

it appears, that we may assume, that the formation of the carbonates from silicate rocks has required *at least some decuples of millions of years*, and this the earth's crust also exists at least the same length of time. But this is a minimum; the real lapse of time since the formation of a solid crust and the appearance of life upon the globe may be *more than a thousand million of years*.

This final result of the investigation, however little claim it may make to exactness, might nevertheless interest geologists and biologists, who generally demand such a vast space of time. Moreover this result would be of some importance, if it should suggest nearer trial of the so called physical methods of estimating the age of the earth, by which Lord KELVIN has acquired unperishable merit for geology and biology, a trial which in many other respects too is desirable and promises important results. In his already quoted latest paper on this subject ¹⁾ Lord KELVIN estimates the age of the earth's crust, on the basis of these methods, at about 24 millions of years, and the sun he estimates about as old. It seems possible to modify some factors in the calculations of Lord KELVIN in such a way that higher results are obtained. The here sketched geological method appears to confirm that opinion. May it therefore be further worked out and lead to a more exact estimate of the age of the earth as an abode fitted for living beings than the estimates hitherto obtained.

Zoology. — "*Further results of an investigation of the Monotreme-skull*". By J. F. VAN BENMELLEN, The Hague (Communicated by Prof. C. K. HOFFMANN).

I. Palate.

In a former note ²⁾ the curious fact was mentioned, that in the Echidna-skull the pterygoids form part of the floor of the cerebral cavity, filling up a gap between the body of the sphenoid bone and its posterior or temporal wings (alisphenoids), so as to be visible on the inner side of the skull-bottom. To this we may now add, that the same is the case with the palatine bones. In a skull, in which the majority of the sutures could still be distinctly traced, a slender posterior process of the palatine was seen running down on

¹⁾ On the Age of the Earth, p. 11 and 25.

²⁾ These Proceedings. October 25th 1899. p. 81.

either side of the sphenoid body, separating it from the pterygoid. Both palatine and pterygoid took part in the formation of the median border of the oval foramen, the palatine forming the anterior, the pterygoid the posterior part of this border. Only at a very advanced stage of growth, the lateral border of the foramen in question also gets closed up by bone, i. e. by that thin bony plate, which in my opinion must be considered as representing the alisphenoid (l.c. p. 82). The antero-median angle of this ossification reaches the posterior border of the curious temporal wing of the palatine, likewise mentioned in my first note.

Of course only that part of the palatine is visible at the inner side of the skull-bottom, which is not overlapped by the body of the sphenoid. This part amounts to about the lateral third of the posterior palatine process (situated behind the temporal wing). The middle strip is covered by the side-border of the corpus sphenoidi, while the inner or medial third-part projects as far as the middle line of the skull forming the floor of the nasal canals. It is well-known, that in *Echidna* this floor is incomplete, the palatine plates diverging posteriorly, so as to leave open between them a deep fissure which however, in *Proechidna*, is reduced to a mere concavity of the transverse hind-border.

It needs hardly to be specially mentioned, that the participation of membrane-bones of the roof of the buccal cavity, such as the palatines and pterygoids, to the formation of the floor of the cerebral skull, can only be explained by the supposition that the primary cartilaginous skull-floor has suffered complete reduction within the limits of these bones. At the same time this hypothesis gives an explanation of the fact, that the ali-sphenoids do not reach the corpus sphenoidi: the cartilage, that was to bring about this connection having disappeared early instead of ossifying. The same phenomenon must have occurred on the outer side of the region of pterygoids and palatines, leading to the formation of the great gap or fontanella in the temporal area of the skull-wall, which is so characteristic for young *Echidna*-skulls. The alisphenoidal ossification, which finally closes up this gap, must thus develop in membrane, and must permanently remain separated from the corpus sphenoidi.

The probability of this supposition receives a firm support by the comparison with the skull of the *Echidna*-pouch-suckling. This shows the primordial cartilage still in situ under the osseous pterygoids and palatines, though it is totally absent in the region of the above-mentioned temporal fontanella. The final disappearance of this cartilage, leading to the entrance of pterygoids and palatine-processes

into the composition of the skull-floor, must therefore occur at a relatively advanced stage, at all events after birth.

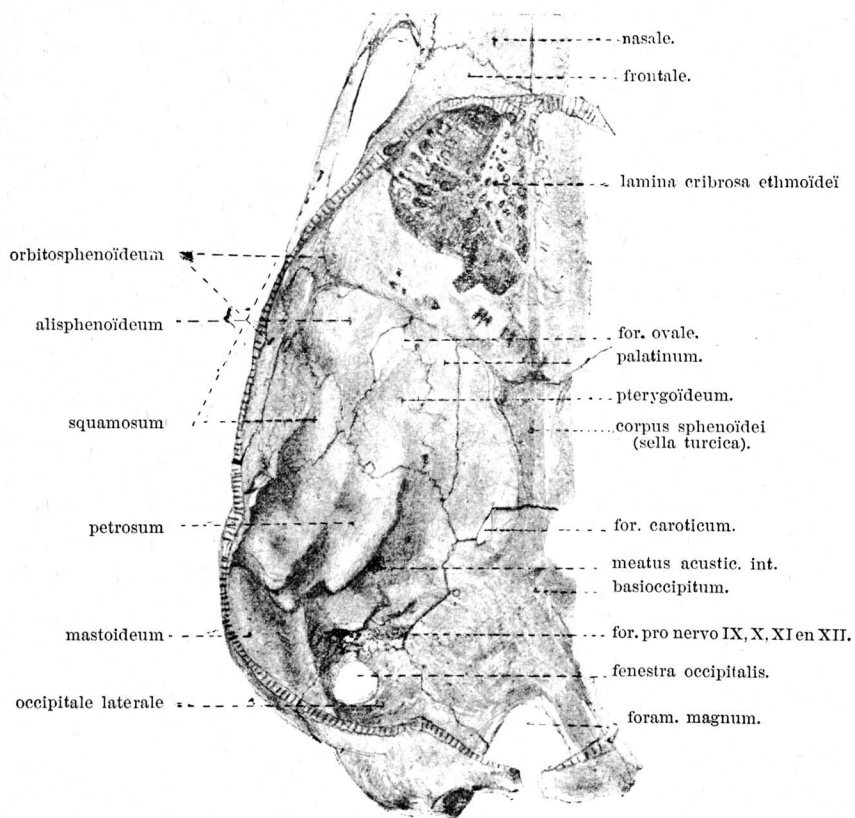
II. *Squamosal.*

In a recent publication¹⁾, Prof. V. SIXTA, has made a comparison between the skulls of the Monotremes and that of *Psammosaurus griseus*, and has come to the conclusion, that the former agree with the latter in most respects, notably in the possession of a quadrate bone. In *Ornithorhynchus* this bone is said to bear the glenoid surface for the under-jaw, in *Echidna*, on the contrary, it is said to form a bony bridge on the ventral side of the stylo-mastoid foramen.

In order to verify the correctness of this assertion, I once more looked over my material of young and adult Monotreme skulls, but I was not able to find any trace whatever of a separate quadrate bone, not even in the skulls of newly-born (or still unborn) sucklings. Moreover the osseous bridging over of the stylo-mastoid-foramen mentioned above is no peculiarity of *Echidna* alone, but occurs, as well and in the very same spot in *Ornithorhynchus*, with only this restriction, that it does not completely surround the ventral side of the foramen, but leaves open a small gap at the medial side.

If therefore this bone-bridge did really represent the Reptilian quadrate, the same designation could never be applied to a far more laterally-situated part of the *Ornithorhynchus*-skull. In my opinion however we have no right at all to consider either part of the Monotreme skull as a quadrate: the glenoid fossa of *Ornithorhynchus* simply forming the ventral face of the squamosal, whereas the bony bridge under the facialis-foramen of both genera is a part of the mastoid, and must be called the *processus mastoideus*. SIXTA, in *Ornithorhynchus*, calls it the *processus paramastoideus*, which name, according to my views, is wrongly applied as it must be retained for an outgrowth of the exoccipital (*pieuro-occipitale* or *occip. laterale*) occurring in many mammals, and not be given to a part of the mastoid.

1) SIXTA, V. Vergleichend-osteologische Untersuchung über den Bau des Schädels von Monotremen und Reptiliën. Zoologischer Anzeiger, Bd XXIII N^o. 613. 23 April 1900.



Echidna hystrix. Floor of the cerebral cavity, left side, inner aspect $\frac{2}{1}$.