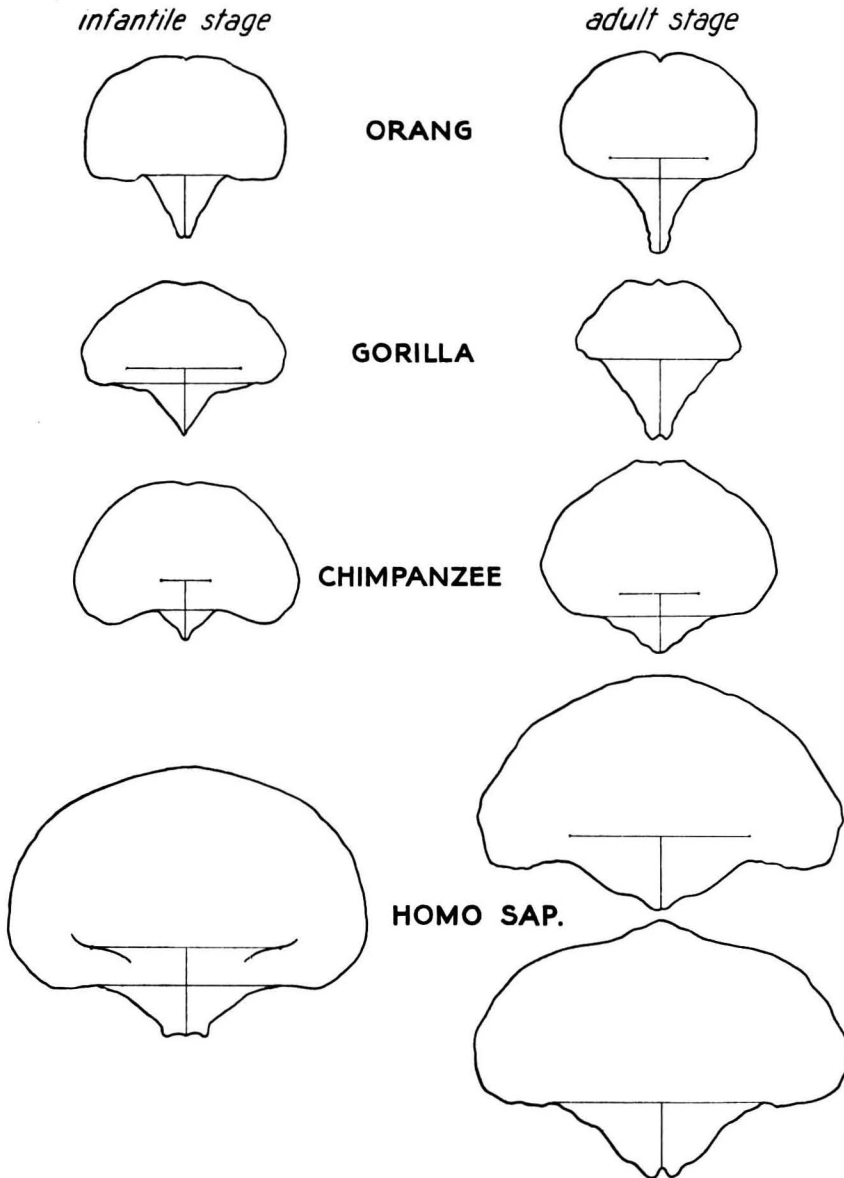


Fig. 5. Comparison of the development of the rostrum orbitale and the relative topography of the orbital roofs in young and adult Summoprimates. (For explanation see text). In the infantile Orang teeth shed was just beginning. The young Gorilla had a milk dentition which was not yet quite complete while in the Chimpanzee child a nearly complete milk dentition was present. The human infant was aged 1.5 years. All drawings $\frac{1}{2}$ natural size.

broad and also higher than in the Anthropoids. The latter is partly due to the fact that in the large apes the frontal bone recedes very soon above the orbits or, in other words, the forehead is really receding, though not so much as is suggested by the big torus supra-orbitalis. A further relative difference at this level between the cavum cranii of Anthropoids and Man is the greater breadth relative to the height in the latter.

Passing to the fossa interorbitalis, containing the rostrum, we cannot demonstrate a clear postnatal ontogenetic difference in each genus separately, but we should remember that the infantile skulls used were not very young. An apparent fossa already occurs in each infantile skull. The impression of the depth of the fossa is determined by two factors, viz. the breadth and the real depth, i.e. the length of the perpendicular between the line connecting the highest points between the two roofs and the basis cranii in the mid-line, as demonstrated in the figures. If the distance between the highest points of the orbital roofs becomes greater, while the real depth of the fossa remains the same, we get the impression that the fossa is less deep than before.

It now appears that the absolute depth of the fossa measured between the roof of the nose and the line between the two highest points of the orbital roofs is not so much greater and at times even less in the Anthropoid skull than in that of Man. It is only the breadth of the fossa, measured between the two highest points, which is always much greater in Man and this is the principal cause why in the latter the fossa seems to be less deep. In fact it is only much broader than in the Anthropoids. The narrowness of the fossa in Apes makes it much more pointed downwards, thus justifying the name of rostrum orbitale or "bec encéphalique" for the part of the frontal brain situated in it. In Anthropoids half of the breadth and often even the whole breadth, is always less than the height, in Man on the contrary this breadth always exceeds the height.

Summarising we can say that the impression of the relatively greater depth of the cavity between the orbits in Anthropoids, in which the rostrum orbitale is situated — taken by neurologists when found in Man for a primitive feature —, in the main is rather due to the smaller distance between the orbits, i.e. the narrowness of the rostrum, than to an absolutely greater depth in comparison to the conditions as found in Man. Nevertheless it is true that the depth of the *U*- or *V*-shaped valley between the orbits in Anthropoids is greater relatively to the total base-vertex height on this level and this fact adds strongly to the impression of a greater rostral development in Anthropoids.

Discussion.

When tracing the ontogenesis of the *U*- or *V*-shaped valley between the orbital roofs in which the rostrum orbitale is situated, we saw that it is already present in young infantile stages of all Sumnoprimates and that

its morphological alterations during postnatal development are only very small and not essential. Yet, this fact does not imply that the orbital roofs protrude during the whole of ontogenesis into the anterior part of the brain cavity. On the contrary, it appeared that in prenatal development of Primates there is a stage in which the roofs of the orbits in the primordial cranium, and still later on, lie nearly in one plane with the lamina cribrosa, the subcerebral roof of the nose. At this time nothing of an orbital keel is to be found, either in Apes or Man. Somewhat later, in *Homo* perhaps in the third month of pregnancy, the roofs of the orbits begin their vaulting and herewith their protruding into the anterior part of the brain cavity. This is a fact which hitherto has not been sufficiently realised and which has a certain value for the understanding of the phylogenetic laws and differences in this region between Man and Anthropoids.

Till now it was commonly thought that the rostrum in Man is absent or far less developed than in Anthropoids, owing to the greater development of the frontal part of the brain in Man. Thus BOULE and ANTHONY, speaking of this "bec encéphalique" say:

"Chez l'homme normal au contraire (to the Apes), par le fait du développement des lobes frontaux, aussi bien dans le sens latéral que dans le sens vertical, la région cérébrale antérieure n'offre pas cet amincissement, et les parois supérieures des cavités orbitaires tendent à s'aplatir et à se placer sensiblement dans un même plan, le bec encéphalique est très réduit."

Consequently they try to explain the lack of a rostrum in Man in a simple mechanical way by the relatively greater development of the frontal brain lobes in Man, unconscious of the fact that also in the ontogenesis of the Apes there is a time when an orbital keel does not exist, though at that time the relative development of these lobes will in essentials not be different from the relations as found in the adult stage¹⁾. As we see, the development of the frontal brain becomes an insufficient explanation for the relative lack of a rostrum in Man. The view of BOULE and ANTHONY, however, is commonly accepted by others, as, for instance, MARTIN, GREGORY and TILNEY.

With the same right one could reverse the causes of the facts, if one could be content with such a simple causality in a living organism, saying: in Apes there is a big rostrum because the orbital roofs protrude far and high into the brain cavity, whereas in Man the orbital roofs protrude less so that the orbital keel is much less developed. Such a view, moreover, takes much better into account the ontogenetic development, in which, as we saw, there occurs a stage where the situation is probably equal in all Primates, no protruding orbital roofs existing at all. It is not

¹⁾ According to BRUMMELKAMP ('40), for instance, the relative size of different field areas of the neocortex of the sheep remains practically constant during ontogenesis.

very probable that from these stages on the relative development of the frontal brain will be very different between the genera¹⁾.

For these reasons it is incorrect to call a brain itself primitive, because it has a somewhat more than usually pronounced rostrum orbitale. For in saying so one would be inclined to consider the physiological possibilities of that brain as being primitive. In such cases it would be better to say that the morphological organisation of the organism, especially that of the facial part of the skull including the orbits, shows primitive or, rather, progressive features.

Another fact which is seldom taken into account by authors dealing with the rostrum orbitale and which is nevertheless of importance for the understanding of the shape of this formation, is the difference in position of the orbits towards each other in Man and Anthropoids. Already by the mere fact that in homotopic levels the absolute distance between the orbits (septum interorbitale of SCHWALBE) is greater in Man, the human orbital keel seems less high than it really is. This is to be seen in figure 5.

The process of rostral development may be described as follows. In Anthropoids as in Man in certain embryonic stages the orbits are situated quite laterally to the nose cavity, so that the orbital roofs and the tectum nasi are practically in one plane. Afterwards the roofs become vaulted primarily by a relatively greater increase of the orbital height, so that they begin to protrude into the frontal part of the brain cavity. In this way the space between the roofs in which the orbital keel of the frontal brain is situated develops. In all Primates this process will be the same. Then, in the group of Summoprimates, we see in non-hominids the beginning of another process: the turning upwards of the orbits as a whole. This implies that the line which connects the centres of the orbits, lying at first beneath the level of the lamina cribrosa, rises above this level. The later process is not equally pronounced in all Anthropoids. Most constant and most expressed it is in Gorilla, whose skull among all Summoprimates shows the greatest morphological differences between younger and older stages (see also Fig. 6). In the adult Gorilla the frontal part of the orbits lies beside the big sinus frontalis instead of beside the nose cavity as in Man. The ontogenetic ascent of the orbits has been already investigated by BOLK.

This ascent of the orbit as a whole cannot be observed in Man, where in this respect fetal conditions are preserved. More or less the same thing was already pointed out in 1885 by LISSAUER, who wrote that the splanchnocranium in Anthropoids turns upwards during ontogenesis, whereas that in Man turns downwards. KEITH, who also investigated these relations, says very pithily: "The face of the adult covers what was the forehead of the infant Anthropoid." This ontogenetic difference also distinctly appears

¹⁾ BRUMMELKAMP ('38) found that the relation between the surface area of the frontal brain and that of the whole neocortex is constant in all Primates, Prosimiae excepted. Thus there is no elective development of the frontal lobes within the group of the higher Primates.

from the figures given by him in his article of 1910. Like BOLK, KEITH concludes that in many features "the infantile condition of Anthropoids becomes the permanent condition of adult Man."

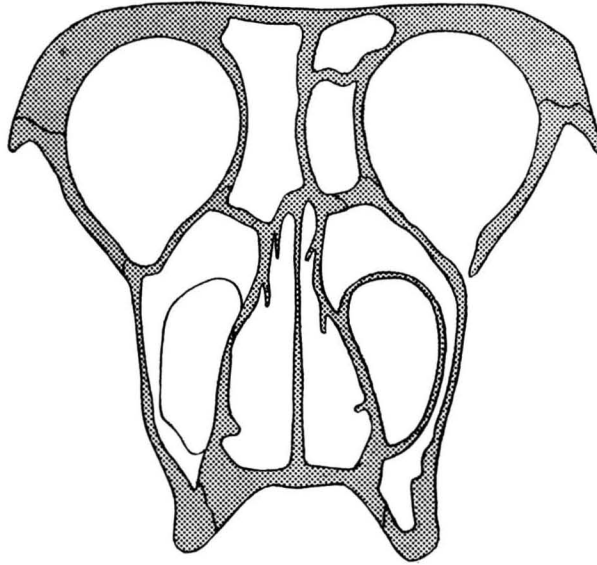


Fig. 6. Frontal section through skull of adult Gorilla. (After BOLK.)

When with these facts in mind we study the endocranial casts of Anthropoids, fossil and recent Men, given in figure 7, we see that they may play a part here also. In the photographs a constantly smaller rostrum is to be found from Ape to recent Man, which is, and not for the least part, also due to a constantly growing distance between the orbital cavities. Likewise a gradually decreasing penetration of the facial part of the skull into the neurocranium is to be deduced. In the cranial casts of lower palaeolithic Man such as the one from Ngandong, the rostrum orbitale is still much more pronounced than in recent Man. From lower palaeolithic Man onwards conditions are nearly the same as in his recent descendant. It is often forgotten that also in these relations a considerable individual variability exists, so that one has to be careful in giving a certain rostrum the epitheton primitive, especially since it is rarely expressed in measurements.

The fact, pointed out by C. U. ARIËNS KAPPERS, that in Anthropoids and also in some fossil Men the upper border of the rostrum, viewed from aside, runs upwards in relation to his lateral subcerebral horizontal line (see Gibraltar cast), whereas in recent Man this border remains beneath that horizontal, is without any doubt due to the fact that in Apes, and also in a much slighter degree in some fossil human skulls, the roof of the orbit, causing that border, runs more upwards in a frontal direction relative to his horizontal line than in recent Man. This again is due to the fact that in the more "primitive" cases the orbits and therefore also their superior walls are relatively more turned upwards in the skull. This agrees with our statement that in Anthropoids and also, though in a minor degree, in lower palaeolithic Man, as we could observe from

some unpublished diagrams, the whole orbital pyramid points more upwards in a frontal direction than in recent human skulls.

The further forward we go in the skull of the large Apes, the more the orbits are situated above and beside the nose cavity, instead of lying only beside it. In a strict sense, therefore, it is impossible to make any direct deductions about the breadth of the inner nose in Anthropoids or about the development of the organ of smell with the aid of the interorbital breadth index, as SCHWALBE did, because the place of measurement of the breadth of the nose cavity on this level lies far above the roof of the latter.

This is very apparent from our figure 6, a frontal section of a Gorilla skull after BOLK, sawn just behind the third molar, so even somewhat caudally to the level, where the breadth of the "septum interorbitale", between the dacrya, must be measured. In Anthropoids there are no parts of the nose lying between the dacrya, as is the case in Man (see fig. 2), where not only the upper part of the nose cavity but also the sinus ethmoidales are situated between those two points. In the large Apes the sinus frontalis, if present, lies between them. Figure 6 again clearly demonstrates the high position which the orbits have relatively to the nose cavity in Anthropoids.

Concluding we can say that, simply speaking, the development of a rostrum orbitale is determined by the ontogenetic protruding of the orbital roofs into the frontal part of the brain cavity and that the extent of this protrusion is a different one among the group of Summoprimates, being greatest in Gorilla and least in Man. Therefore the development of a rostrum is primarily due to a more or less progressive development of the facial sphere. This being fetalised or conservatively developed in Man, the reduced rostrum may be explained as a secondary fetalised feature. The development of the frontal brain in the sense of BOULE and ANTHONY will scarcely play a part, if any, here.

Though we think we have demonstrated that the greater or lesser development of a rostrum is primarily due to a greater or lesser protruding of the orbital roofs into the brain cavity, we do not mean to say that these roofs exert any direct pressure on the frontal brain lobes, thus forming the rostrum. By no means this protruding is the simple direct causal factor in rostral development. As everywhere in an organism the diverse structures are adjusted to each other in a way which is of a far more complex nature. At best one could say that, comparing the facial sphere and the brain, the facial sphere in Anthropoids plays an increasingly important part during ontogenesis, whereas in Man the balance, as existing in young fetal times, is preserved.

Acknowledgements.

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assistance in making the röntgenograms of which one is published in this paper and to Prof. C. U. ARIËNS KAPPERS for the photograms of the endocranial casts of his collection.

Summary.

1. The topographic relations between the orbits and the nose cavity in Man and Anthropoids have been studied during ontogenesis. Special attention has been given to the relations between the orbital roofs and the cribriform plate, forming together the relief of the fossa cranii anterior.

2. It has been found that in young embryonic stages of all Summoprimates the anterior part of the skull base is almost flat. The orbits are situated beside the nose cavity. In consequence no *U*- or *V*-shaped valley between the orbital roofs, in which the rostrum orbitale of the frontal brain in adult stages lies, occurs as yet. Neither in embryonic Apes nor in embryonic Man is there such a rostrum at all.

3. Some factors are concerned with the formation of this valley in later ontogenesis. Primarily, and this is true of all Summoprimates, there is an increase of the vertical orbital height relative to that of the nose cavity. This causes a protrusion of the orbital roofs into the brain cavity. In the second place the orbits of Anthropoids turn upwards in the face so that their position, being at first quite lateral to the nose cavity, changes to one above and beside it. Therefore the orbital roofs will protrude relatively more in Anthropoids than in Man. These processes are almost completed at a young infantile stage.

4. The difference in form between the rostrum in Man and in the Apes is due to at least the following factors:

a. The absolutely lesser distance between the orbits in Anthropoids which makes the rostrum much narrower.

b. The greater height of the valley in which the rostrum lies in relation to the total height of the frontal brain in Anthropoids.

c. The turning upwards of the orbits in Anthropoids.

The greatest absolute height of the rostrum in Man is not very different from that in Anthropoids and therefore the whole difference, apart from the greater narrowness in Apes, is merely a relative one.

5. In pleistocene Man conditions are intermediate between recent Man and the Anthropoids, although they are much nearer to modern human conditions. Some more progressive, anthropoidal, developmental features, however, are apparent.

6. Certainly the relatively lesser development of the rostrum in Man is not simply due to a greater development of the frontal lobes, as was thought before. The cause may be sought in the more conservative development of the topographic orbital relations in Man in contrast to the more progressive one, especially that of the facial sphere, in Anthropoids. The relations in the orbital sphere of Man are fetalised in the sense of BOLK's theory.



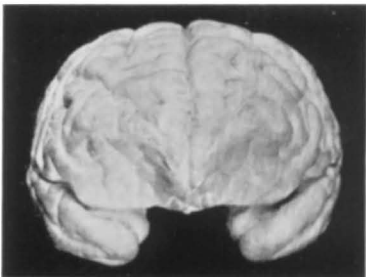
Fig. 1. Frontal section through head of human embryo aged 2 months.



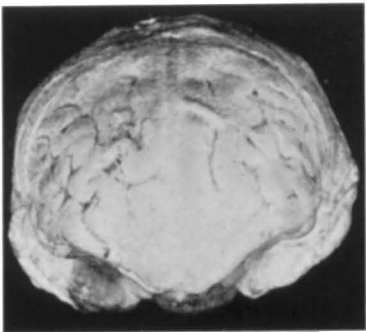
Fig. 4. X-ray photogram through head of Gorilla fetus.



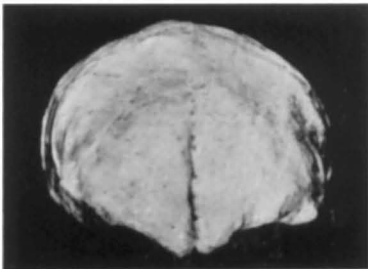
Gorilla.



Chimpanzee.



Sinanthropus.



Ngandong V.



Gibraltar (from aside).



Predmost III.



Torres straits.



Eskimo.

Fig. 7. Photograms of endocranial casts from Anthropoids, fossil and recent Man in different orientations.

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