

THE CARNOSAUR DINOSAUR BRAIN

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Paleontology Zhurnal, 1965, No. 2, pp. 141-143

(translator unknown)

Study of the brain of dinosaurs and other extinct animals entails great difficulties, because the brain, like many internal organs and soft tissues, suffers rapid decay after the animal's death. At best, the investigator may come across natural casts of the brain (Tertiary and Quaternary mammals) or plaster casts (reptiles). The work of Marsh (1886), Edinger (1929), Orlov (1947, 1961) and Gabuniya (1959), however, show that study of the volume and shape of the brain and the dimensions of the nerves running from it based on cast and plaster molds are of great interest for an understanding of the evolution of many forms.

Nevertheless as Orlov (1961) rightly notes, we must approach the study of plaster moulds with great care, since the cast may not always correspond with the size and relief to the brain itself. In many reptiles the brain is often separated from the cranial bones by considerable expansions of the cerebral membranes and vascular plexuses and also by large cavities for the blood reservoirs (cranial sinuses), and the brain as it were "floats" suspended on fine, fibrous threads inside the tough cerebral membrane, the dura mater. Dendy (1911), studying the *Sphenodon* brain established, for example, that the brain occupied by no means the whole of the cranial cavity which corresponds to the volume of the dura mater. The latter is almost twice that of the brain itself. Such a ratio between the volume of the cranial cavity and that of the brain itself was evidently characteristic also of the dinosaurs.

The mould of *Tarbosaurus efremovi* Maleev (T. Yefremovi Maleyev) (fig. 1) cranial cavity

has the following dimensions (in mm): length from anterior end of olfactory lobes to posterior boundary of medulla oblongata 180; transverse width in region of cerebral hemispheres 62; maximum height in region of cerebellum 83; transverse width of medulla oblongata 41. Volume of mould about 360-400 cc; consequently the volume of the brain itself was not more than 180-200 cc. This is a very small brain in comparison with the gigantic dimensions of the body. The brain is longitudinally prolate, S-shaped, so that the anterior part was higher than the posterior. The olfactory lobes are situated in front, connected by a powerful trunk with the hemispheres of the prosencephalon. Slightly behind and below the hemispheres, the optic lobes of the midbrain stand out in relief. Behind them in a very large part of the metencephalon, consisting of the cerebellum, which is strongly extended in the dorsoventral direction and protrudes above the other sections of the brain. Below and behind the cerebellum lies the medulla oblongata. Viewed from above the longitudinal fold of the dura mater is clearly visible running medially from the olfactory lobes to the beginning of the cerebral hemispheres, where it branches into two lateral folds which arch round the posterior border of the prosencephalon. At the boundary between the cerebellum and the medulla oblongata there emerges a broad, vertical fold, which may have become ingrown in the skull bone, as is shown by the deep furrow on the inner surface of the parietal and supraoccipital. This is the dinosaurian pseudotentorium, which separated the cerebellum from the medulla oblongata and seems to have served as a reliable protection against impact. In addition, on the dorsal surface numerous smaller furrows can be seen and a network of blood vessels supplying the dura mater and the brain.

On the lateral surface of the mould the points at which the cranial nerves emerge are clearly marked: I, II, III, IV, V, VII, VIII, IX-XI, XII. The largest that can be distinguished are those for the optic and acoustic nerves, and also for nerves XI-XI, along with which the jugular veins may possibly have traveled. The plaster mould of *Tarbosaurus efremovi* cranial cavity is morphologically hardly distinguishable from that of *Tyrannosaurus rex* Osborn; there is only a slight difference in size. According to Osborn's data (1912), the volume of the *T. rex* brain is 250 cc, or 50-70 cc larger than that of *Tarbosaurus efremovi*.

It is very difficult to draw any conclusions regarding the functional differentiation of all the sections of the brain and we can attempt only a very approximate interpretation of them.

The *Tarbosaurus* brain was primitive, of reptile type; all the sections are situated almost on a single level with a slight bend in the region of the diencephalon and cerebellum. The olfactory lobes, the cerebral hemispheres of the prosencephalon, the prominent convex optic lobes of the midbrain and the large cerebellum can be morphologically distinguished. The function of these sections seems to have consisted in receiving impulses from the sensory receptors and transmitting them to the motor nuclei and also in acting as a coordinating center (the olfactory, optic and coordination apparatus of the cerebrum and cerebellum).

It is interesting that of all the dinosaurs, the carnosaurs display the greatest development of the brain: *Tyrannosaurus*, *Tarbosaurus* and other predators (fig. 2); the volume of the brain increases from the lower to the higher forms.

Further, the volume of the brain in the land forms is much greater than in the aquatic forms. In *Tyrannosaurus rex* and *Tarbosaurus efremovi* it is three or four times greater than in the sauropods, ankylosaurs and ceratopsids.

In the carnivorous dinosaurs, olfaction was well developed and the animals were sensitive to scent; acute vision, possibly binocular, was also developed as is shown by the characteristic direction of the skull orbits; strict coordination of movements was a feature of almost all biped forms.

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Figure Captions

Fig. 1. Plaster-of-Paris casts of the cranial cavity in giant carnivorous dinosaur *Tarbosaurus efremovi* Maleev: a – view from above; b – side view; olf – olfactory lobes; cer – cerebral hemispheres; opt – optic lobes; cbl – cerebellum; mo – medulla oblongata; ps – longitudinal fold of dura mater; pt pseudotentorium; I-XII – cerebral nerves.

Fig. 2. Diagram of comparative volume of cranial cavity in dinosaurs in the order of their evolutionary affinity (according to Colbert): Ac – *Anchiceratops*; As – *Ankylosaurus*; P – *Pachycephalosaurus*; S – *Stegosaurus*; T – *Tyrannosaurus*; B – *Barosaurus*.