

Resumen por el autor, E. C. Case,
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Sobre un vaciado endocraneal del reptil triásico *Desmatosuchus spurensis*, del triásico superior del occidente de Texas.

El vaciado endocraneal descrito en el presente trabajo corresponde a un individuo de un nuevo subórden de reptiles, el de los *Desmatosuchia*, descrito en un trabajo preliminar publicado en el *Journal of Geology*, vol. 28, Núm. 6, 1920. Mediante un vaciado, el autor ha conseguido obtener una reproducción muy perfecta de la cavidad endocraneal. El vaciado demuestra la existencia de una epísis o parásis casi vertical, con procesos laterales que se extienden de la misma región cerebral. Los procesos laterales son los vaciados de dos fosas profundas, tal vez orificios, que marcan la pared interna de la caja cerebral a cada lado de la profunda fosa que deprime la pared del cráneo en la posición del orificio pineal, sin llegar a perforarle.

La hipófisis es muy grande y está ligeramente inclinada hacia atrás; la porción anterior no es visible por no estar osificadas anteriormente las paredes de la caja cerebral. Apenas existe una expansión de los lóbulos cerebrales y no se presentan estructuras que indiquen la posición de los nervios ópticos y tálamo. El tracto olfatorio es voluminoso y ancho; los nervios II, III y IV pasan a través de escotaduras formadas por la aproximación de los alisfenoides u orbitosfenoides; el nervio V sale al exterior por un ancho orificio de las paredes laterales de la caja craneal y no se divide hasta después de abandonar esta. El nervio VI pasa exteriormente a través de la base de la caja craneal. La región ótica está indicada solamente por un proceso, puesto que las otras estructuras fueron destruidas por la fosilización. Los nervios VII y VIII abandonan la cavidad cerebral cerca del orificio ótico. Los nervios IX, X y XI salen por un solo orificio grande que también aloja la vena yugular. El XII pasa al exterior a través de un orificio del exoccipital.

ON AN ENDOCRANIAL CAST FROM A REPTILE,
DESMATOSUCHUS SPURENSIS, FROM THE
UPPER TRIASSIC OF WESTERN TEXAS

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NINE FIGURES

As has been shown by the author¹ in a preliminary paper, the remains of *Desmatosuchus* indicate a new suborder of phytosauroid reptiles. In cleaning the skull of this specimen it was found that the brain cavity was practically undistorted and that it was possible to obtain a plastic cast of the endocranium. As is well known, any endocranial cast does not reveal the true shape of the brain, and this is particularly true of the reptiles where the brain is surrounded by a mass of connective tissue or by a large space between the pia and dura mater which is crossed by fibers of connective tissue. Nevertheless, such casts give an idea of the form and relative size of brain and the location of the cranial nerves and blood-vessels. Such casts from mammalian skulls are not uncommon in some localities as the Oligocene deposits of the Big Bad Lands of South Dakota, but very few have been found from the lower vertebrates. Even skulls so well preserved that the cavity may be cleaned out and casts made are not common. Moodie² has figured such a cast from the Pennsylvanian deposits of Kansas without assigning any taxonomic position to the specimen and has briefly reviewed the literature of endocranial casts of fossil forms up to the time of his paper. To his publication the reader is referred for a historical account of the subject and a discussion of such casts as have been found or made. Moodie mentions two papers by

¹ *Journal of Geology*, vol. 28, no. 6, 1920, p. 524.

² Moodie, R. L., *Jour. Comp. Neur.*, vol. 25, no. 2, 1915.

Cope describing such casts, one from a cotylosaurian reptile, *Diadectes*, from the Permian of Texas, and one from a phytosaur, *Belodon*, from the upper Triassic of Texas, but he neither discusses these papers nor reproduces the figures given by Cope. This is understandable, as the figures are very poor and difficult to interpret and the subject-matter is only distantly related to the material of his paper. As the casts figured and described by Cope are from forms more nearly related to the one described in this paper, the figures are reproduced in line drawings as accurately as they may be made out.

The cranial cavity of *Desmatosuchus* was completely cleared out, leaving the surface of the bone in good condition with all the pits and foramina clearly marked. As may be seen in the figures, the cast as finally secured shows the general form and proportions of the brain cavity and the positions of the main outlets. The anterior wall of the cavity was entirely cartilaginous or membranous, and as this portion was not preserved in the fossil the opening was stopped with plastic clay which is easily detected in the figures; for this reason, the form of the olfactory tract and of the pituitary body is not completely shown.

The olfactory tract was evidently large, as in most of the primitive forms, and extended well forward directly beneath the upper wall of the skull. The cerebral portion was relatively small, scarcely any swelling being revealed in this part of the cast except at the posterior end of the prosencephalic region. The anterior-lower part of this region was enclosed by the alio-orbitosphenoid bones, and the approximation of the bones of the two sides forms notches in two places which indicate the points of escape of the nerves which supplied the eye. No indication of the origin of the II, III, or IV pair of nerves is shown on the cast and no outlets except the notches mentioned.

It is impossible in the cast to distinguish between the diencephalic and the mesencephalic regions of the brain, but the area

³ Cope, E. D., Proceedings American Association Advancement of Science, Ann Arbor meeting, 1885, and Proceedings American Philosophical Society, 1886, p. 234.

Proceedings American Philosophical Society, 1887, p. 219, and American Naturalist, vol. 22, 1888, p. 914.

occupied by these two is marked by a slight but distinct depression, which is outlined by definite elevations; the posterior one amounting to a low, sharp ridge. From this depression rise the processes, above and below, which may be referred to in general terms as the epiphysis and the pituitary body.

The upper process is complex and is, perhaps, composed of two parts. Just posterior to the edge of the proencephalic portion there are two protuberances which mark the position of a pair of deep pits in the upper wall of the brain case. In cleaning the skull it was impossible to be certain that the bottom of these cavities had been reached, but it seemed probable that it had. With the aid of a dentist's mouth-mirror and fine curved awls the pyrite filling was picked out until it seemed that the bottom had been reached, but because of the inaccessibility of the cavities and their small diameter it is possible that the cavities may have been deeper and even that they may be the entrances to foramina. Cope, in describing the endocranial casts of a phytosaur, *Belodon*, and of a cotylosaurian reptile, *Diadectes*, speaks of the 'lateral processes of the epiphysis' and in describing the skull of *Belodon* speaks of the process as lying in a "large canal which enters the posterior part of the orbit." To this canal he gave the name of the orbitopineal canal and in certain papers speaks of the orbitopineal process on the casts. The function of this canal he was unable to determine, but suggests that it carried a nerve or blood-vessel.⁴ In his earlier papers he was inclined to the belief that *Diadectes* was blind because he could find no outlet for the optic nerve and because the structure of the animal suggested that it was burrowing in habit; as the parietal foramen is exceptionally large in this form, he was inclined to believe that the orbitopineal canal might have carried a nerve from the large, probably functional, eye which occupied the parietal foramen, which in part supplied the necessary vision. It is impossible to tell whether such a canal existed in *Desmotosuchus*, but if it was present it was very small, and the author of this paper is inclined to believe

⁴Dr. R. L. Moodie, in conversation with the author, has suggested that these processes may indicate a portion of the course of the ductus endolymphaticus.

that it did not exist. Moreover, there is a decided difference in the endocranial casts in this region. In *Belodon* and *Diadectes* the processes are large and rise from the sides of the epiphysis, in *Desmatosuchus* they are small and are entirely anterior to the epiphysis. It is possible that if a true cast of the brain could be obtained the origin of the processes might be found to be the same in all, but as the casts were all made from empty cavities a similar origin should be apparent.

The epiphysis is very different in form. In *Belodon* and *Diadectes* there is a strong posterior process, and Cope describes the epiphysis of the former as 'subquadrate.' The orbitopineal process extends either directly outward from the side, *Diadectes*, or outward and forward, *Belodon*. In *Desmatosuchus* the epiphysis is erect and narrow anteroposteriorly with no posterior process. In both *Belodon* and *Desmatosuchus* the processes referred to as the epiphysis are casts of a deep pit on the under side of the skull in the exact position of the pineal foramen in other reptiles, but in neither of these is the roof perforated. In looking up this matter the author has found that much uncertainty exists as to the exact character of this process in the brain; it is known that both the epiphysis and the paraphysis may reach large size and that either one may terminate in a functional eye; at least, either one may carry organs which possess the histological structures of the retina and the crystalline lens. In some forms there has also been found a third evagination of the brain, posterior to the epiphysis, called the pineal organ, which has a similar histological structure. Wilder, in his *History of the Human Body*, states that it is the paraphysis which was developed in the extinct *Stegocephalia* and filled the parietal foramen and the epiphysis which was developed in the reptiles, birds, and mammals. On the other hand, it is known that the epiphysis is not developed in the modern alligator. The term epiphysis is used in this paper only in a general sense and without knowledge of its true nature.

On the lower side of the diencephalic region of the cast is the second process; this represents the combined infundibulum and the saccus vasculosus, or the pituitary body. Only the posterior

and lower borders are shown, for the anterior part was enclosed by the cartilaginous anterior wall of the skull which was lost in fossilization. The process extended directly downward by a narrow neck which passed through a narrow notch formed by the approximation of the alisphenoid bones at their lower borders. Its posterior face lay against the basisphenoid bone, not penetrating it, and its lower surface is an excavation on the upper surface of the posterior part of the parasphenoid. The lower part of the process was enlarged and the posterior face, at least, extended backward at a sharp angle. The lower end terminates in a bifurcate extension which is formed by the casts of the beginnings of two foramina which open outwardly and downward in an excavation on the upper surface of the parasphenoid. These foramina continue and terminate in deep grooves on the side of the basisphenoid. On the posterior face of the process are two small prominences which mark the position of two foramina on the lower face of the basisphenoid, evidently the openings for the internal carotid arteries.

The posterior part of the depressed area mentioned above must also include the mesencephalic portion of the brain, but there is nothing to mark the presence of either optic lobes or optic thalami. This does not, however, suggest either their absence or relatively small size, for if a cast were made of the brain cavity of *Sphenodon* or of an alligator no evidence of these structures would appear, though they are of large size.

Posterior to the depressed area the whole cast is curved sharply downward and then straightened out horizontally in the metencephalic region. On the lower edges of the anterior part of this region there are large prominences which mark the position of the large foramina for the passage of the V pair of nerves. There is no indication in the cast of the division of this nerve into its parts; this must have taken place external to the cranial wall. Within and a little posterior to these prominences is indicated the position of a pair of small foramina in the floor of the skull, evidently the outlets for the V pair of nerves. Posterior to the V and at about the middle of the posterior part of the cast there are a pair of processes on each side, one almost directly above the

other. The upper pair are the casts of the otic cavities and mark approximately the position of the VIII, and probably, also, the VII nerves, for these two pairs escape from the skull of the *Crocodylia* in almost the same place. The otic cavities were injured in fossilization both by pressure and by the crystallization of the gypsum and pyrite which filled the cavities of the skull. It is apparent that there was a thin wall between the otic cavity and the brain cavity, but this has been so injured that it is impossible to determine the original form of the otic cavity or the form and position of the semicircular canals.

Below are the large cylindrical projections which filled large foramina carrying the IX, X, and XI nerves and the jugular vein. All of these must have escaped through a common opening, as the walls of the brain are very perfect in this place and no other openings are present.

Near the posterior end of the cast are slender processes which mark the position of the XII nerves. Above these processes there are small prominences which filled pits in the inner walls of the exoccipital bones. These pits were entirely cleared, and it is certain that they were not the beginnings of foramina; their meaning is unknown.

The whole metencephalic portion of the cast is rather high and narrow. It is possible that this is due in some degree to crushing, but there is no indication of such crushing in the skull, and it is probable that it is the true form. The whole cast is very small relative to the size of the animal, and even assuming that the brain occupied the whole cavity its size would be remarkable, though after all it is not much smaller, relatively, than the brain of *Sphenodon* or of an alligator.

It is difficult to make any satisfactory comparison of this endocranial cast with the one made by Cope from the specimen of *Belodon buceros* because of the unsatisfactory nature of his figures, but some points can be made out. As can be seen by the figures in this paper, the whole shape is different, the cast from *Belodon* does not show the sharp downward curve posterior to the middle region. The cast of *Desmotosuchus* is thinner for its height and does not have so long a metencephalic portion.

The epiphysis lacks the posterior prolongation, certainly it is not 'subquadrate' in form, and the lateral processes rise in front of, not at the sides of, the epiphysis. The olfactory tracts were much broader. The optic nerves did not escape through distinct foramina. Only the origin of the pituitary body is shown in Cope's figures, but he describes it as small and occupying a fossa in the base of the cranial cavity. These characters support the evidence afforded by the bones of the skull that *Desmatosuchus* must be placed, at least, in a distinct suborder from the *Phytosauria*.

In considering the endocranial casts from the four very different primitive reptiles figured in this paper, it is certain that the brains of all had certain very distinctive characters in common. The brain cavity was relatively long and narrow with small development of the cerebral hemispheres. The optic lobes and tracts were too small to leave any distinct marks on the casts, though they were probably well developed. The brain was sharply elevated in the middle portion with large epiphysial or paraphysial processes. There was a sharp downward bend in the posterior portion. There is a considerable degree of constancy in the location of the origin of the cranial nerves. One thing is especially noticeable—the large size of the pituitary body in the giant forms. *Tyrannosaurus* was the largest of the carnivorous dinosaurs; *Diplodocus* was one of the largest creatures that has lived upon the earth; *Triceratops* was elephantine in size; *Desmatosuchus*, though not so large as the dinosaurs mentioned, was 10 or 12 feet long and probably a giant of its kind. In all of these forms the brain is exceedingly small relative to the body, but the pituitary body is very large relative to the size of the brain. The connection between the size and activity of the pituitary gland and the size and the proportions of the body in mammals is well known. Hyperpituitarism results in large size or the over-development of certain structures, as the fingers, features, etc. It is equally well known to paleontologists that one of the common variations among those which occur so abundantly in the senile stages of any phylum is giantism. The suggestion naturally rises that the disturbances which

arose in the phylum coincident with the development of adverse conditions were primarily of a physiological character affecting the deep-seated organs of the nervous system and through them, and only secondarily, the superficial structures. The teratological affections of the pituitary body which produced abnormal structures in a normal phylum may have gradually become a fixed character and resulted in normal giantism in certain groups. Similar correlations between other glands of the body and such characters as spines, horns, tusks, etc., which finally developed into excessive overgrowths in the senile stages of various phyla may have arisen in the same way.

Since this manuscript was prepared two excellent figures of endocranial casts have been published: Osborn and Mook, *Memoirs American Museum of Natural History, New Series*, volume 3, part 3, plate LXIV, Endocranial cast of *Camarasaurus supremus*; Lambe, *Canada Department of Mines, Memoir 120*, fig. 27, Endocranial cast of *Edmontosaurus*.

PLATES

PLATE 1

EXPLANATION OF FIGURES

- 1a Lateral view of endocranial cast of *Belodon buceros*. After Cope.
1b Upper view of the same. Both figures $\times \frac{1}{4}$.

ABBREVIATIONS

<i>Ep.</i> , epiphysis	<i>Olf.</i> , olfactory tract
<i>Orb.Pin.</i> , orbitopineal process	<i>Cb.</i> , cerebellum
<i>Cer.</i> , cerebrum	<i>II, V</i> , cranial nerves

- 2a Upper view of endocranial cast of *Diadectes phaseolinus*. After Cope.
2b Lateral view of the same. Both figures $\times \frac{1}{4}$.

ABBREVIATIONS

<i>Olf.</i> , olfactory tract	<i>Cb.</i> , cerebellum
<i>Cer.</i> , cerebrum	<i>V</i> , cranial nerve
<i>Ep.</i> , epiphysis	<i>Ot.</i> , otic tract

- 3a Lateral view of endocranial cast of *Tyrannosaurus rex*. After Osborn.
3b Upper view of same. Both figures $\times \frac{1}{4}$.

ABBREVIATIONS

<i>Olf.</i> , olfactory tract	<i>I to XII</i> , cranial nerves
<i>Cer.</i> , cerebrum	<i>h1</i> and <i>h2</i> , epiphysis
<i>Opl.</i> , optic lobe	

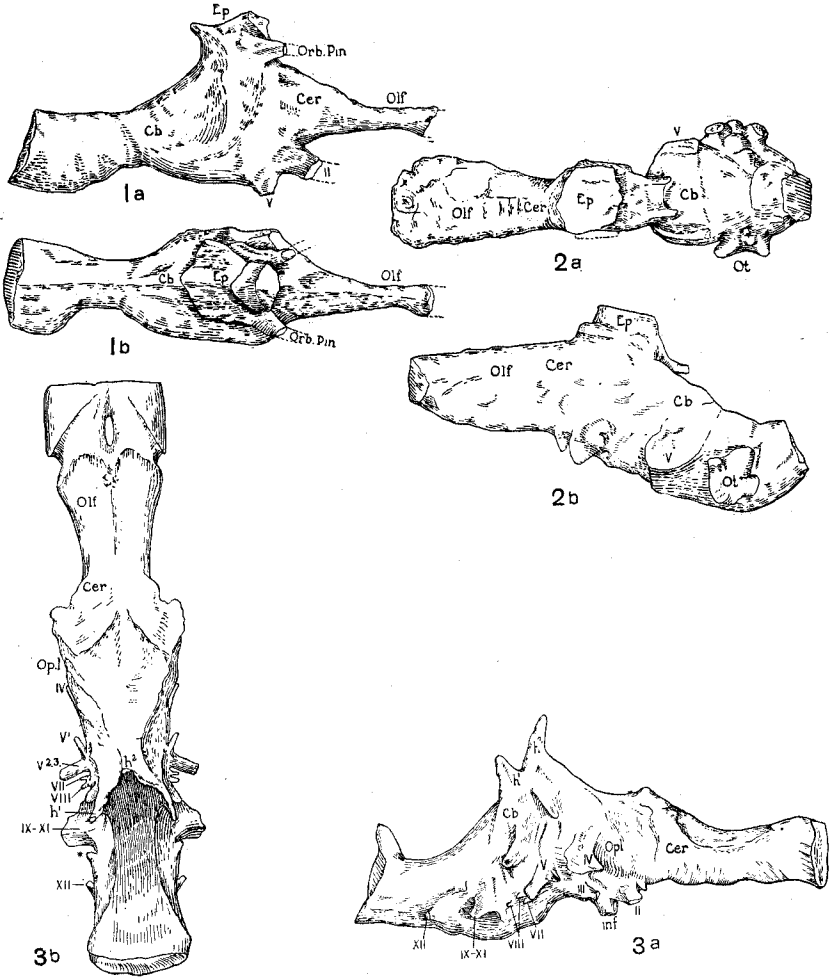


PLATE 2

EXPLANATION OF PLATES

4 Lateral view of endocranial cast of *Diplodocus longus*. After Osborn.
 $\times \frac{1}{4}$.

ABBREVIATIONS

Sac.End., saccus endolymphaticus *II to XII*, cranial nerves
Int.Car., internal carotid arteries

5a Upper view of endocranial cast of *Triceratops serratus*. After Hatcher from Marsh.

5b Lower view of same. Both figures $\times \frac{1}{4}$.

ABBREVIATIONS

Olf., olfactory tract *Ve.*, vein
Cer., cerebrum *Pit.*, hypophysis
Cb., cerebellum *II to XII*, cranial nerves

6a Lower view of endocranial cast of *Triceratops serratus*. After Hay. This and the two following figures give Hay's interpretation of the casts, as opposed to that given by Hatcher.

6b Upper view of same.

6c Lateral view of same. All figures $\times \frac{1}{4}$.

ABBREVIATIONS

Olf., olfactory tract *Car.*, carotid artery
Cer., cerebrum *Ju.v.*, jugular vein
Ve., vein *II to XII*, cranial nerves
Pit., hypophysis *Ep.*, epiphysis
Op.a., base supposed ophthalmic artery

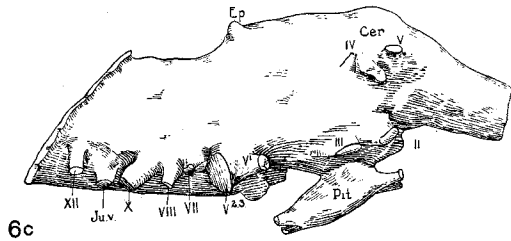
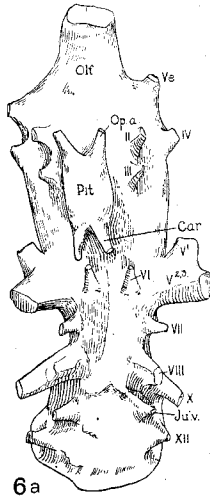
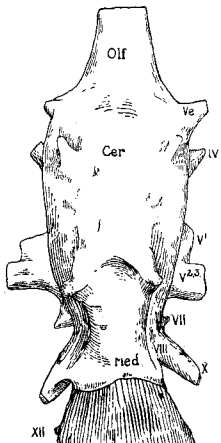
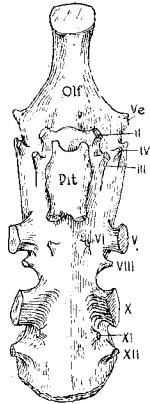
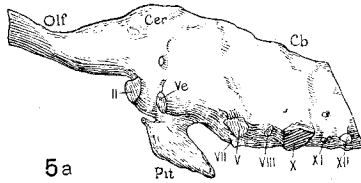
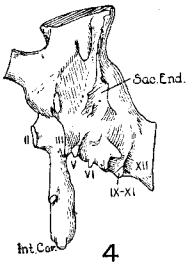


PLATE 3

EXPLANATION OF PLATES

- 7 Lateral view of endocranial cast of *Dematosuchus spurensis*.
- 8 Upper view of same.
- 9 Lower view of same. All figures $\times \frac{1}{2}$.

ABBREVIATIONS

Ep., epiphysis
Lat.proc., lateral processes
Olf., olfactory tract

Ca., carotid artery
Hyp., hypophysis
II to XII, cranial nerves

