Anatomy. — *"On the existence of a dolichocephalic race of Gorilla".* By Prof. L. BOLK.

(Communicated at the meeting of March 28, 1925).

The discovery of a fossilized not fully grown part of an anthropoid skull at Taungs (South Africa), has rightly awakened general interest; moreover whereas the discoverer — Prof. DART of the university of Witwatersrand (Johannesburg) ascribes the found fossil as belonging to an extinct primate group: "Intermediate between living anthropoids and man [1]).

It would be rather premature, already to judge the biological importance of the found object, on the ground of the very short description given by DART. For this we will have to wait until the promised detailed description is at hand, after the discoverer will have had the opportunity of comparing the infantile skull of the Australopithecus africanus, so named by him, with equally old infantile skulls of the still living Anthropomorphs. It is not unlikely that by this comparison the obvious enthusiasm, wherewith the discoverer views his discovery, and of which his conclusions at present clearly manifest, will have to give place to a more composed criticism and objective judgment. It will in no way wrong the great importance of the discovery; more likely it will do justice to its true morphological significance.

The description of the object by DART, and principally the main arguments, which he gives for his opinion viz. that the new form "exhibits an extinct race of apes intermediate between living anthropoids and man" prompts me to give a short description of a skull, through which our knowledge of the present living Gorilla races is extended and through which the judgment of the morphological importance of the Australopithecus skull may be more accurate.

The discoverer begins his description by pointing out "that the whole cranium displays *humanoid* rather than anthropoid lineaments. It is markedly dolichocephalic and leptoprosopic". The first — and as regards the skeleton — the most prominent human attribute of the new form, the longheadedness, together with a long and narrow face is stated.

To what extent this attribute of the Australopithecus forms an anti-

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[1]) RAYMOND A. DART. Australopithecus africanus: The man-ape of South-Africa. Nature, February 7, 1925.

thesis to the present living man-ape, is known to every morphologist, who more especially studies the comparative anatomy of the Anthropoids.

In the critic of the fossilized remains of the Australopithecus by KEITH (Nature Febr. 14, 1925), he especially lays stress on this attribute. He writes: "Even if it be admitted that the Australopithecus is an anthropoid ape, it is a very remarkable one. It is a true longheaded or dolichocephalic anthropoid — the first so far known".

Seeing that the type of the skull of the Australopithecus promises to play an important part in the discussion on the place of this form in the system, I considered it desirable, to draw the attention to the fact, that also among the present living Gorillas, a race is found, which is strongly dolichocephalic and leptoprosopic and shows both these qualities to the same high degree as the fossil of the Australopithecus. This race is evidently only few in number.

Amongst the 50 Gorilla skulls in the Anatomical Museum of the University of Amsterdam only one example of this race is present. This skull is conspicuous on account of its outstanding difference from the rest. To what degree this is so, will be seen from what follows.

The skulls present in the above named museum are partly derived from Camerun and partly from the French Congo. The last named group was obtained throughout years by the intercession of the firm TRAMOND in Paris.

Some years ago this firm again informed me that they held at their disposal three skulls for the museum, "dont un d'une forme particulière". I mention this detail in order to show, how strongly the shape of this skull differs from the rest. That its characteristic shape is due to its strongly dolichocephalic and leptoprosopic nature, I immediately noticed on receiving it.

I never till now could execute my intention of giving a description of this object, but the discovery of the dolichocephalic Australopithecus prompts me not to wait any longer.

In order to assure an easy comparison, next to the sketch of the dolichocephalic skull a conformable sketch of the skull of a common brachycephalic Gorilla, will be placed.

In fig. 1 the norma verticalis of the dolichocephalic form is sketched, in fig. 2 that of the brachycephalic. The terms dolichocephalic and brachycephalic, are not truly applicable, in that the index cephalicus is not taken in the same way from full grown Gorillas as from man. As regards the greatest breadth of the cranium, this could if need be, be determined in a comparative way with that in man, but the greatest length is not to be determined, because the strongly developed crista occipitalis in the occipital region and the more strongly developed crista supraorbitalis in the frontal region, make an accurate measurement of the true length of the skull impossible.

Only in infantile skulls, where the crista occipitalis is wanting, the

orbits still situated subcerebral [1]) and the frontal eminence still absent, it is possible to determine an index cephalicus.

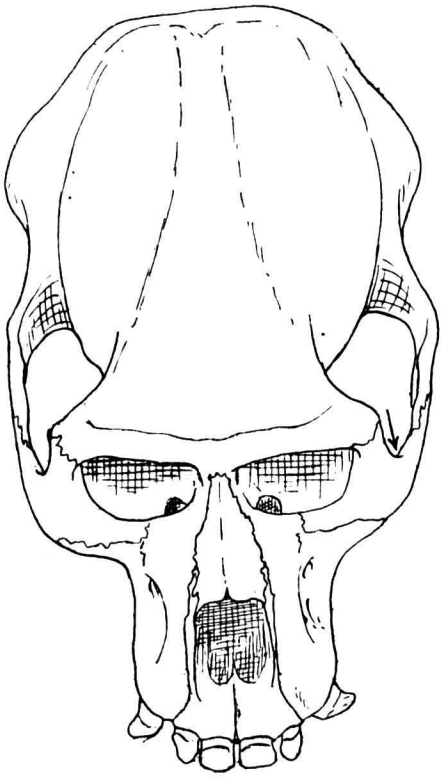

Fig. 1.

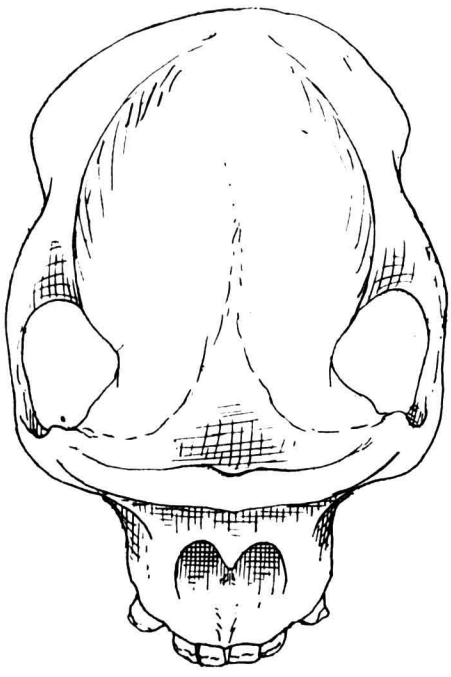

Fig. 2.

In the adult skull the index encephalicus i. e. the length-breadth-relation of the cranial cavity, which is easily to be determined in a sagittal section of the skull, should be used instead of the index cephalicus.

Although the difference in type between the skulls in figs. 1 and 2 is not to be expressed by the value of the index cephalicus, a comparison between both figures leaves no doubt about the essential difference in shape. Both skulls have been drawn, with the arcus zygomaticus running horizontally.

It is immediately evident, that together with the long, narrow cranium of the one specimen, we also find a long and narrow face, while the other object not only has a short round skull, but is also characterized by a short broad face. To this harmonical relation between the shape of cranium and face, the concurrency of dolichocephaly and leptoprosopy, which was also established in the Australopithecus by DART, this author especially draws attention to.

[1]) As regards the origin of the supraorbital cristae, the result of the forward shifting of the orbits, see my communication about the significance of the frontal ridges in the Primates. These Proceedings 25, 1922.

We will now study the facial part of the skull more closely. The leptoprosopy in the dolichocephalic Gorilla is the result of two causes, which is easily pointed out by the comparison of figs. 3 and 4. It

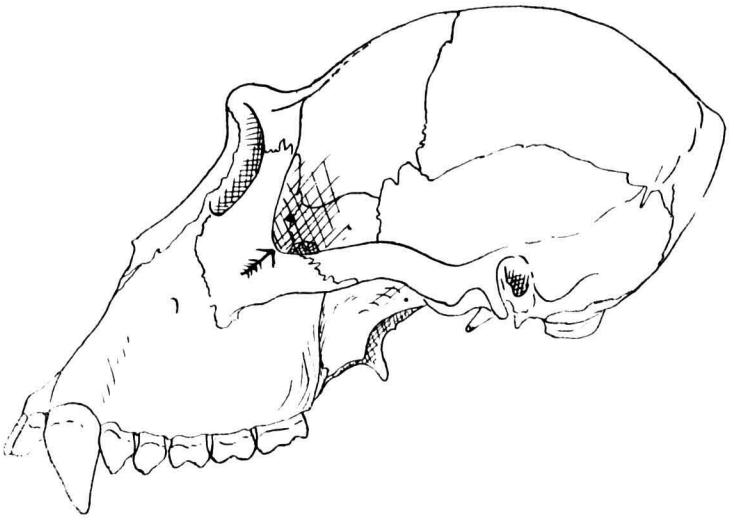

Fig. 3.

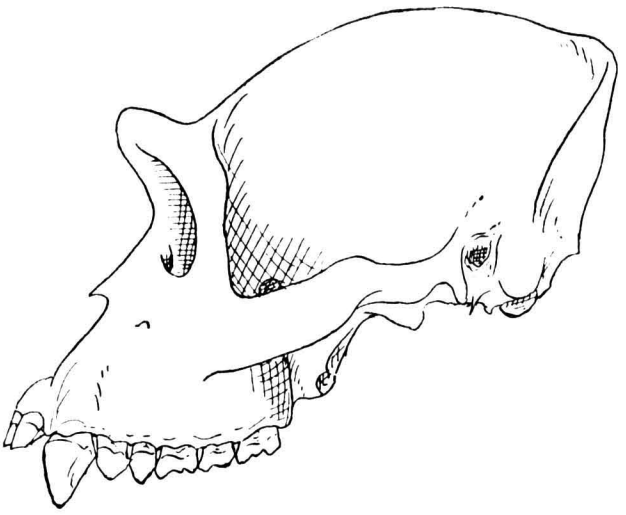

Fig. 4.

follows from measurements, that a true lengthening of the face has taken place. But this cause — about which presently more — is not the only. The leptoprosopy was partly brought about because the base of the face — the palate therefore — was as a whole, pushed horizontally in a frontal direction. This appears to be so, on account

of different anatomical peculiarities, but is most clearly demonstrated by drawing a line perpendicularly down from the highest point of the crista supra-orbitalis. In the brachycephalic skull, this line passes through the row of teeth viz. through 1st molar. In the dolichocephalic skull, however, the whole row of teeth lies in front of this line.

As a result of this displacement of the bottom of the face, the facial part of the skull is stretched in length, and has thus acquired a profile, which strongly differs from that of the ordinary Gorilla skull.

The same cause is also to same extent responsible for the difference in the direction of the plane of entrance of the orbits. In the common skull, as appears from figs. 2 and 4 this direction is rather vertically. In the dolichocephalic skull, however, the lower margin of the orbits strongly inclines to the front. The forwardly inclined pterygo-maxillary suture in this skull, in opposition to the vertically directed in the chamaeprosopic type, also is the result of the shifting of the facial base forwardly. In conclusion attention is still drawn to the strongly developed lamina externa, of the Pterygoid, through which the fossa pterygoidea is shaped into a form strongly resembling that of the human skull. I lay stress upon these points because, as said, the skull of Australopithecus also is leptoprosopic. The drawings, however, of this object lead us to suppose that in this case the leptoprosopy is caused in the main by the narrowness of the facial skeleton, for there is nothing to see about a shifting of the palate as is the case in our Gorilla. Therefore the profile of the Australopithecus differs strongly from that of the leptoprosopic Gorilla. From a comparison between both, no conclusion may however be drawn, the profile of the fossil having still an infantile character.

That, however, the leptoprosopy in our Gorilla is not only due to the lengthening of the face, but has to a large extent the same cause on which the leptoprosopy of the Australopithecus depends, viz. the narrowness of the facial skull, will now be shown.

An impression of the difference between the physionomic aspect of the common Gorilla skull and that of the dolichocephalic form, is acquired by a comparison of figs. 5 and 6. To get a more precise insight into these differences, it is desirable to take a few measurements, and to compare the resulting facial index of the ordinary skull with that of the long headed variety. When one intents to use measurements and indices in order to point out individual differences in the Gorilla, it is not possible to apply the usual measurements of the craniometric system of the human skull. This system has originated in accordance with the shape and structural properties of this skull. The strongly different Gorilla skull, however, requires an own craniometric system. This has already appeared to be so in the index cephalicus, which in the Gorilla cannot be determined in the same way as in man. In the Gorilla, an exact consideration is also necessary to find the appropriate measurements

and method through which the individual differences may be stated accurately by numbers and numerical relations.

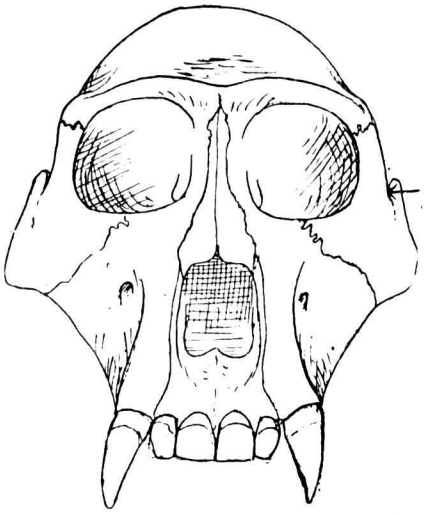

Fig. 5.

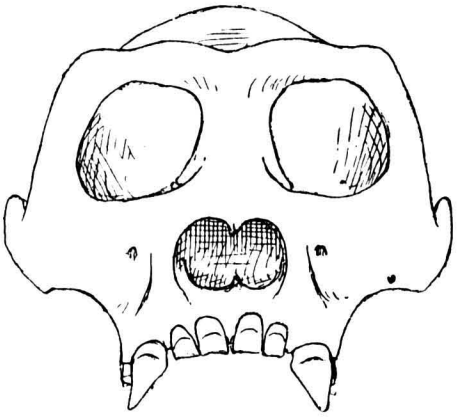

Fig. 6.

As regards the facial skeleton, both the following measurements appear to me the most recommendable to express the facial index. The greatest breadth is taken between the points where the upper margin of the zygomatic arch bends itself round into the lateral orbital margin. This point is represented by a little arrow in figs. 1, 3 and 5. As the greatest length we may take that of the profile, i.e. the distance measured in the median line between the highest point of the Crista orbitalis and the front margin of the intermaxillare between the median incisors.

I have determined the length and breadth of the face of 43 adult Gorilla skulls in this way and calculated the index facialis according to the formula $\frac{100B}{L.}$ = index facialis.

That in the dolichocephalic Gorilla, we indeed have to deal with a separate race, appears convincingly from the fact that with no exception the width of the face of the common Gorilla is greater than its length. The index facialis is therefore always greater than 100. In the dolichocephalic skull, however, the relation is vice versa, the breadth —120 m.M. is considerably less than the length — 134 m.M. The index facialis is therefore less than 100.

In this short communication it is superfluous to state, in extenso, the measures and the resulting indices of the measured skulls. It is sufficient if I give the general result of my measurements. While the index facialis of the dolichocephalic Gorilla is 89.5, it varied between 103.4 and 122.6 with an average of 111.5 in the common type.

The index facialis of the dolichocephalic skull is therefore much below the variability of the common type. The dolichocephalic skull is therefore not an extreme individual variation of this type, but a true variant of the species with a specific attribute, f.i. a marked leptoprosopy.

As regards the absolute measures it is to be noticed that in the chamaeprosopic type individuals occurred, whose facial breadth was less than that of the leptoprosopic specimen, but they were small female individuals. On the other hand again, some very large skulls, of which the absolute length surpassed that of the leptoprosopic form, are present in the collection. This will become evident from what follows. The face of the leptoprosopic skull was 120 m.M. accross and 134 m.M. long. The common skulls varied from 116—170 m.M. accross, with an average of 146 m.M., and the length between 101 and 154 m.M. with an average of 131 m.M.

From these figures it now clearly appears, that the leptoprosopy of the dolichocephalic skull is not only due to an increase in the length of the face as a result of the shifting already treated, but also in account of a decrease in the breadth. Because whereas the length is only a little more than the average length of the common skulls i. e. 134: 131 m.M., the breadth is considerably less i. e. — 120: 146 m.M.

The narrowness of the face is no primary structural property of the skull, it is an adaptation to the dolichocephalic nature of its braincase because a smaller crane necessarily has a smaller base, also in its forepart, to which the facial part is affixed. Dolichocephaly therefore is the primary and leptoprosopy is the secundary consequence of it, through which the harmonical shape of the whole skull is brought about. The narrowness of the face is associated with the somewhat deviating shape of the orbits from the ordinary. Just as in the Australopithecus they are less angled. And as a further harmonic association the entrance to the nasal cavity is long and narrow. These and still other details are clearly seen by a comparison of figs. 5 and 6.

It was evident, that in accordance with the narrowness of the maxilloorbital part of the face and the base of the skull, the mandible would also be narrower. The comparative investigation has shown this to be so. In this comparison the greatest breadth of the mandible was taken as the distance between both the lateral margins of the condyles. This measure is shown as a dotted line in fig. 7. This dimension, at the same time, gives an impression of the breadth of the base of the skull, as it is identical to the greatest breadth between the two Fossae glenoidales. The greatest length of the mandible was determined as the distance from the Incision to a line drawn perpendicularly from the middle of the line, joining the posterior margins of the capitula mandibulae. This measure is also represented by a dotted line in fig. 7. The index mandibularis was calculated from the obtained measures to the following way: length $\div$ 100 $\times$ breadth. For 41 common skulls this index varied between

82.7 and 103.3, while it was 71.6 in the mandible of the dolichocephalic skull. There is therefore again a great difference between the relative smallest mandible of the common skulls and those of the particular form, which is a quite apart specimen.

It has already been stated, that it is not possible to determine an index cephalicus from the adult Gorilla skulls, because during growth the orbits shift themselves in frontal direction, and thus make it impossible to determine the true length of the cranium. The form of the cranium, thus has to be expressed by an index other than the index cephalicus. The most suitable for this is the index encephalicus i.e. the relation between the greatest length and breadth of the cranial cavity. These measurements may be determined quite accurately from skulls sagitally bisected.

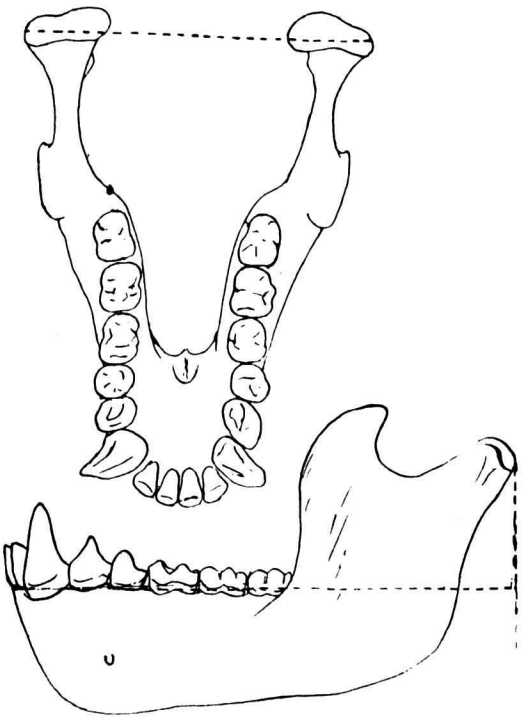

Fig. 7.

As points from which the greatest length of the cranial cavity must be determined, I have in previous communications recommended and applied the Fronton and Occipiton. In literature it is usually wrongly stated that in anthropoids during growth, the frontal part of the braincase is flattened off, through which the frontal vault disappears. This conception is wrong. The vaulting of the frontal region which is externally so clearly seen in the infantile skull of the anthropoids, in reality persists throughout life, but externally this vault is covered, because during the growth the orbits, which originally are situated beneath the brain, even as in man, i.e. beneath the base of the skull are displaced to the front, so that they come to lie anterior to the frontal vault. As a result of this displacement, the orbita receives a new roof, which grows out from the frontal wall of the skull [1]). One can show this quite easily on a sagitally bisected skull of a full grown Gorilla, the internal surface of the frontal region is not vaulted less in

[1]) See my communication: Die Topographie der Orbita beim Menschen und Anthropoïden und ihre Bedeutung für die Frage nach der Beziehung zwischen Menschen- und Affenschädel. Verhand. Kon. Akad. v. Wetensch. 2e Sectie, Deel XX. 1919.

such a skull than in an infantile one. Vide f.i. the mediagramms of both the skulls in figs. 8 and 9.

In the mentioned communication the point where the frontal wall and the base of the skull meet in the median line, was termed as Fronton.

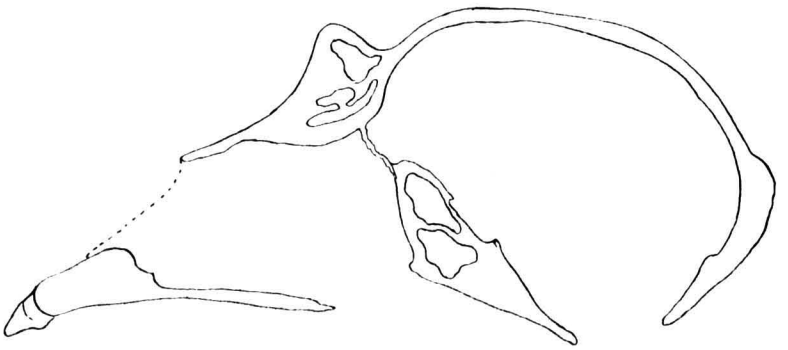

Fig. 8.

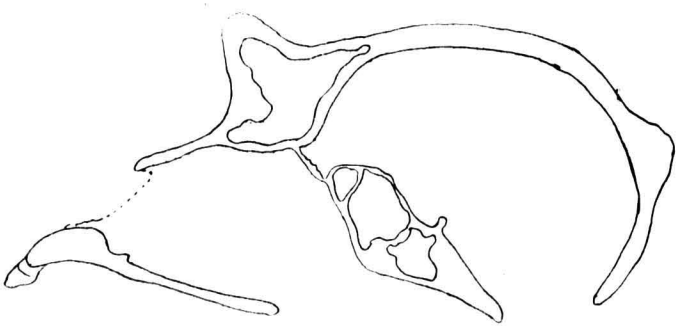

Fig. 9.

As Occipiton was termed the point on the occipital surface of the inner wall most distant from the Fronton. Between both these points is found the greatest length of the cranial cavity. For the greatest breadth add the greatest depth of the cranial cavity of each of the two halves together.

In this way I have determined length and breadth of the cranial cavities in 10 skulls, and calculated the index encephalicus. This varied between 80.6 and 85.9. This therefore confirms the known fact, that the Gorilla is brachycephalic. The index encephalicus of our particular skull again strongly differs from this. The length of the cavum cranii was 127 m.M., the breadth 92 m.M., the index therefore was 72.4.

This index only differs to a small extent from that which KEITH determined for the Australopithecus africanus, i.e. 71.

As regards the capacity of the dolichocephalic skull the following may be mentioned. The capacity of the anthropoid skulls, which are in the Anatomical Museum of the University of Amsterdam, has been

determined by one of my assistents [1]) and as regards the Gorilla skulls, he got the following results.

Capacity of the Gorilla-skull:

	minimum	*maximum*	*average*	*number*
male	450 c.M.^{3}	655 c.M.^{3}	550 c.M.^{3}	27
female	390 c.M.^{3}	595 c.M.^{3}	478 c.M.^{3}	12

KEITH estimates in his mentioned article on the skull of the Australopithecus the average for the Gorilla skull as 470 c.M.^{3} with a maximum capacity of 620 c.M.^{3}. From the very accurate researches of HAGEDOORN it follows, that this amount is too little, because it is already surpassed by that of the female skulls. The general average will have to be taken as easily 500 c.M.^{3}. The found maximum — 655 c.M.^{3} — also is higher than that mentioned by KEITH [2]) i.e. 620 c.M.^{3}. The dolichocephalic skull had a capacity which agreed with the average for male skulls i.e. 550 c.M.^{3}.

In conclusion mention is still made of the following pecularity of our skull. The determination of the sex in the common type of skull is quite easy, at least when it concerns adult individuals. The mighty developed and strongly projecting canines, together with the often enormous cristae on the skull, are always a true indication of the masculine skull. As regards the sex of our skull I, however, am undecided. The strongly developed canines will lead to think of a masculine skull, but a crista sagittalis is totally absent, the lineae temporales do not even reach the median line. From this we may conclude, to a mediocre development of the musculi temporales; the musculi pterygoidei, on the contrary, appear to have been developed more strongly than in the common Gorilla. DUCKWORTH already remarked [3]) that in the Gorilla as a rule the lamina externa of the Pterygoid is weakly developed, and the Fossa pterygoidea is shallow. In the dolichocephalic Gorilla, this lamina is broad, and the Fossa deep, just as in man. This lesser development of the musculi temporales and stronger development of the musculi pterygoidei may perhaps stand in connection with a somewhat varied mecanism of the so much narrower mandible of the dolichocephalic type.

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[1]) A. HAGEDOORN. Schedelcapaciteit van Anthropomorphen. Ned. Tijdschr. v. Geneeskunde. Jaargang 1923.

[2]) See also A. KEITH. The Growth of Brain in Men and Monkeys. Journ. of Anat. and Phys. Vol. XXIX. 1895.

[3]) W. L. H. DUCKWORTH. Variations in crania of Gorilla savagei. Journ. of Anat. a. Phys. Vol. XXIX. 1895.