

LEIDYOSUCHIUS STERNBERGII, A NEW SPECIES OF CROCODILE FROM THE CERATOPS BEDS OF WYOMING.

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The Division of Vertebrate Paleontology of the U. S. National Museum has recently acquired from Mr. C. H. Sternberg, of Lawrence, Kansas, an unusually well-preserved crocodilian skull and jaws associated with other parts of the skeleton. The specimen was found by his son, Mr. Charles M. Sternberg, on the north side of the Cheyenne River, in the Ceratops Beds of Converse County, Wyoming, during the summer of 1909.

Although there is abundant evidence of the existence of crocodiles in these beds, well-preserved specimens are exceedingly rare. Such fragmentary remains as have been found from time to time paleontologists have usually referred to *Crocodylus humilis* Leidy, a Judith River species founded upon insufficient evidence, and as Hatcher<sup>a</sup> has pointed out, "the simple conical teeth upon which the species was based furnish no characters for the positive identification of other material."

The specimen considered here, I refer to the recently established genus *Leidyosuchus* of Lambe,<sup>b</sup> which is founded upon specimens from the Judith River Beds (Belly River) of Alberta, Canada. Even though it occurs in a geological horizon of considerably later age, no characters were detected which would justify more than its specific separation from *Leidyosuchus canadensis* Lambe, and I therefore take great pleasure in naming the species after the veteran collector, Mr. C. H. Sternberg, whose devotion to paleontology has done so much to further that science.

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<sup>a</sup> Bull. No. 257, U. S. Geol. Surv., 1905, p. 82.

<sup>b</sup> Trans. Royal Soc. Canada, vol. 1, 1908, pp. 219-244.

## LEIDYOSUCHUS STERNBERGII, new species.

Pls. 23, 24, 25, 26, and 27.

*Holotype*.—Cat. No. 6533, U.S.N.M., consists of the greater portion of the skull, the left ramus almost entire, anterior part of the right ramus, eight vertebrae in various stages of preservation, both humeri, right fibula, second metatarsal of the left hind foot, and other fragmentary parts of the skeleton.

*Type-locality*.—North side of Cheyenne River, about 3 miles west of McKeow's ranch, Converse County, Wyoming.

*Horizon*.—Ceratops Beds, Cretaceous.

*Detailed description*.—Viewed from above the form of the skull resembles that of the living crocodile, although compared with *Crocodylus americanus* it is proportionally broader posteriorly, approaching nearer in its general outline the skull of *C. porosus*. Evidently the specimen is that of an adult as shown by the complete coalescence of many of the sutures. A section across the whole width of the median preorbital region and extending back on the right posterior half of this aspect has been lost through erosion. In Pl. 23 is shown a superior view of the skull, reproduced here from a photograph taken after the missing portions were restored. The lighter color of the restored parts distinguishes them at once from the original fossil.

The coalesced parietals occupy the posterior median position, their anterior lateral borders forming the inner boundaries of the supratemporal fossæ. The least width of the parietals between these vacuities is 17 mm. The posterior half of the dorsal surfaces of the parietals is covered with large, deep, irregularly shaped pits, while on that portion between the fossæ there is a single median longitudinal ridge with comparatively smooth tracts on either side which extend laterally to a smooth, raised ridge of bone around the inner and posterior boundaries of the supratemporal vacuities. The suture between the parietal and squamosal of the left side can not be distinguished, but as shown in *L. canadensis* their union is probably at the middle of the posterior boundary of the supratemporal fossa.

The union of the parietals with the frontal is only dimly discernible, but on the inner anterior surface of the left supratemporal fossa the suture is quite distinct and shows clearly that the frontals contribute to the boundary of the fossa on the superior surface between the parietal and postfrontal, as in *Diplocynodon* Pomel. Two detached but broken parts of the frontal bone, which were found near this specimen and which supplement each other, may, from their size and sculpturing, be considered as belonging to the present species, and shows that this bone was broad behind and narrow in front. In the type skull the side of the frontal is excavated for a distance of

18 mm. by the inner border of the orbit. The posterior upper surface is ornamented with well-defined pits, smaller than those found on the same surface of the parietals. These pits vary in size and shape from subround to elongate-oval, being arranged in transverse rows and separated by ridges narrower than themselves; none are confluent. The larger pits have their greatest diameter transversely. The median anterior portion is without decided ornamentation, as best shown in a detached frontal (Cat. No. 6542, U.S.N.M.). The whole of the under surface is smooth except an area on either side posteriorly for the sutural union with the alisphenoids, where it forms a considerable part of the roof of the cranial cavity. Between the alisphenoids is a median longitudinal depression, which carries the sense organs to the olfactory lobes of the brain. This groove traverses the whole length of the bone, widening anteriorly to the fronto-prefrontal suture. Posteriorly, this suture can only be made out on the inner orbital surface where it occupies approximately the same position as in *C. americanus*, and on the orbital side runs obliquely downward and forward.

The squamosal meets the quadrate and exoccipital below and forms part of the roof of the external auditory meatus. It is pitted above, and, with the prefrontal, forms the outer boundary of the supratemporal fossa. The postfrontal unites as usual with the jugal by a strong postorbital bar. The shape or extent of the nasals, prefrontals, or lacrymals can not be determined in this specimen, as all of the sutures are obscure. These bones are roughly sculptured. That portion of the preorbital region which is preserved in this specimen is depressed medially and at the sides is bent sharply downward and inward to the alveolar border; more anteriorly the direction of the side is only downward. As a whole, the snout is bent somewhat upward, so that in profile the anterior portion is slightly concave above. (See Pl. 25.) The cranium above and extending down the sides on the jugal, maxillary, and premaxillary bones is beautifully sculptured with pits of irregular size and shape, inclosed by reticular ridges of varying widths. The sculpturing is most rugose on the posterior elements, particularly on the jugal and posterior half of the maxillary; medially on the nasals, are long, broken, longitudinal grooves, while on the muzzle the pitting as a rule is finer and more shallow, and lacks the definition of the posterior surfaces.

Over the alveoli for the ninth and tenth teeth, the lateral borders of the maxillæ are swollen outwardly, but anteriorly the muzzle gradually contracts to the elongated notch which receives the lower canines, this being the narrowest part of the skull, measuring 50 mm. in transverse diameter. In advance of the notch the premaxillæ swell out into a moderately broad but evenly rounded nose. The widest part, over the fourth premaxillary teeth, measures 58 mm.

The premaxillæ inclose the heart-shaped external nares, but it can not be determined from this specimen whether or not the nasals extended into this opening. In *Diplocynodon hautoniensis* (Wood), which Owen figures in his monograph<sup>a</sup> under the name *Crocodylus hastingsiæ*, the nasals do not reach the narial opening, and taking into account the many other resemblances it may be that the same condition prevails in the nasals of *Leidyosuchus*. Lambe, from incomplete evidence, was inclined to believe the nasals reached a point in advance of the maxillaries in *L. canadensis*, and if his observation be correct, they at least approach the nares more closely than in *Diplocynodon*.

The posterior extent of the facical processes of the premaxillæ can not be determined, although the maxillo-premaxillary and maxillo-nasal sutures can be traced (see Pl. 23) back as far as the missing facical section previously mentioned. Latero-inferiorly the posterior boundary of the premaxillary is at the back of the notch behind the fifth tooth, where the maxillo-premaxillary suture passes on to the palate.

The supratemporal fossæ are of good size and subelliptical in shape, measuring 33 mm. longitudinally and 23 mm. transversely. The orbit communicates with the infratemporal fossa. The latter are slightly smaller than the supratemporal fossæ and angularly rounded. The left fossa, the borders of which are nearly intact, measures about 25 mm. both transversely and antero-posteriorly.

The orbits are large and look upward and forward, with their inner borders everted as in the alligator. The greatest longitudinal diameter of the left orbit is 55 mm. and the transverse diameter 38 mm.

The inferior or palatal surface is more complete than the dorsal, lacking only the posterior ends of the palatines, the right pterygoid, transpalatine, and posterior half of maxillary of same side. The anterior palatal region is decidedly concave transversely, and between those elements which have not suffered mutilation all of the sutures are plainly distinguishable. The palatine processes of the premaxillæ reach the level of the alveolus for the first maxillary tooth, the posterior ends being rounded. In this view the premaxillæ inclose a small rounded anterior palatine vacuity which measures 12 mm. longitudinally and 13 mm. transversely.

The anterior processes of the maxillæ extend forward on the median line to the level of the middle of the notch which separates the maxillary and premaxillary dental series.

The palatines meet the maxillæ at the center by a nearly straight transverse suture opposite the tenth maxillary tooth. The median posterior processes of the maxillæ extend back on the sides of the palatines to a point opposite the thirteenth maxillary tooth. The palatines are narrow and at the middle of the posterior palatine

<sup>a</sup> Monograph of the fossil Reptilia of the London Clay, pt. 2, 1850, pp. 42-44, pl. 6, fig. 7.

vacuity measure only 23 mm. in transverse diameter. Their sutural union with the pterygoids, owing to the damaged condition of this part of the palate, can not be determined.

The posterior palatine vacuities are comparatively large, measuring 101 mm. longitudinally and 34 mm. transversely. The anterior border of these vacuities is opposite the twelfth maxillary tooth, as in *Diplocynodon*.

The pterygoid of the left side is practically entire and has suffered no distortion. It extends downward and backward from the general level of the palate at an angle of 45°. The postpalatal vacuities encroach but little on the pterygoids. The preservation of the back border of the posterior aperture of the nasal passages is sufficient to establish its position as being wholly surrounded by the pterygoids. There is a bridge of bone 12 mm. wide separating this opening from the posterior median border of the pterygoids which leads down to the median Eustachian foramen. (See Pl. 24.) In all modern crocodiles these two openings are separated by only a thin septum of bone. In this respect *L. sternbergii* from the Cretaceous is intermediate between those early Triassic and Jurassic forms having the posterior narial opening well forward on the palate, and the Tertiary crocodiles where it has receded posteriorly to a position nearly, if not quite, as far as in modern crocodilians. The posterior border of the conjoined pterygoids is notched, the notch being the interval between two thin diverging processes from the back part of the pterygoids. The form of the posterior nares can not be determined from this individual.

The transpalatines connect the pterygoids with the maxilla, as shown in Pl. 24.

In the posterior view of the skull (Pl. 26) hardly any of the sutures can now be distinguished, and a comparison of this aspect with the excellent figures given by Lambe of *Leidyosuchus canadensis*, only serves to give one an approximate idea of the relations of the several elements comprising the occiput. In the proportion of its breadth to its depth, *L. sternbergii* differs from *L. canadensis* in the considerably less vertical extent of the coalesced elements overlying the foramen magnum, in the shortness vertically of the descending part of the basioccipital, and in the comparative lightness, both horizontally and vertically, of the condyle of the quadrate. In the latter respect it approaches *Diplocynodon hantoniensis* of the London Clay.

The basioccipital is deeper than broad, and viewed from behind almost hides the basisphenoid which lies in front of it. Between these two bones at their lower extremities is the opening for the median eustachian canal. (See *m. e. c.*, Pl. 26.) Below the occipital condyle on the median posterior surface of the basioccipital a prominent sharp vertical keel is developed which is even more pro-

nounced than that found in the living alligators. Another alligator-like character is seen in the entire exclusion from this view of the posterior nostril, due to its position below the opening of the eustachian canal and in advance of the posterior border of the pterygoids, from which it is partitioned off by a strong bridge of bone 12 mm. wide.

The exoccipital is pierced by four foramina. Of these, three are close together a little above the floor of the foramen magnum Pl. 26. Beginning with the most posterior, they are (XII) foramen for the exit of the hypoglossal nerve (X) foramen for the pneumogastric, and (VII) the largest of the three, which gives passage to the facial nerve and certain blood vessels. Below these, near the lower extremity of the exoccipital, is the large foramen through which the internal carotid artery enters the skull.

The external auditory meatus leading into the tympanic cavity occupies the usual position deep in under the squamosals, and compared with the same opening in *Crocodylus americanus* no essential differences are apparent. Leading back from the tympanic cavity is a canal in the quadrate through which the cartilaginous rod passes, and during life is continuous with Meckel's cartilage within the articular bone of the mandible.

Viewed from the side, the occiput above the level of the floor of the foramen magnum is inclined decidedly forward up to the parietal, and the part below this level inclined forward to a somewhat greater extent in passing down to the lower extremity of the basisphenoid, which continues below the basioccipital to meet the conjoined pterygoids.

On account of the damaged condition of the brain case, the elements comprising it can not be differentiated, although all the important foramina can be located. Taken in order from back to front they are: *Foramen orali* for the trigeminal nerve; the pair of foramina lying beneath the pituitary fossa which furnish passage for the carotid arteries; and the large anterior foramen for the exit of the olfactory nerves. In all essentials the relationships of the several foramina are very similar to those found in the skull of extant crocodylians.

*The teeth.*—The dental formula of *Leidyosuchus sternbergii* is  $\frac{24-24}{21-21} = 90$ . In the type-specimen we are fortunate in having fourteen teeth in the upper and three in the lower mandible in a good state of preservation, in addition to the crowns of three others found detached.

The teeth *in situ* are distributed as follows: First of the left premaxillary; fourth, sixth, seventh (germ tooth), eighth, twelfth, thirteenth, fifteenth (germ tooth), seventeenth, and eighteenth of the left maxillary; fourth (germ tooth), seventh, eighth, and ninth

of the right maxillary. In the left ramus of the lower mandible are the fourth and seventeenth, with the base of the twelfth and in the portion of the right ramus is the base of the third and a young tooth in the eighth alveolus. Taken in the order mentioned above, the crowns of the teeth give the following measurements in millimeters, the first of each pair of numbers being the height; the second, the basal or antero-posterior extent: First, 4.5—3.5; fourth, 9 (tip broken off)—7.5; sixth, 6—5; eighth, 4.8—4; twelfth, 6—6; thirteenth, 5—5.7; seventeenth, 3.2—4.7; eighteenth, 2.5—4.5. Right side, seventh, 5—4.1; eighth, 5.1—4.5; ninth, 5—5.6.

Most of the teeth, excepting those enlarged, are much the same shape, with short, compressed subacute or obtuse crowns. The crown bears on each side a distinct, sharp-edged ridge placed a little toward its inner face, and unworn crowns extending from the apex to near the base. These ridges or carina define laterally, on the shorter teeth of the series, an area on the inner surface that is less convex and slightly less in breadth than the outer surface. In most of the enlarged teeth these ridges are placed nearer together and define an area on the inner side, the breadth of which slightly exceeds one-third the circumference of the tooth. The crowns of all the smaller teeth are separated from the fang by a slight constriction or neck.

The larger teeth in cross section are more rounded and proportionally narrower transversely than the smaller, but somewhat more curved. A scrutiny of the measurements given above shows that the crowns of the posterior teeth are greater in width than in height, while in advance of the twelfth maxillary tooth the height is greater.

The anterior pair of premaxillary teeth are close together, being separated on the median line by a narrow slit, which emerges dorsally into an enlarged rounded foramen. The one preserved tooth of this pair is small and comparatively slender. The first pair is separated from the alveoli of the second pair by deep pits for the reception of the anterior mandibular teeth, which do not perforate the upper surface as in some extinct and all modern crocodiles. The second pair are small and in close contact with the alveoli for the third pair, which are much enlarged. The fourth pair appear to be a trifle larger than the third, from which they are separated on the inner side by a pit. The fifth and last pair in the premaxillaries are very small and in close contact with the fourth.

Between the fifth pair of the premaxillaries and the first of the maxillaries are elongated notches (anterio-posteriorly they measure 15 mm.) which receive the two enlarged teeth of the mandibular series.

The first three maxillary alveoli are rather small, though they increase in size from front to back. The fourth and fifth are much enlarged, and, judging from the size of the alveolus, the fourth is the

most robust tooth of the upper dental series. The sixth, seventh, eighth, and ninth are much reduced in size, but the tenth and eleventh alveoli appear to have carried larger teeth. From this point, however, to the end of the series, the teeth gradually diminish in size toward the back. In the lower mandibular series all of the alveoli and three of the teeth are preserved. The front teeth of the symphyseal region, that is, the first to the fourth, were directed obliquely outward. This peculiarity is somewhat manifest as far back as the eleventh of the series, back of which an upright position is maintained. The dental series of the anterior half passes in a curve from the outer to the inner side of the dentary. The fourth tooth was probably the largest of the lower series, although, judging from the alveoli, the third must have been approximately the same size. The fifth to the tenth were small. The eleventh, twelfth, and thirteenth were slightly and about equally enlarged, and those posterior to the thirteenth gradually decrease in size.

*Comparative measurements of skulls.*

	Holotype of <i>Leidyosuchus</i> <i>sternbergii</i> .	Paratype of <i>Leidyosuchus</i> <i>canadensis</i> .
	mm.	mm.
Width between outer edges of quadrates, posteriorly.....	183	201
Height of occiput, in median line, from upper surface of parietal to anterior edge of opening of median eustachian canal.....	61	90
Height of foramen magnum.....	13	14
Width of foramen magnum.....	16	17
Height of basioccipital, in median line.....	37.5	42.5
Breadth of basioccipital at midheight.....	37	39
Breadth of condyle of quadrate.....	30	39
Height of condyle of quadrate at center.....	11	15
Breadth of the upper surface of parietal, posteriorly.....	<sup>a</sup> 40	43
Length of upper surface of parietal, in median line.....	<sup>a</sup> 10	38
Distance of posterior end of preserved surface of nasal passage to anterior edge of opening of median eustachian canal.....	12	16

<sup>a</sup> Estimated.

*Mandible.*—The parts preserved of the lower jaw consist of the left ramus almost entire, lacking only the coronoid and portions of the articular, and the anterior portion of the right ramus as far back as the alveolus for the eleventh tooth.

The mandibular symphysis is short and composed of the splenial and dentary. In *Leidyosuchus canadensis* the splenial participation in the symphysis is about one-fifth of its total length, while in *L. sternbergii* it is somewhat less. In this particular, among American brevirostrate crocodiles, *Leidyosuchus* is approached by *Crocodylus polyodon* of the Wasatch and *Bottosaurus* from the Cretaceous of New Jersey, in the latter the splenial reaches the symphysis without contributing to it.

On the dorsal border of the left ramus, alveoli for twenty-one teeth can be clearly distinguished.



By referring to the table of measurements it will be observed that the dimensions of the ramus of the specimen under consideration are almost identical with those of the holotype of *L. canadensis*.

Viewed from the side the alveolar border is undulating, while the lower side from a point just posterior to the external mandibular foramen presents a nearly straight border to the upturn of its extremity near the symphyseal end. The external mandibular foramen is relatively large and in outline has the form of an elongated ellipse. (See *e. m. f.*, Pl. 25.)

The internal mandibular foramen is relatively small, and in relation to the large external foramen is located more posteriorly than in living crocodylians. The position of this foramen is well shown in Pl. 27 (*i. m. f.*).

In the region of the eighth tooth the dentary is constricted, but anteriorly it widens both inward and outward, reaching its maximum breadth in line with the fourth tooth, with a transverse diameter of 32 mm. Posterior to the constriction the alveolar border ascends rapidly to the position of the twelfth tooth. From this point posteriorly the upper border rises gradually with a gentle concave curve, thus adding considerably to the depth of the jaw. The maximum depth of the ramus is just posterior to the external mandibular foramen, where it reaches 53 mm.

The dentary articulates in the usual manner with the surangular above and the angular below. The upper posterior prolongation of the dentary, however, does not extend so far back over the external foramen as in living crocodiles. The anterior extension of the angular is received between the dentary and splenial, terminating under the alveolus for the nineteenth tooth. The external surfaces of both the angular and surangular, especially the former, are roughly sculptured (well shown in Pl. 25). The irregular pitting of the upper half of the external surface of the angular is succeeded below by long, somewhat irregular grooves and ridges which conform to the curves of the lower margin of the jaw. The dentary along the whole of its outer and under surface is pitted by numerous vascular openings leading obliquely forward into the interior of the bone. These openings become more numerous anteriorly, and on the lower part the surface is roughened by numerous longitudinal grooves.

The splenial covers the whole inside of the ramus back to the internal mandibular foramen. Just behind the symphyseal union, the splenial is pierced by a small, longitudinally elongated foramen which leads into the meckelian groove. Lambe has shown<sup>a</sup> that beneath this opening there is a small foramen in the dentary leading into the dental canal. Unlike the type of *L. canadensis*, the bony

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<sup>a</sup> Trans. Royal Soc. Canada, vol. 1, 1898, pp. 223-224.

divisions of the alveoli form distinct sockets for the teeth and furnish additional evidence of the mature age of this individual.

The coronoid is missing.

The articular is somewhat damaged but the parts remaining show no unusual characters.

*Comparative measurements of rami.*

	Holotype of <i>Lcidyo-</i> <i>suchus</i> <i>sternbergii</i> .	Holotype of <i>Lcidyo-</i> <i>suchus</i> <i>canadensis</i> .
	mm.	mm
Length of ramus.....	380	<sup>a</sup> 335
Breadth of ramus through center of alveolus of fourth tooth.....	31	31
Height of symphysis in line with alveolus of fourth tooth.....	19	18
Length of symphysis.....	56	<sup>a</sup> 57
Length of splenial contribution to symphysis.....	7.5	11.5
Length of postsymphysial foramen.....	6	7.5
Height of postsymphysial foramen.....	3	3.2
Height of splenial behind postsymphysial foramen.....	16	16
Breadth of dentary at alveolus for eighth tooth.....	11	18
Height of dentary in line with same alveolus.....	18	17.5
Height of ramus at posterior end of external mandibular foramen.....	53	53
Thickness of angular a little above lower border where last measurement was taken.....	16	16
Thickness of surangular at upper border where last measurement was taken.....	7	8.5
Length occupied by alveoli from fourth to eighteenth tooth.....	123	128

<sup>a</sup> Estimated.

*Vertebrae.*—Of the vertebral column of this specimen there are preserved the left neurapophysis of the atlas, four dorsal, two lumbar, and one sacral (second) vertebrae. All of those present are of the procoelian type.

The neurapophysis, when compared with the homologous part in *Crocodylus americanus*, shows the anterior process to be a little longer and wider vertically, and the constriction above the articular end forming a somewhat deeper notch on the forward side.

The dorsals show the typical cup and ball articulation. The centra have the sides concave antero-posteriorly, with the least transverse diameter toward the posterior end. In all of the dorsals preserved the inferior surface is evenly rounded. In this respect they differ from those of *Lcidyosuchus canadensis*, which are described as being flat in this aspect. The centra increase in breadth below the neuro-central suture. The neural arches inclose the neural canal which is slightly higher than wide. The arches of these vertebrae are firmly coossified with the centra, which furnishes additional evidence of the mature age of the individual. Two of the dorsal centra show shallow longitudinal depressions on the mid-lateral surfaces. None of the spinous processes are complete though the broken bases show them to have been broad antero-posteriorly. The transverse processes are given off well up on the sides of the arches. The most anterior dorsal,

corresponding perhaps to the eighth in recent crocodiles, shows the same step-like facets with which the tubercula of the ribs articulate.

As Lambe has pointed out, the anterior zygapophyses together with the bases of the transverse processes form an undulating platform of considerable extent. The more nearly horizontal position of these zygapophyses would appear to distinguish the vertebrae from those of *L. canadensis*.

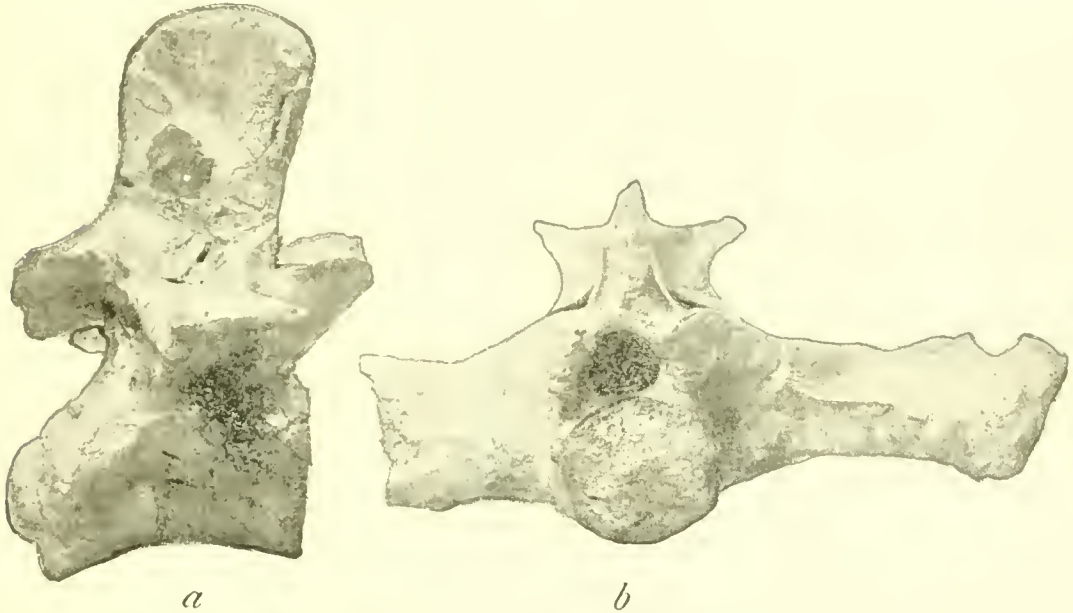


FIG. 1.—LEIDYOSUCHUS STERNBERGII. *a*, FOURTH (?) LUMBAR VERTEBRA, SEEN FROM RIGHT SIDE; *b*, SECOND SACRAL VERTEBRA, SEEN FROM FRONT. BOTH FIGURES NATURAL SIZE.

*Measurements of dorsal vertebrae of Leidyosuchus sternbergii.*

	I.	II.	III.	IV.
	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>	<i>mm.</i>
Greatest length of centra.....	30	30	33	34
Greatest transverse diameter, anterior end.....	19	20	20	20
Greatest vertical diameter, anterior end.....	19	19	18.5	19
Greatest transverse diameter, posterior end.....	17	17	19	20
Greatest vertical diameter, posterior end.....	17	16	16	16
Greatest antero-posterior extent of left transverse.....	19			
Greatest length of left transverse from median line.....	48			

The two lumbar vertebrae are probably the third and fourth of the series. Their centra differ from the dorsals in being more broadly rounded inferiorly and having their least transverse diameter nearer the middle. The neural canal is more nearly circular, and the transverse processes are narrower and spring from the sides of the arch at a lower level than in the dorsals, thus leaving the anterior zygapophyses standing out alone and well above them. The spinous processes rise above the middle of the centrum as a broad, thin plate with a truncated upper extremity (see *a*, fig. 1).

*Measurements of lumbar vertebra of Leidyosuchus sternbergii.*

	Third.	Fourth.
	mm.	mm.
Greatest length of centra.....	30	30
Greatest transverse diameter, anterior end.....	20.5	21
Greatest vertical diameter, anterior end.....	18.5	18
Greatest transverse diameter, posterior end.....	20	20
Greatest vertical diameter, posterior end.....	16.5	17
Greatest antero-posterior extent of transverse.....	13	9.5
Greatest length of right transverse process from median line.....		37
Greatest width (antero-posteriorly) spinous process near top.....		20
Greatest width between outer edges of prezygapophyses.....		35

The concave, convex, articulating ends of the second sacral are much less pronounced than in the presacrals described above. The inferior surface is broad and only slightly rounded; the sacral ribs are heavy and firmly ankylosed with the whole side of the centrum and half way up on the neural arch. In size and general shape it agrees in all essentials with the sacral figured by Lambe,<sup>a</sup> except in this species the neural canal is circular instead of being elongated vertically as in *Leidyosuchus canadensis*. (See *b*, fig. 1.)

*Measurements of second sacral vertebra of Leidyosuchus sternbergii.*

	mm.
Greatest length of centrum.....	27.5
Greatest transverse diameter, anterior end.....	16
Greatest transverse diameter, posterior end.....	17
Greatest transverse diameter from middle of centrum to end of sacral rib.....	41
Greatest width between outer edges of postzygapophyses.....	23

*Limb and foot bones.*—The few bones of the limbs found with the type skull show that the proportional lengths of the fore and hind limbs in *Leidyosuchus* are approximately the same as in modern crocodiles, although the humeri, when compared with those of a specimen of *Crocodylus americanus* of the same size, are relatively more slender.

The general characteristics of these bones are well shown in fig. 2 and their principal dimensions are given in the table of measurements below.

*Measurement of limb and foot bones of Leidyosuchus sternbergii.*

	mm.
Greatest length of right humerus.....	164
Greatest width of proximal end of humerus.....	34
Greatest length of fibula.....	140
Greatest width of proximal end of fibula.....	27
Greatest width of distal end of fibula.....	25
Greatest length of metatarsal.....	84
Greatest width of proximal end of metatarsal.....	20
Greatest width of distal end of metatarsal.....	10

<sup>a</sup> See Trans. Royal Soc. of Canada, vol. 4, art. 16, pl. 4, fig. 13, 1908.

*Scutes*.—There were no scutes found with the holotype of *L. sternbergii*, but in a small collection of fossils made by Mr. A. L. Beekly from the Ceratops Beds (or their equivalent) on the Standing Rock Indian Reservation, of South Dakota, were two dermal scutes (Cat. No. 6545, U.S.N.M.) of a crocodilian, which correspond closely in all respects to those figured by Lambe. These were associated with detached teeth which can not be distinguished from those of *Leidyosuchus*, and the range of this genus is thus extended into South Dakota. These remains were associated with a typical Ceratops

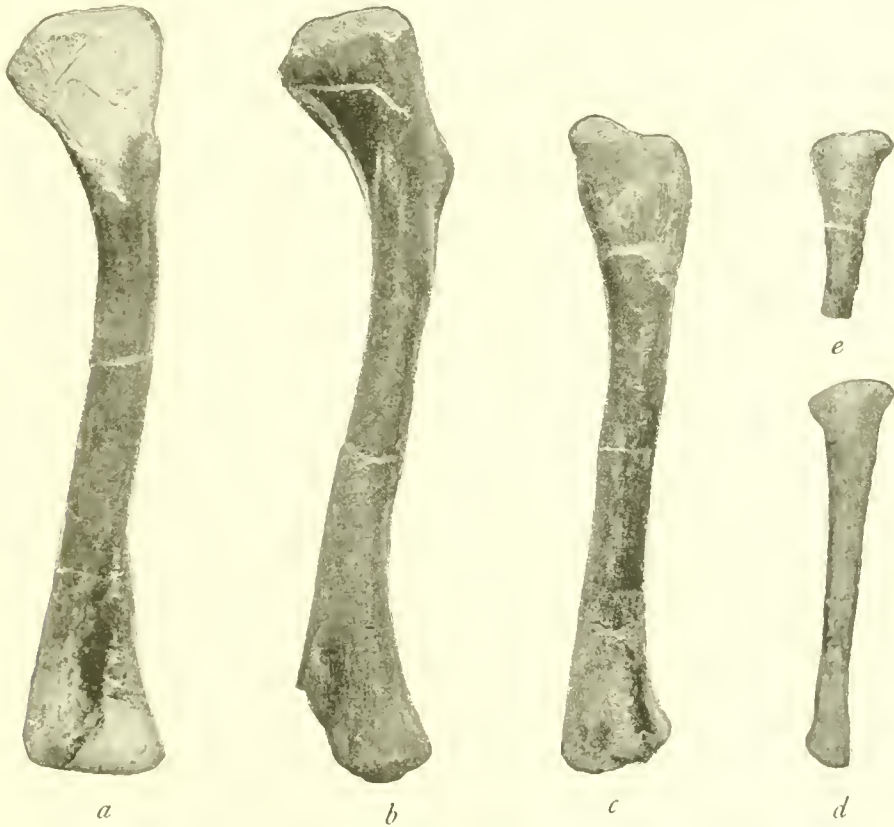


FIG. 2. —LEIDYOSUCHUS STERNBERGII. *a*, LEFT HUMERUS, VENTRAL VIEW; *b*, RIGHT HUMERUS, DORSAL VIEW; *c*, RIGHT FIBULA LATERAL VIEW; *d*, SECOND METATARSAL OF LEFT HIND FOOT; *e*, PROXIMAL HALF OF A METATARSAL. ALL FIGURES HALF NATURAL SIZE.

Beds fauna, the following forms having been recognized. *Tricceratops*, *Trachodon*, *Champsosaurus*, *Basilemys*, and *Lepidosteus*.

#### NOTES ON A CROCODILE FROM THE HELL CREEK BEDS OF MONTANA.

Since the preceding pages were written a second specimen (Pls. 28 and 29) belonging to this species from the vertebrate paleontological collection of the American Museum of Natural History has been received. It bears the catalogue number 5898 and consists of the greater portion of the cranium, lacking only the lower part of the occiput, left quadrate, and posterior portions of the pterygoids. The skull was collected from the Hell Creek Beds, on Gilbert Creek,

Dawson County, 135 miles northwest of Miles City, Montana, by Mr. Barnum Brown, through whose courtesy I am now permitted to describe it.

The specimen is that of an adult individual of slightly larger size than the type of the species. Like the latter, however, nearly all the sutures of the facical portion of the skull are obliterated and we must await the discovery of other material before the relative relationships of these elements can be determined.

Compared with the type of the species, it differs in the greater breadth of the muzzle, the larger size of the teeth, the flatness of the facical region without the upturn of the premaxillary part, and the uniform coarseness of the sculpturing of the superior aspect. At first I was inclined to believe the differences enumerated were sufficient to justify the establishment of a new species, but after a careful study of a series of recent crocodile and alligator crania, and noting the occurrence of essentially the same differences in skulls of individuals collected from the same region, and undoubtedly belonging to the same species, there appeared no warrant for so doing. Such characters as have been mentioned can all be accounted for, in recent forms, by individual variation due in most part to differences in age, and it would appear reasonable to suppose these observations would also apply to the fossil members of this group.

The dental formula of the cranium is the same as in the type—that is, five premaxillary and nineteen maxillary teeth. The ends of the premaxillary processes on the palate are more broadly rounded than in the type.

The difference in the contour of the muzzles of the two skulls is apparently due to the difference in age of the two specimens, the latter, as shown by its larger size and complete obliteration of most of the sutures, being considered the more mature.

In this individual the palatines are complete, though their line of union with the pterygoids can not be made out. Those parts of the pterygoids still attached to the posterior ends of the palatines (shown in Pl. 29) are most important as giving the shape and position of the posterior nares. This aperture in *Leidyosuchus* appears to have been wholly surrounded by the horizontal plate of the pterygoids. In outline (see *p. n.* fig. 29) it may best be described as heart-shaped with the apex directed backward. While it resembles the posterior nares in *Diplocynodon* as figured by Owen,<sup>a</sup> its position, as would be expected from their relative geological positions, is considerably more forward on the palate. Measured from a line drawn transversely across the back borders of the posterior palatine vacuities, the anterior border of the nares is 14 mm. posterior to it.

<sup>a</sup> Monograph of the fossil Reptilia of the London Clay, pt. 2, 1850, pl. 7, fig. 2.

Though the evidence is not entirely conclusive, it would appear from the occurrence of an open median suture at the posterior border of the external nares, that the nasals did not reach the narial opening.

That the skulls discussed in the preceding pages do not represent the largest individuals of this genus is shown by an incomplete mandible (Cat. No. 984, American Museum of Natural History) whose total length from the tip to the broken end below the middle of the articular portion of the articular bone measures 403 mm. The same measurement taken from the left ramus of the type of *L. sternbergii* is 343 mm.

The alveolar border of the dentary shows alveoli for twenty-one teeth as in the type of the species mentioned above. The sculpturing is somewhat coarser, but this is probably an age characteristic. The splenial, as in the other specimens, enters the symphysis, but the extent of its contribution can not be accurately determined.

The ramus was collected by Mr. Barnum Brown near the top of the Hell Creek Beds, 350 feet above the Pierre, 16 miles north of Jordan <sup>a</sup> and about 135 miles northwest of Miles City, Montana.

*Measurements of skulls of Leidyosuchus sternbergii.*

	Cat. No. 6533 U. S. N. M.	Cat. No. 5898 Am. Mus. Nat. Hist.
	mm.	mm.
Length of skull on median line.....	303	319
Length of skull in front of orbits.....	200	204
Transverse diameter of skull, outer angles of quadrates.....	184	216
Transverse diameter of skull, front of orbits.....	132	131
Transverse diameter of snout across level of tenth tooth.....	77	95
Transverse diameter of snout across premaxillaries.....	58	72
Least transverse diameter of snout at notch.....	50	63
Longitudinal diameter, orbital opening.....	55	58
Transverse diameter, orbital opening.....	38	37

Genus LEIDYOSUCHUS.

The genus *Leidyosuchus* was founded <sup>b</sup> by Lambe upon crocodilian remains from the Judith River (Belly River) formation of Alberta, Canada. Lambe says: "The material from Red Deer River includes a left mandibular ramus, the posterior part of a cranium, portions of the skull, teeth, and a number of vertebræ and scutes. Of these specimens the ramus of the lower jaw is selected as the type of the species; the other specimens, of which the back portion of the cranium may be regarded as the cotype, are associated with the type."

<sup>a</sup> The geographical location of these specimens (Cat. Nos. 984 and 5898, American Museum of Natural History) is well shown on a small sketch map of the western half of Dawson County, Montana, published by B. Brown. Bull. Am. Mus. Nat. Hist., vol. 23, 1907, fig. 1.

<sup>b</sup> Trans. Royal Soc. Canada, vol. 1, 1908, pp. 219-235, pls. 1-5.

The chief generic distinction was found in the contribution of the splenial to the symphysis which was equal to one-fifth of the latter's length.

*Leidyosuchus canadensis* Lambe is the type-species of the genus.

The characters displayed by the specimens considered in the preceding pages, combined with those shown by the Judith River species, show that the genus *Leidyosuchus* may now be characterized as follows: *Generic characters*.—*Cranium short and of moderate breadth; palatal aspect of the premaxillæ slightly lengthened, with posterior borders convex and indented medially by the anterior processes of the maxillæ. Nasals not (?) reaching nares. Frontals contributing to boundary of supratemporal fossa. Premaxillary fissure and external nares both heart-shaped. Posterior nares wholly inclosed by pterygoids and placed about their middle. Mandibular symphysis short and contributed to by the splenial. Upper teeth more numerous than lower; first lower received into a pit and third and fourth into a notch in the cranium; third lower quite as large as fourth. Vertebra procoelian. A dorsal and ventral armour.*

*Discussion*.—A study of the specimens considered in the preceding pages confirms the conclusions of Lambe, that *Leidyosuchus* represents a procoelian, brevirostrate form of *Eusuchia*.

A review of the characters of the skull shows that they combine those which have been attributed to the genus *Crocodylus* and the genus *Alligator*. The resemblances to the latter may be seen in the reception of the anterior teeth of the lower jaw in pits which do not perforate the dorsal surface of the premaxilla; in the relative size and everted position of the orbits; and in apparently having the smaller lower teeth biting within the upper teeth. On the whole, however, the characters displayed by the known specimens of *Leidyosuchus* places that genus nearer to the crocodiles than otherwise.

Lambe has already called attention to the resemblance of the dentition to that of *Diplocynodon*, and the discovery and study of more complete material than that to which he had access show other resemblances. The more important likenesses are the participation of the frontal in the boundary of the supratemporal fossa; and the exclusion (?) of the nasals from the anterior narial opening.

The intermediate position of the posterior nares is one of the interesting features of this genus, and entirely in accord with its geological position. For instance, in the Triassic *Belodon* the posterior nares open in front of both palatines and pterygoids. In the Jurassic *Telosaurus* the posterior nares are farther back and surrounded by the palatines. In the Cretaceous *Leidyosuchus* they lie still farther back, in the middle of the pterygoids. Finally, in the Tertiary forms the arrangement is approximately as found in living crocodiles.



In the matter of the splenial contributing to the symphysis, *Leidyosuchus* may be considered ancestral to such Wasatch forms as *Crocodylus polyodon* Cope and *C. subulatus* Cope. The relationship of these forms is still further indicated by their reference by Professor Cope to *Diplocynodus*<sup>a</sup> (*Diplocynodon*) on account of the presence in the upper mandible of two adjacent enlarged teeth. Later<sup>b</sup>, however, both species were provisionally assigned to the genus *Crocodylus* by the same authority.

In *Leidyosuchus* and the gigantic *Deinosuchus* recently described<sup>c</sup> by Dr. W. J. Holland, we have in the Judith River beds the first authentic record of the appearance of procoelian crocodiles in the Cretaceous of the Rocky Mountain region.

#### EXPLANATION OF PLATES.

##### PLATE 23.

Skull of *Leidyosuchus sternbergii*. Cat. No. 6533, U.S.N.M. One-half natural size. Seen from above.

*e. na.*, external nares; *ex. occ.*, exoccipital; *fr.*, frontal; *i. t. f.*, infratemporal fossa; *ju.*, jugal; *la.*, lachrymal; *mx.*, maxillary; *n.*, nasal; *o.*, orbit; *oc. c.*, occipital condyle; *pa.*, parietal; *p. f.*, postfrontal; *p. fr.*, prefrontal; *pmx.*, premaxillary; *pt.*, pterygoid; *q.*, quadrate; *q. ju.*, quadrato-jugal; *s. t. f.*, supratemporal-fossa; *sq.*, squamosal.

##### PLATE 24.

Skull of *Leidyosuchus sternbergii*. Cat. No. 6533, U.S.N.M. One-half natural size. Seen from below.

*a. p. v.*, anterior palatine vacuity; *b. occ.*, basioccipital; *b. s.*, basisphenoid; *m. e. c.*, median eustachian canal; *mx.*, maxillary; *oc. c.*, occipital condyle; *p.*, palatine; *pmx.*, premaxillary; *p. na.*, posterior nares; *p. p. v.*, posterior palatine vacuity; *pt.*, pterygoid; *q.*, quadrate; *q. ju.*, quadrato-jugal; *t. p.*, transpalatine.

##### PLATE 25.

Skull and jaws of *Leidyosuchus sternbergii*. Cat. No. 6533, U.S.N.M. One-half natural size. Lateral view.

*ang.*, angular; *d.*, dentary; *e. m. f.*, external mandibular foramen; *ju.*, jugal; *mx.*, maxillary; *pmx.*, premaxillary; *q.*, quadrate; *q. ju.*, quadrato-jugal; *s. ang.*, surangular; *sq.*, squamosal.

##### PLATE 26.

Skull of *Leidyosuchus sternbergii*. Cat. No. 6533, U.S.N.M. Natural size. Posterior view.

*b. occ.*, basioccipital; *b. s.*, basisphenoid; *e. a.*, foramen for carotic artery; *ex. occ.*, exoccipital; *f. m.*, foramen magnum; *m. e. c.*, median eustachian canal; *oc. c.*, occipital condyle; *pt.*, pterygoid; *q.*, quadrate; vii, x, xii, foramina for cranial nerves.

<sup>a</sup> Sixth Ann. Rept. U. S. Geol. Surv. Terr. for 1872, 1873, pp. 613-614.

<sup>b</sup> Rept. U. S. Geol. Surv. Terr., vol. 3, 1884, p. 154, pl. 31, figs. 18-23.

<sup>c</sup> Annals of the Carnegie Museum, vol. 6, 1909, pp. 281-294.

## PLATE 27.

Lower jaw of *Leidyosuchus sternbergii*. Cat. No. 6533, U.S.N.M. One-half natural size. Superior view.

*ang.*, angular; *art.*, articular; *d.*, dentary; *f.*, postsymphysial foramen; *i. m. f.*, internal mandibular foramen; *s.*, splenial; *s. ang.*, surangular.

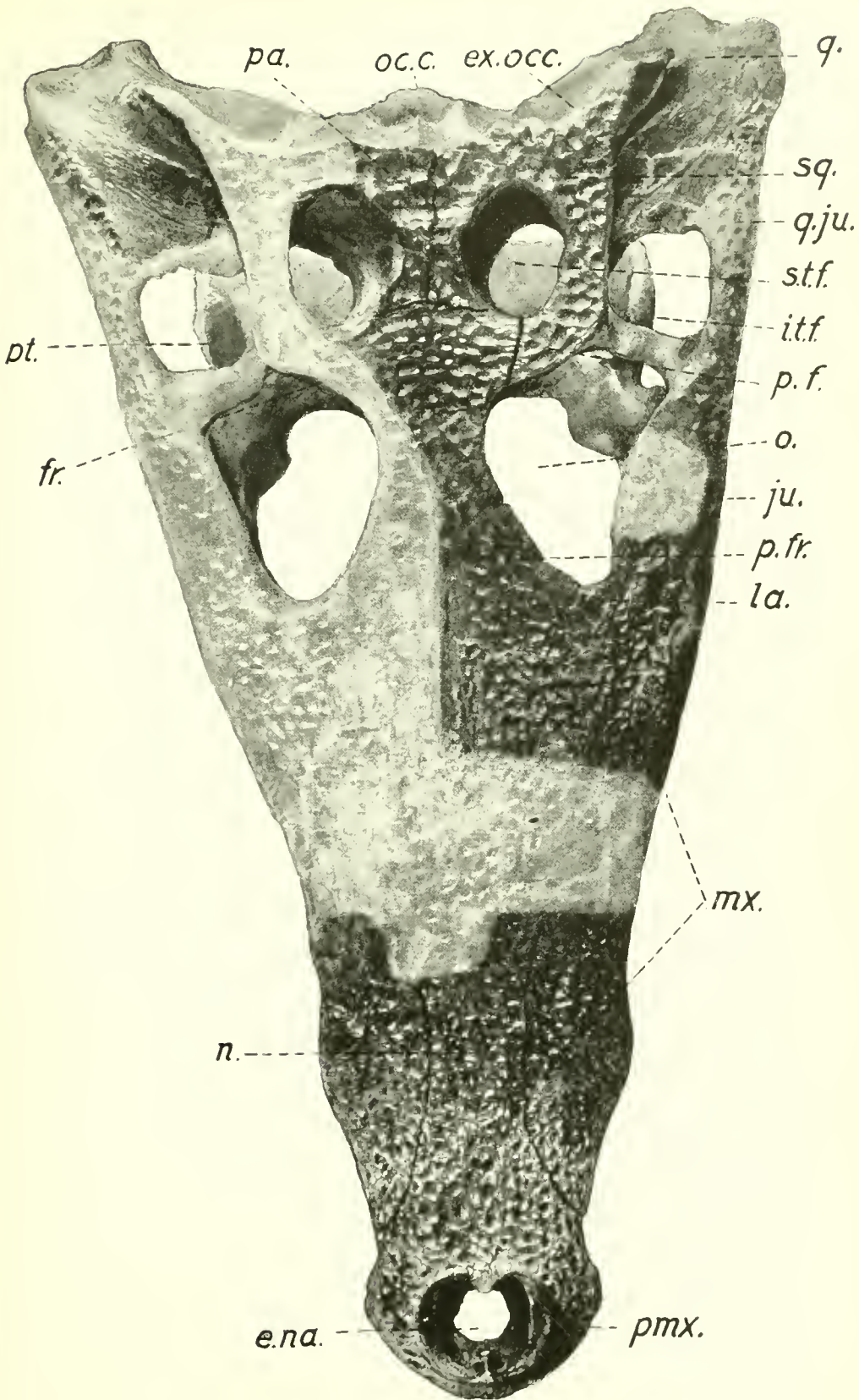
## PLATE 28.

Skull of *Leidyosuchus sternbergii*. Cat. No. 5898, Amer. Mus. of Nat. History. One-half natural size. Seen from above.

## PLATE 29.

Skull of *Leidyosuchus sternbergii*. Cat. No. 5898, Amer. Mus. of Nat. History. One-half natural size. Seen from below.

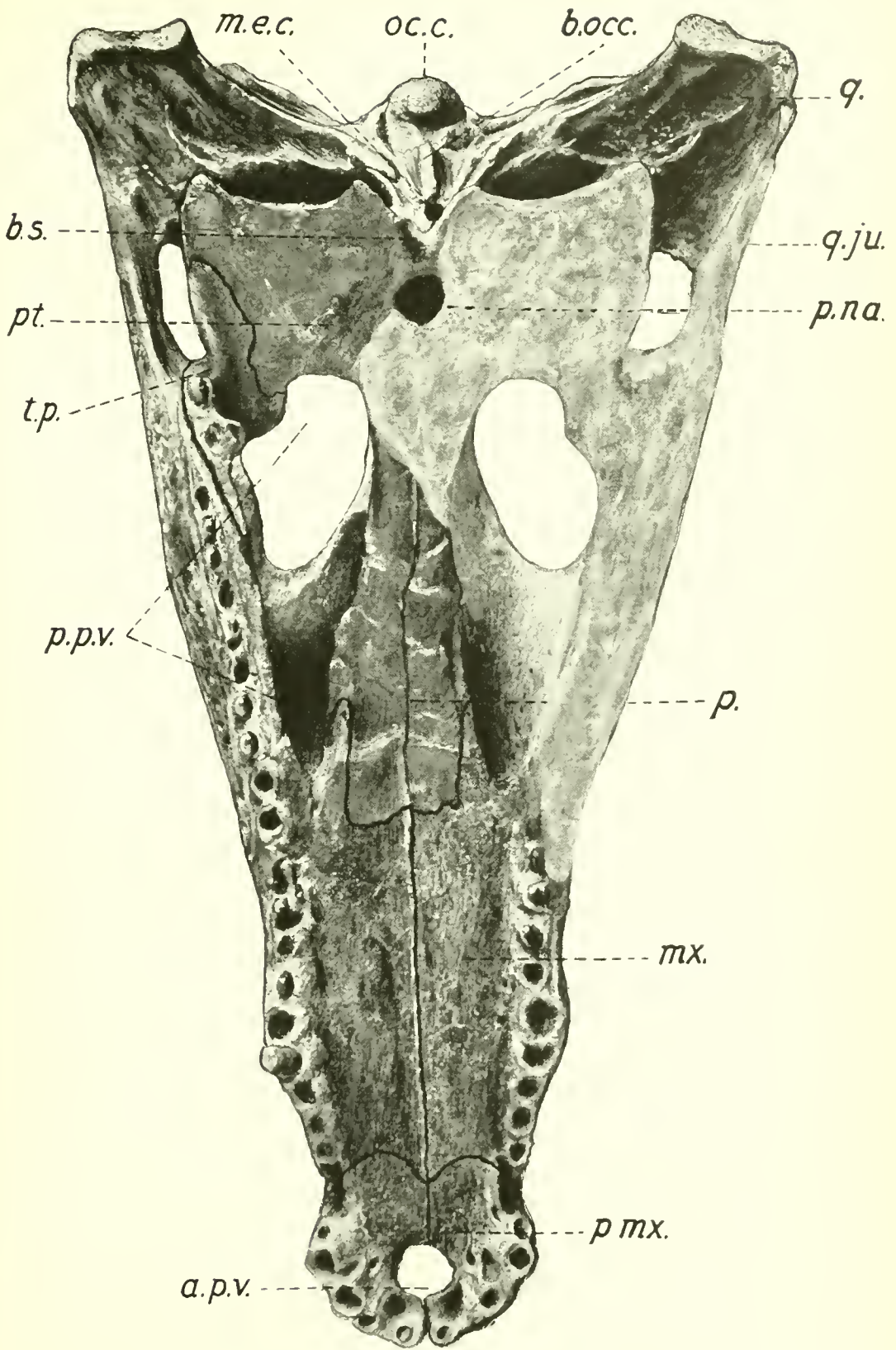
*a. p. v.*, anterior palatine vacuity; *mx.*, maxillary; *q.*, quadrate; *p.*, palatine; *pmx.*, premaxillary; *p. n.*, posterior nares; *pt.*, pterygoid.



SKULL OF LEIDYOSUCHUS STERNBERGII.

FOR EXPLANATION OF PLATE SEE PAGE 501.

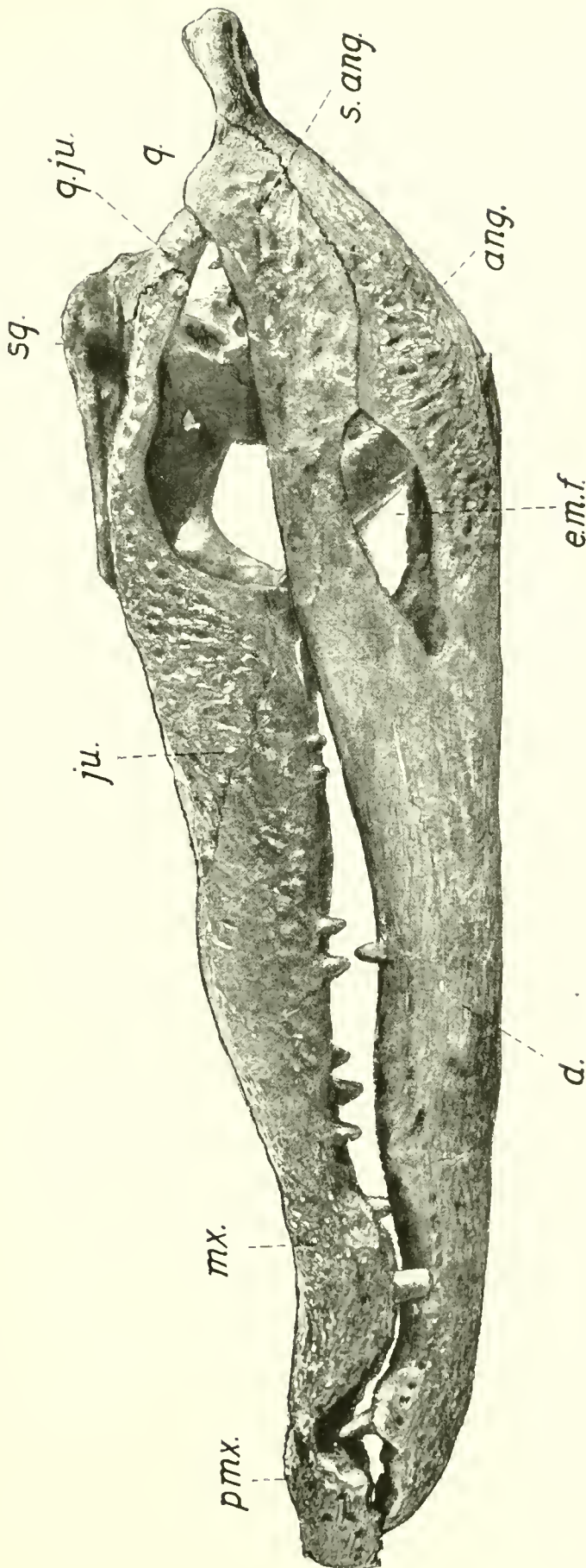




SKULL OF LEIDYOSUCHUS STERNBERGII.

FOR EXPLANATION OF PLATE SEE PAGE 501.



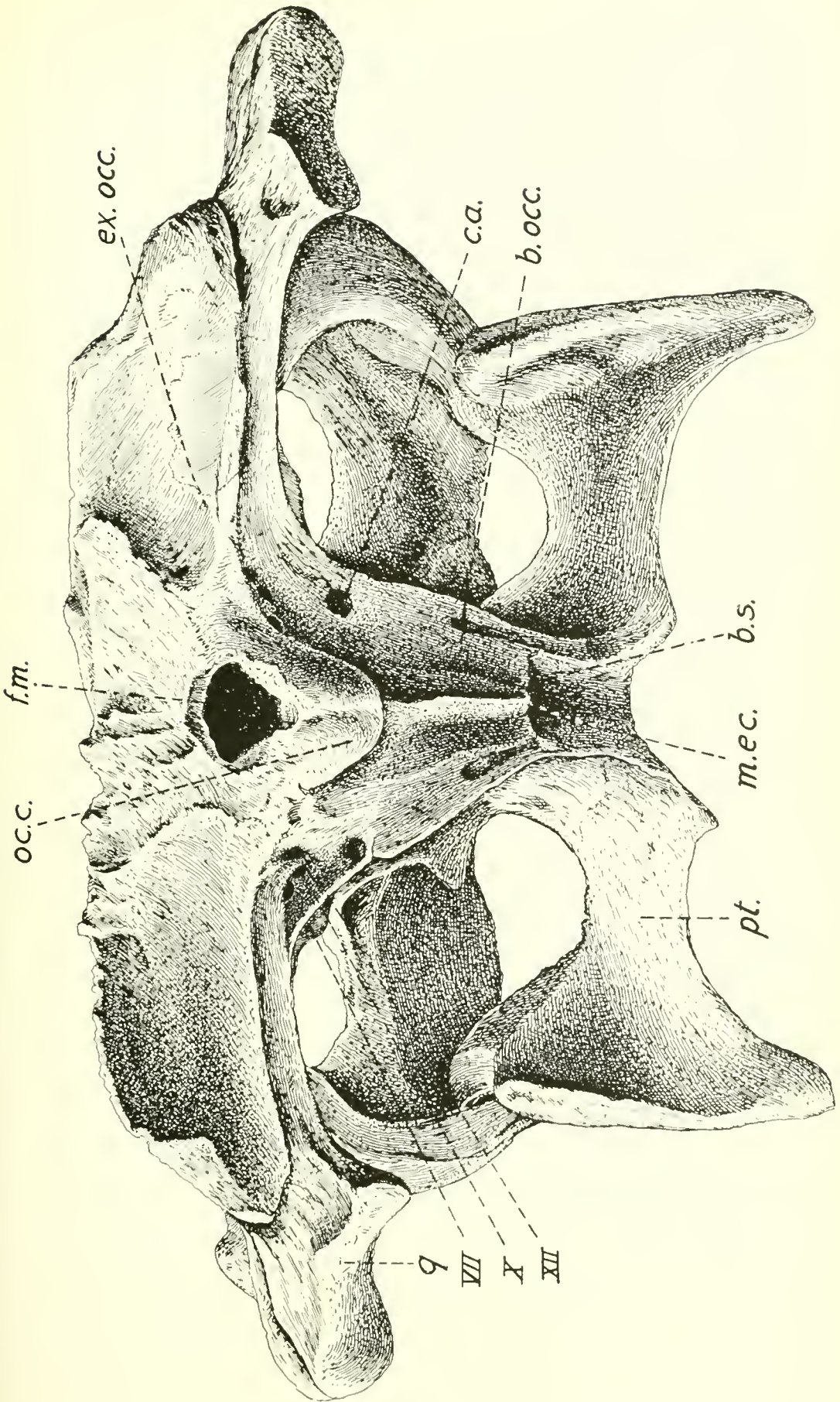


SKULL AND JAWS OF LEIDYOSUCHUS STERNBERGII.

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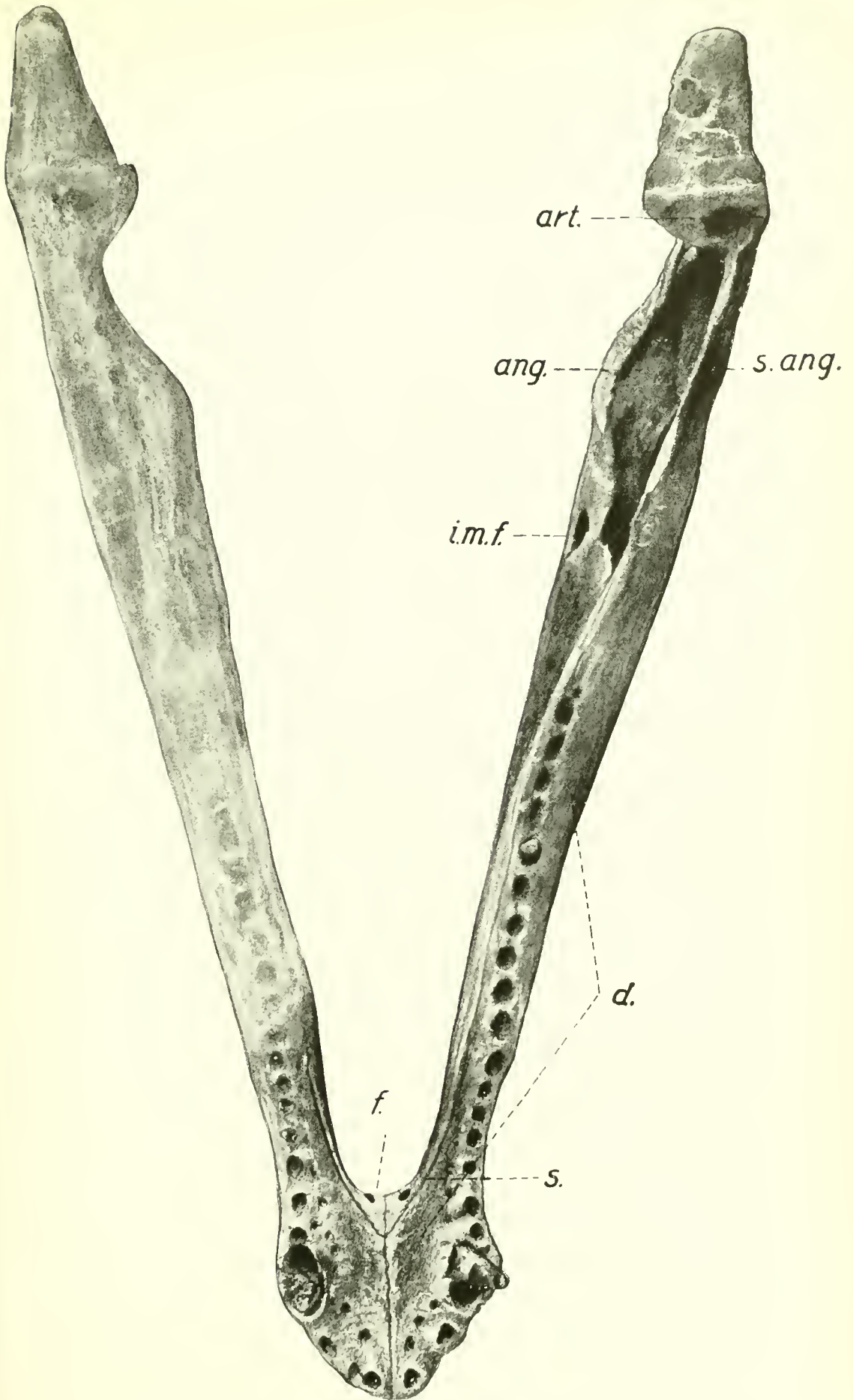




SKULL OF LEIDYOSUCHUS STERNBERGII.

FOR EXPLANATION OF PLATE SEE PAGE 501.

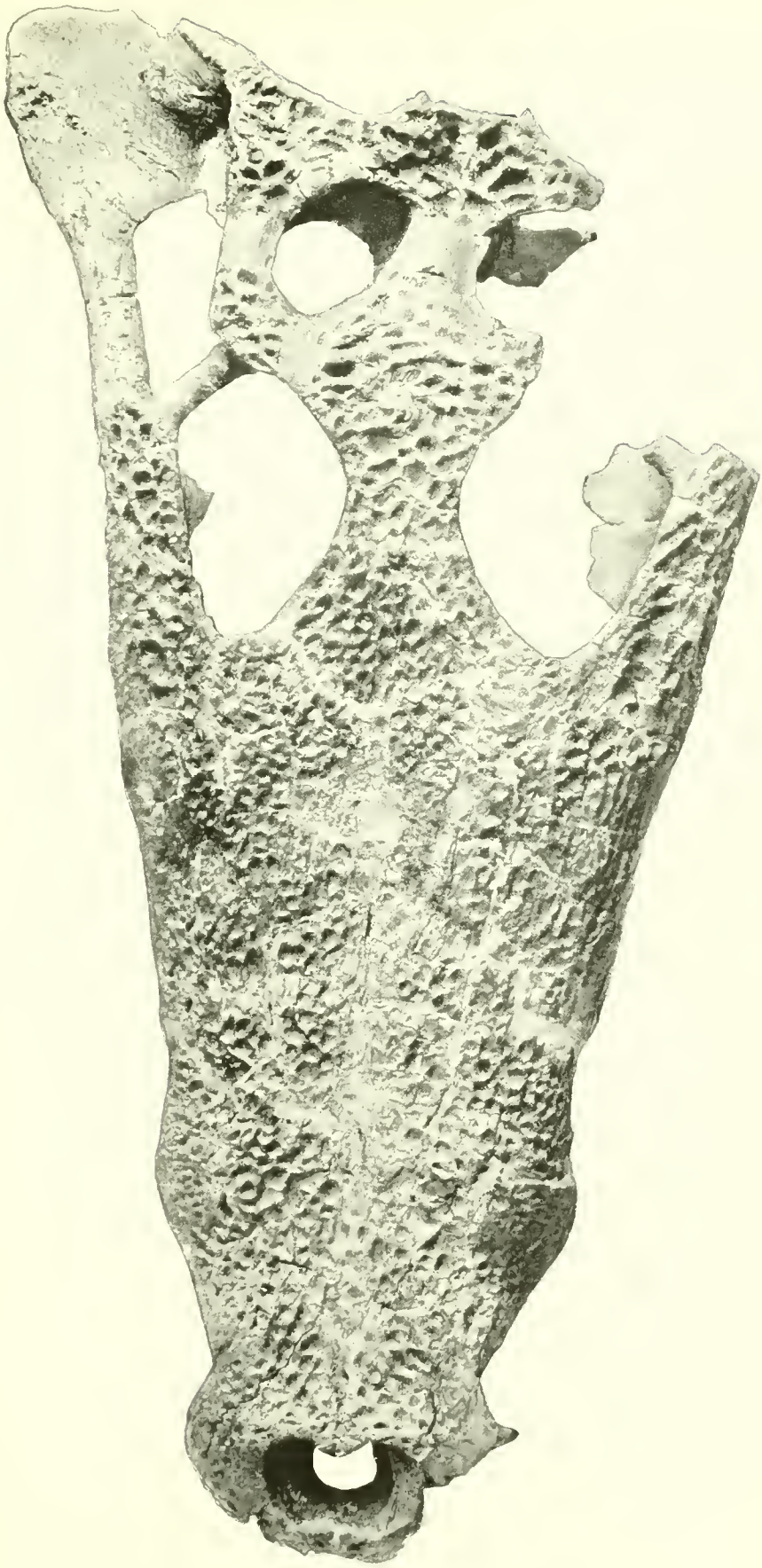




LOWER JAW OF LEIDYOSUCHUS STERNBERGII.

FOR EXPLANATION OF PLATE SEE PAGE 502.

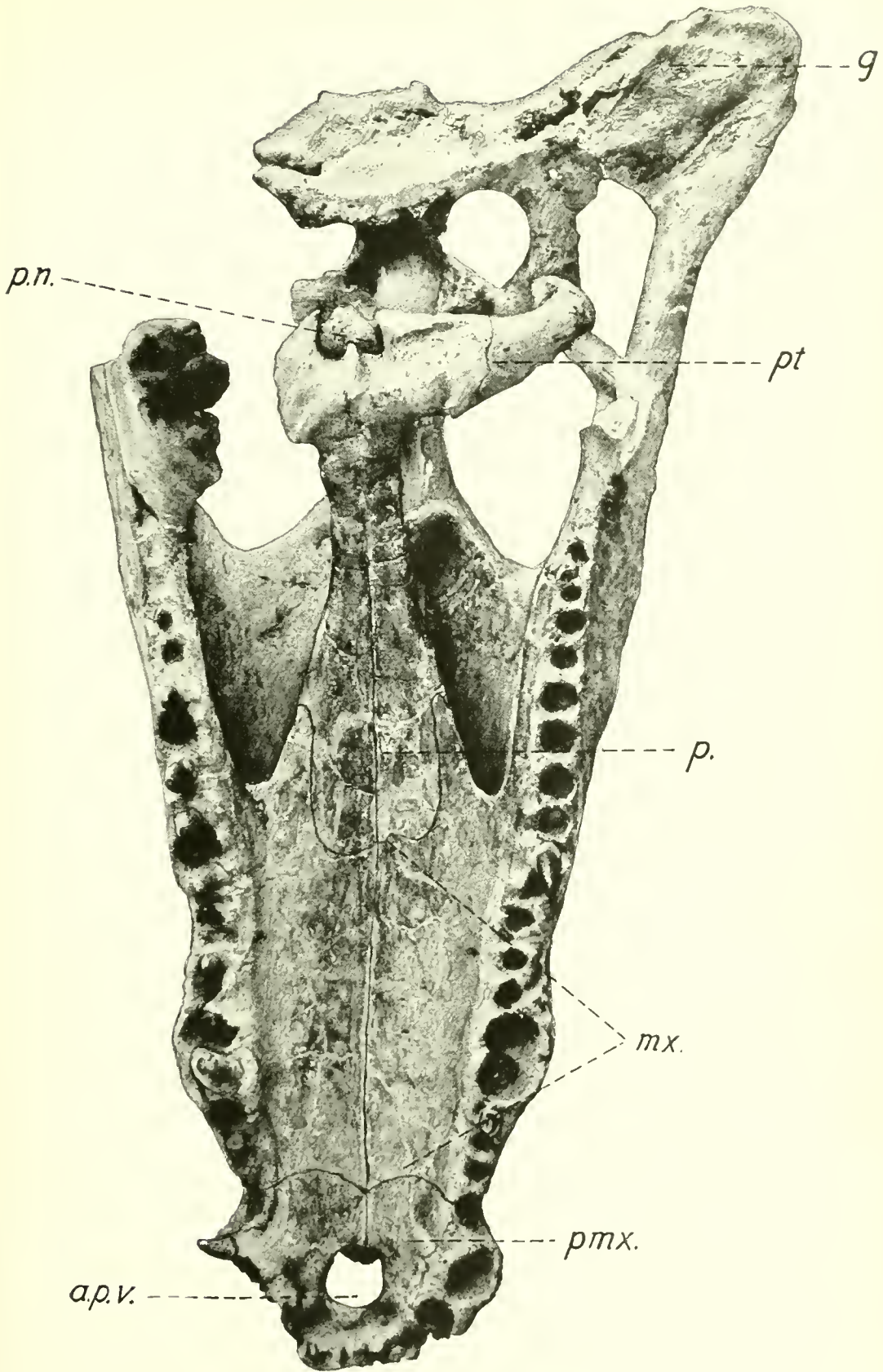




SKULL OF LEIDYOSUCHUS STERNBERGII.

FOR EXPLANATION OF PLATE SEE PAGE 502.





SKULL OF LEIDYOSUCHUS STERNBERGII.

FOR EXPLANATION OF PLATE SEE PAGE 502.