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Article IX.—A REVISION OF THE MESOZOIC CROCODILIA OF NORTH AMERICA[1]

PRELIMINARY REPORT

By Charles C. Mook

Plates IV and V; 63 Text Figures

CONTENTS

[1]Contributions to the Osteology, Affinities and Distribution of the Crocodilia. No. 16.

INTRODUCTION

This article contains material gathered in the preparation of a monographic revision of the fossil crocodilians of North America. The completion of this revision may be delayed indefinitely, and it has therefore been decided to publish the results of the preliminary investigations in the present form. The original references, as many of the later references as were available or were thought pertinent, and the original figures of all the genera and species of North American Mesozoic crocodilians have been brought together, along with statements of their geographic and geologic occurrences, the constitution and present disposition of the type specimens, and the original descriptions, quoted in full. In a few cases new figures were prepared under the writer's direction by Mr. John Germann.

No attempt has been made, at this stage of the work, to discuss the characters of the genera and species as they may be determined at the present time, and the determination indicated in each case after the citation of the original description is for the most part provisional. Further study will doubtless necessitate the changing of many of these determinations. Such a study cannot be satisfactorily made without careful and detailed comparison of the North American forms with those of Europe, Asia, Africa and South America. The purpose of the present report is to bring together in available form the present knowledge of the North American Mesozoic crocodilians.

The genera are treated chronologically in the order of their establishment, and under each genus the species are arranged chronologically.

GONIOPHOLIS Owen

ORIGINAL TYPE REFERENCE.—OWEN, R., 1842, 'Report on British Fossil Reptiles,' Rept. Brit. Assoc. Adv. Sci. Meeting at Plymouth (1841), II, pp. 69, 70.

SUBSEQUENT REFERENCES.—HULKE, J. W., 1878, 'Note on two Skulls from the Wealden and Purbeck Formations indicating a new Subgroup of Crocodilia,' Quart. Journ. Geol. Soc. London, XXXIV, pp. 377–381. OWEN, R., 1878, [Discussion of paper by J. W. Hulke on 'Note on two Skulls from the Wealden and Purbeck Formations indicating a new Subgroup of the Crocodilia'], Quart. Journ. Geol. Soc. London, XXXIV, p. 382; 1878, 'On the Influence of the Advent of a Higher Form of Life in Modifying the Structure of an Older and Lower Form,' Quart. Journ. Geol. Soc. London, XXXIV, pp. 421–430; 1878, 'Monograph on the Fossil Reptilia of the Wealden and Purbeck Formations. Supplement No. 8,' Palæontographical Soc., XXXII, pp. 1–10; 1879, 'Monograph on the Fossil Reptilia of the Wealden and Purbeck Formations. Supplement No. 9,' Palæontographical Soc., XXXIII, pp. 1–12. KOKEN, E., 1886, 'Über Gehirn und Gehör fossiler Crocodiliden vor,' Sitzber. Gesellsch. naturforsch. Freunde zu Berlin, No. 1, p. 2; 1888, 'Thoracosaurus macro-

rhynchus Bl. aus der Tuffkreide von Maastricht,' Zeitschr. d. Deutsch. Geol. Gesellsch. (Jahrg. 1888), pp. 754–773. LYDEKKER, R., 1888, 'Catalogue of the Fossil Reptilia and Amphibia in the British Museum,' Part 1, p. 79. NICHOLSON, H. A., AND LYDEKKER, R., 1889, 'A Manual of Palæontology for the Use of Students with a General Introduction on the Principles of Palæontology,' p. 1191. LYDEKKER, R., 1890, 'Catalogue of the Fossil Reptilia and Amphibia in the British Museum,' Part 4, p. 299. ZITTEL, K. VON, 1890, 'Handbuch der Palæontologie,' Abth. 1, Palæozoologie, III, Vertebrata, p. 676. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 516. HOLLAND, W. J., 1905, 'A New Crocodile from the Jurassic of Wyoming,' Ann. Carn. Mus., III, No. 3, Art. 9, pp. 431–434. WILLISTON, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV, pp. 3, 6–10, 12. LULL, R. S., 1907, 'The Reptilia of the Arundel Formation,' Maryland Geol. Surv., Lower Cretaceous, p. 177; 1907, 'Vertebrata,' Maryland Geol. Surv., Lower Cretaceous, p. 210.

TYPE.—*Goniopholis crassidens* Owen.

ORIGINAL TYPE DESCRIPTION.[1]—"The second form of tooth having generic characters of those of the Crocodile, which has been discovered in the Wealden and approximate strata, is as remarkable for its thick, rounded and obtuse crown as the teeth of the preceding species [*Suchosaurus cultridens*] are for their slender, compressed, acute and trenchant character. It consequently approaches more nearly to the teeth which characterize the broad and comparatively short-snouted Crocodiles; but it differs from these in one of the same characters by which the tooth of *Suchosaurus cultridens* differs from those of the Gavials, viz. in the longitudinal ridges which traverse the exterior of the crown. These are, however, more numerous, more close-set, and more neatly defined than in the *Suchosaurus cultridens*. Two of the ridges, larger and sharper than the rest, traverse opposite sides of the tooth, from the base to the apex of the crown; they are placed, as in the Crocodile and Gavial, at the sides of the crown, midway between the convex and concave lines of the curvature of the tooth. These ridges are confined to the enamel; the cement-covered cylindrical base of the tooth is smooth. The size of the teeth varies from a length of crown of two inches, with a basal diameter of one inch and a half to teeth of one-third of these dimensions."

The genus may provisionally be considered valid.

Goniopholis vebbianus (Cope)

ORIGINAL TYPE REFERENCE.—COPE, E. D., 1872, 'On a new Testudinate from the Chalk of Kansas,' Proc. Amer. Phil. Soc., XII, p. 310, (*Hyposaurus vebbianus*).

SUBSEQUENT REFERENCES.—COPE, E. D., 1872, 'On the Geology and Paleontology of the Cretaceous Strata of Kansas,' Prel. Rept. U. S. Geol. Surv. of Montana and Portions of Adjacent Territories, F. V. Hayden in Charge, Fifth Annual Report, p. 327, (*Hyposaurus Vebbii*); 1874, 'Review of the Vertebrata of the Cretaceous Period found West of the Mississippi River,' Bull. U. S. Geol. Surv. Terr., F. V. Hayden in Charge, I, No. 2, p. 26, (*Hyposaurus vebbii*); 1875, 'The Vertebrata of the Cretaceous Formations of the West,' Rept. U. S. Geol. Surv. Terr., F. V. Hayden in Charge, II, pp. 52, 67, 68, 250, Pl. IX, figs. 8*a*, 8*b*, 8*c*, 8*d*, (*Hyposaurus vebbii*).

[1]No distinction was made between generic and specific characters in Owen's original description, and the following extract is from the original description of *Goniopholis crassidens*.

MARSH, O. C., 1877, 'Notice of some New Vertebrate Fossils,' Amer. Journ. Sci. and Arts, (3) XIV, p. 254, (*Diplosaurus vebbii*). WILLISTON, S. W., 1898, 'Crocodiles,' Univ. Geol. Surv. Kansas, IV, Part 4, p. 78. ZITTEL, K. VON, 1890, 'Handbuch der Palæontologie,' Abth. 1, Palæozoologie, III, Vertebrata, p. 677, (*D.* [i.e., *Diplosaurus*] (*Hyposaurus*) *Vebbii* Cope). HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 516. WILLISTON, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV, No. 1, p. 7.

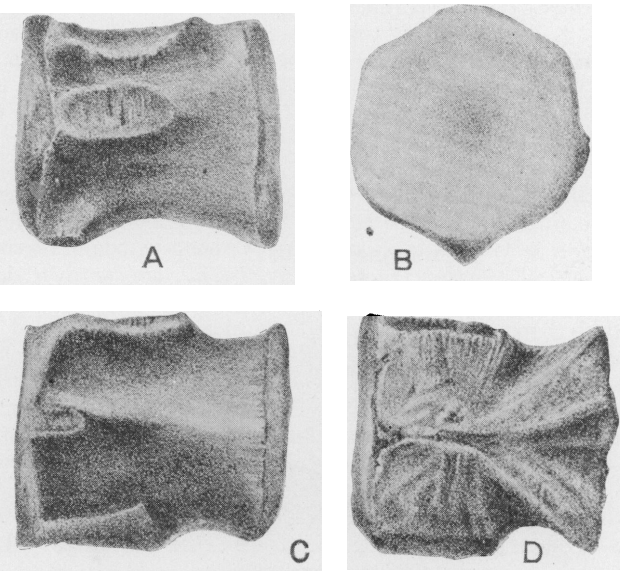

Fig. 1. *Goniopholis vebbianus* (Cope). Type specimen, anterior cervical vertebra.

Two-thirds natural size. A, lateral view, left side; anterior view; C, inferior view; D, superior view. Original type figures. (After Cope.)

ORIGINAL TYPE FIGURES.—COPE, E. D., 1875, 'The Vertebrata of the Cretaceous Formations of the West,' Rept. U. S. Geol. Surv. Terr., F. V. Hayden in Charge, II, Pl. IX, figs. 8*a*, 8*b*, 8*c*, 8*d*.

TYPE.—An anterior cervical vertebra.

TYPE LOCALITY AND LEVEL.—Brookville, Kansas. Benton Group, No. 20 of Meek and Hayden.

ORIGINAL TYPE DESCRIPTION.—"The crocodile may be called *Hyposaurus vebbianus* in recollection of Dr. Wm. E. Webb, of Topeka; it is similar in size to the *H. rogersii* of New Jersey.

An anterior cervical presents the following characteristics: It is that one in which the parapophysis occupies a position opposite the lower third of the vertical diameter. In it the centrum is stout in form, the articular faces but little concave, the posterior a little more so than the anterior. The anterior is almost regularly

hexagonal, the posterior sub-round, a little deeper than wide. The inferior surface possesses a strong obtuse median carina, which disappears in front of the posterior margin. Anteriorly it terminates in a short obtuse hypapophysis. The suture of the neural arch is very coarse. Surface of the bone smooth.

	M.
Length of centrum	.037
Diameter, " anteriorly, vertical	.037
" " " horizontal	.031
" " posteriorly, vertically	.032
" " " horizontally	.031
Length of surface of parapophysis	.015

As compared with the *H. rogersii* of the New Jersey Cretaceous, this vertebra is shorter and stouter, and the extremities less concave; the suture for the neural spine is much coarser."

The species may provisionally be considered valid.

Goniopholis felix (Marsh)

ORIGINAL TYPE REFERENCE.—MARSH, O. C., 1877, 'Notice of some New Vertebrate Fossils,' Amer. Journ. Sci. and Arts, (3) XIV, p. 254, (*Diplosaurus felix*).

ORIGINAL TYPE REFERENCE.—MARSH, O. C., 1877, 'Notice of some New Vertebrate Fossils,' Amer. Journ. Sci. and Arts, (3) XIV, p. 254, (*Diplosaurus felix*).

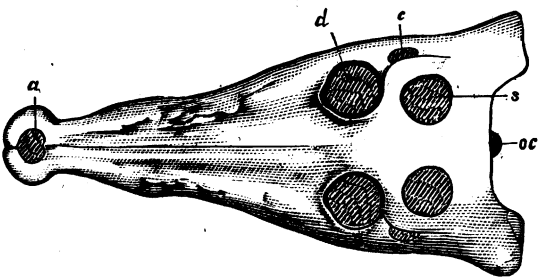

Fig. 2. *Goniopholis* (*Diplosaurus*) *felix* (Marsh). Type specimen, skull (Yale Mus. Coll.).
One-fourth natural size. Superior view. Original type figure. (After Marsh.)

SUBSEQUENT REFERENCES.—KING, C., 1878, 'Systematic Geology,' U. S. Geol. Explor. of the 40th Parallel, I, p. 346, (*Diplosaurus felix*). ZITTEL, K. VON, 1890, 'Handbuch der Palæontologie,' Abth. 1, Palæozoologie, III, Vertebrata, p. 677. MARSH, O. C., 1896, 'A New Belodont Reptile (*Stegomus*) from the Connecticut River Sandstone;' Amer. Journ. Sci., (4) II, p. 61, fig. 2, (*Diplosaurus felix*); 1897, 'Vertebrate Fossils of the Denver Basin,' U. S. Geol. Surv., Monograph XXVII, pp. 506, 507, fig. 62, (*Diplosaurus felix*). HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 516. WILLISTON, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV,

No. 1, p. 7. LULL, R. S., 1910, 'Vertebrata,' Maryland Geol. Surv., Lower Cretaceous, p. 211. MOOK, C. C., 1916, 'A Study of the Morrison Formation,' Ann. N. Y. Acad. Sci., XXVII, p. 148.

ORIGINAL TYPE FIGURE.—MARSH, O. C., 1896, 'A New Belodont Reptile (*Stegomus*) from the Connecticut River Sandstone,' Amer. Journ. Sci., (4) II, p. 61, fig. 1; 1897, 'Vertebrate Fossils of the Denver Basin,' U. S. Geol. Surv., Monograph XXVII, p. 507, fig. 62.

TYPE.—Skull and vertebræ. Yale Museum.

TYPE LOCALITY AND LEVEL.—Near Morrison, Colorado. Morrison beds. Comanchean (possibly latest Jurassic).

ORIGINAL TYPE DESCRIPTION.—"An interesting discovery recently made in the lower Cretaceous, or Wealden beds, of Colorado, is a new genus of Crocodilians, intermediate between the old Teleosaurian type and the modern *Crocodilus*. The new genus has a head and teeth very similar to the latter, but with this the ancient biconcave vertebræ. The present type species is based upon a nearly perfect skull, and a number of vertebræ belonging with it. These pertained to an animal smaller than most existing Crocodilians.

Some of the principal measurements of this species are as follows:

Length of skull on median line	255. mm.
Length of skull from quadrate to end of snout	275.
Transverse diameter of premaxillaries	46.
Transverse diameter of skull, at front of orbits	90.
Transverse diameter at ends of quadrates	122.
Transverse diameter of quadrate at end	20.

A second species of this genus is apparently the *Hyposaurus Vebbii* Cope, which may be called *Diplosaurus Vebbii*."

The species may provisionally be considered valid.

Goniopholis lucasii (Cope)

ORIGINAL TYPE REFERENCE.—COPE, E. D., 1878, 'Descriptions of New Extinct Vertebrata from the Upper Tertiary and Dakota Formations,' Bull. U. S. Geol. and Geog. Surv. Terr., F. V. Hayden in Charge, IV, No. 2, pp. 391, 392, (*Amphicotylus lucasii*).

SUBSEQUENT REFERENCES.—COPE, E. D., 1888, 'Goniopholis in the Jurassic of Colorado,' Amer. Nat., XXII, pp. 1105, 1106. ZITTEL, K. VON, 1890, 'Handbuch der Palæontologie,' Abth. 1, Palæozoologie, III, Vertebrata, p. 677, ((*D.* (*Goniopholis*) *lucasi*)). HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 516. WILLISTON, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV, p. 7. MOOK, C. C., 1916, 'A Study of the Morrison Formation,' Ann. N. Y. Acad. Sci., XXVII, p. 148.

ORIGINAL TYPE FIGURE.—No figure of the type has been published.

TYPE.—Dorsal and lumbar vertebræ, ribs and dermal bones. Amer. Mus. Cope Coll. No. 5766.

TYPE LOCALITY AND LEVEL.—Garden Park, near Canyon City, Colorado. Morrison beds of Comanchean or possibly uppermost Jurassic age.

ORIGINAL TYPE DESCRIPTION.—"*Char. specif.*—The base of the neural arch extends over the greater part of the length of the centrum. The diapophysis of the dorsal vertebra is compressed so as to be vertical. The centrum is so compressed as to have a narrow inferior surface, forming the apex of a triangle, which the section near the middle will represent. The anterior articular face is subround, the posterior subquadrate. There are some rugosities of the sides of the centra, resulting from small longitudinal grooves of the surface near the extremities.

The anterior zygapophyses of the lumbar vertebræ are transverse ovals. The diapophyses are obliquely truncate at the anterior side of the extremity. The anterior extremity of the centrum becomes more concave on the posterior lumbars, which are also longer than the anterior ones.

Measurements.

	M.
Length of six consecutive dorsal and lumbar vertebræ	0.160
Length of a posterior dorsal	0.023
Diameter of a posterior dorsal, vertical	0.017
Diameter of a posterior dorsal, transverse	0.019
Transverse diameter of the same with the diapophyses	0.040

This species, which is smaller than the alligator of the Southern States, is dedicated to Superintendent Lucas, who discovered it near Canyon City, Colo. The bones were found in the light-colored sandstone of the locality which produced the *Camarasaurus supremus*."

The species may provisionally be considered valid.

Goniopholis gilmorei Holland

ORIGINAL TYPE REFERENCE.—HOLLAND, W. J., 1905, 'A New Crocodile from the Jurassic of Wyoming,' Ann. Carn. Mus., III, No. 3, pp. 431–434, 1 fig., Pl. XVI.

SUBSEQUENT REFERENCES.—WILLISTON, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV, p. 8. MOOK, C. C., 1916, 'A Study of the Morrison Formation,' Ann. N. Y. Acad. Sci., XXVII, p. 148.

ORIGINAL TYPE FIGURES.—HOLLAND, W. J., 1905, 'A New Crocodile from the Jurassic of Wyoming,' Ann. Carn. Mus., III, No. 3, fig. 1, Pl. XVI.

TYPE.—Skull. Carn. Mus. No. 1339.

TYPE LOCALITY AND LEVEL.—Near T. B. Ranch, Freezeout Hills, Wyoming, Morrison beds.

ORIGINAL TYPE DESCRIPTION.—"The specimen consists of a skull without the lower jaws. It has been subjected to vertical pressure and is evidently somewhat crushed, so that the transverse dimensions, more particularly in the neighborhood of the orbital and postorbital openings, are greater than they would have been in life and the perpendicular dimensions are less. Otherwise the skull is remarkably well preserved. The entire upper surface is covered with round or angular pits from 2 to 3 mm. in diameter, with intervals of about 1–1½ mm. between them, formed by convex reticularly arranged ridges of the bone, in this respect agreeing perfectly with the generic description given by Owen.

The premaxillaries have not sustained much crushing; the anterior edge has been broken, and the margin of these bones is not entire. A portion of the posterior

Fig. 3. *Goniopholis gilmorei* Holland. Type specimen, skull (Carn. Mus. No. 1339).

Two-fifths natural size. Superior view. Original type figure. (After Holland. The portions marked + have been restored.)

margin of the right dental foramen is, however, preserved, showing that the animal possessed the dental foramina, and thus was allied to the genus *Crocodilus* rather than to the genus *Alligator* Cuvier, or the genus *Gavialis* Oppel, the former of which is characterized by the absence of the dental foramina, except possibly in extreme age, and the latter of which is always without these openings. The foveæ on the lower surface of the intermaxillaries which lead from the orifices of the dental foramina are distinctly marked on the under surface of the skull. The snout is strongly constricted at the point where the premaxillaries unite with the maxillaries at the dental incisure. The nasal bones do not reach the narial opening, their anterior ends terminating between the premaxillaries fully three centimeters from the posterior margin of this opening. The alveolar border of the maxillaries extends backward from the point of union with the premaxillaries, in a widening curve, to a point in advance of the orbital cavities. There does not appear to be much, if any, evidence of lateral compression of the skull about the middle of the maxillaries, as is the case in the skull of many species of recent crocodiles, notably *Crocodilus Americanus* Seba. The distortion of the specimen to which the skull has been subjected as the result of vertical pressure may have slightly obliterated the evidence of constriction at the point indicated, in case it existed in life.

The arrangement of the bones composing the roof of the back part of the skull is essentially like that in the recent genus *Crocodilus*. At the point where the mastoid and the parietal bone form the inner and posterior margins of the supratemporal fossæ there are developed well marked convex bony ridges, rising about four mm. in height above the plane of the upper surface of the bones which have been named. This bony ridge is far more strongly marked than in the recent genus *Crocodilus*, where it exists only as a vestige. In other respects the upper surface of the skull shows no points of difference from modern types. The under surface of the specimen preserves, though greatly crushed, the outlines of the bones of the inferior surface of the skull, and these do not seem to diverge in form and arrangement from well known recent types.

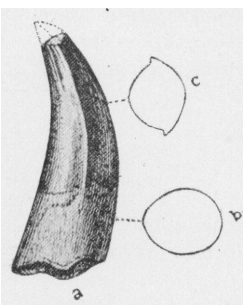

Fig. 4. *Goniopholis gilmorei* Holland. Type specimen, teeth (Carn. Mus. No. 1339).

Natural size. a, lateral view; b, outline of section at base; c, outline of section at middle of crown. Original type figure. (After Holland.)

With the skull were associated a few teeth. The alveolar border of the maxillaries and premaxillaries is sufficiently perfect to show that the number of teeth was identical with that of the modern genus *Crocodilus*, and the arrangement of the teeth and their relative sizes, so far as it is possible to ascertain the facts from the skull under consideration, was the same as in *Crocodilus*. Three successional teeth are preserved on the left hand side of the upper jaw, and the crowns of two larger teeth were found detached from the skull and in the matrix beside it, evidently belonging to the same specimen. These teeth differ somewhat from those of the recent genus *Crocodilus* in being somewhat more compressed and trenchant and not as conical. They are not, however, as obtuse as the teeth described by Owen as belonging to the genus *Goniopholis*, although upon the crown, particularly upon the inner surface, they distinctly reveal the neatly defined longitudinal ridges, which appear to agree with the description given by Owen. The two lateral ridges, one anterior and the

other posterior, midway between the convex and concave surfaces, are in both cases sharply defined, and even more sharply than in the genus *Crocodilus*. The larger of the teeth that have been preserved appears to the writer to be, reckoning from the front, No. 10 in the left series.

DIMENSIONS OF THE SKULL OF GILMORE'S CROCODILE

Length of skull on median line	38.50 cm.
" " " from posterior extremity of quadrate to end of snout	44.50 "
Transverse diameter of snout across premaxillaries	7.20 "
" " " " at junction of maxillaries and premaxillaries	4.00 "
" diameter of skull at front of orbits	10.80 "
" " " " at upper ends of mastoids	12.00 "
" " " " at end of quadrates	20.00 "
Longitudinal diameter of left orbital foramen	4.00 "
Transverse " " " " "	5.20 "
Longitudinal " " " postorbital foramen	4.50 "
Transverse " " " " "	3.50 "
Diameter of supratemporal foramen	4.00 "

The specific characters by which this species may be distinguished from the other species of the genus *Goniopholis* described from North America appear to be the very closely pitted superior surface of the bones of the skull, the existence of the elevated ridges partly surrounding the supratemporal foramina, and the less obtuse, elongated and compressed shape of the teeth.

The writer assigns the species to the genus *Goniopholis* with doubt: first, because no vertebræ were collected, and therefore it is unknown whether the centra were amphicœlous as in *Goniopholis* or not; and, secondly, because the longer, less obtuse, and more trenchant teeth do not fully accord with the generic description given by Owen."

The species may provisionally be considered valid.

Goniopholis affinis Lull

ORIGINAL TYPE REFERENCE.—LULL, R. S., 1910, 'The Reptilia of the Arundel Formation,' Maryland Geol. Surv., Lower Cretaceous, pp. 177, 210, 211; 'Vertebrata,' same volume, pp. 210, 211, Pl. xx, fig. 7.

SUBSEQUENT REFERENCE.—GILMORE, C. W., 1921, 'The Fauna of the Arundel Formation,' Proc. U. S. Nat. Mus., LIX, p. 589, Pl. cx, fig. 1 (Pub. 2389).

ORIGINAL TYPE FIGURE.—LULL, R. S., 1910, Maryland Geol. Surv., Lower Cretaceous, Pl. xx, fig. 7.

TYPE.—A tooth. Maryland Geol. Surv. No. 8175 according to Lull; U. S. Nat. Mus. No. 8452 according to Gilmore.

TYPE LOCALITY AND LEVEL.—Branchville, Prince George's County, Maryland. Arundel formation.

ORIGINAL TYPE DESCRIPTION.—"The fauna includes a crocodile, *Goniopholis*, found in the Wealden and Purbeck beds of Europe and in the Morrison of Colorado and Wyoming. The teeth are so similar to those from the western quarries that the name *Goniopholis affinis*, the nearly related, is given to the Potomac type. These are

crocodiles of moderate size, 6 feet or more in length, and may have resembled the modern genus *Crocodilus*, with its narrow snout, quite closely in general appearance.

Fig. 5. *Goniopholis affinis* Lull. Type specimen, tooth (Md. Geol. Surv. No. 8175, U. S. Nat. Mus. No. 8452). Natural size. Edge view. Original type figure. (After Lull.)

A crocodile is represented by a number of teeth and part of a scute. The teeth, however, are the most distinctive. They show beyond question the generic characters of *Goniopholis:* 'stout, rounded, slightly curved, with the enamel ridged and grooved, and well-marked carinæ placed in a 'plane coincident with that of the curvature of the crown'. . . They resemble very closely a multitude of teeth from 'Quarry 9,' Como, Wyoming (Morrison), preserved in the Yale Museum, which agree in size with those of the type specimen of *Goniopholis* (*Diplosaurus*) *felix* (Marsh). Unfortunately, none of the crowns in the last specimen show their outer surface, but those of the Maryland specimen differ from those from Como by having secondary ridges between the main ridges on the proximal portion of the crown. See figure. The similarity aside from this feature is very great and shows a close relationship with the Morrison type as the specific name implies. The sculpturing on the scute (No. 5465) is coarser than on any of those in the lot of material from Como. This may, however, be due to the portion of the body from which the scute came, and is probably not of importance.

Tooth No. 8175, M. G. S., may be taken as type.
Length of crown about.....25 mm.
Width of crown at base.....12 mm."

According to Gilmore, this species cannot be considered as determinate. It is possible that, in spite of the fragmentary nature of the type, distinctive characters may be found on further study of the type material. No further determination can be made at the present time, however.

Bottosaurus Agassiz

Original Type Reference.—Agassiz, L., 1849, [Remarks on the Crocodilia of the Greensand of New Jersey and on *Atlantochelys*], Proc. Acad. Nat. Sci. Phila., IV, p. 169.

Subsequent References.—Leidy, J., 1865, 'Cretaceous Reptiles of the United States,' Smith. Contrib. Knowl., XIV, p. 12. Cope, E. D., 1869, 'The Fossil Reptiles of New Jersey,' Amer. Nat., III, p 90; 1869, 'Synopsis of the Extinct Batrachia and Reptilia of North America,' Trans. Amer. Phil. Soc., N. S., XIV, Part 1, Art. 1, pp. 62, 65. Marsh, O. C., 1877, 'Introduction and Succession of Vertebrate Life in America,' Amer. Journ. Sci. and Arts, Ser. 3, XIV, Art. 42, p. 346. Toula, F., and Kail, J. A., 1885, 'Über einen Krododil-Schädel aus den Tertiärablagerungen von Eggenburg in Niederösterreich,' Denkschr. k. Akad. Wissensch, Wien, p. 354. Lydekker, R., 1886, 'Siwalik Crocodilia, Lacertilia, and Ophidia,' Mem. Geol. Surv. India, Palæontologia Indica, Ser.10, III, Part 7, p. 3 (211). Zittel, K. von, 1890, 'Handbuch der Palæontologie,' Abth. I, Palæozoologie, III, Vertebrata, p. 679. Williston, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV, pp. 2–4. Gilmore, C. W., 1910, 'Leidyosuchus sternbergii, a New Species of Crocodile

from the Ceratops Beds of Wyoming,' Proc. U. S. Nat. Mus., XXXVIII, p. 492 (Pub. No. 1762); 1911, 'A New Fossil Alligator from the Hell Creek Beds of Montana,' Proc. U. S. Nat. Mus., XLI, pp. 297, 298 (Pub. No. 1860).

TYPE.—*Crocodilus macrorhynchus* Harlan = *Bottosaurus harlani* Meyer.

ORIGINAL TYPE DESCRIPTION.—"Professor Agassiz made some remarks on the distinctions between the fossil Crocodiles of the green sand of New Jersey, described by Drs. Harlan and Morton, and characterized that of Dr. Harlan as a distinct genus under the proposed name of *Bottosaurus*." (Minutes of meeting of Academy of Natural Sciences of Philadelphia for March 6, 1849).

The genus may provisionally be considered valid, though it requires further study to determine its characteristics.

Bottosaurus harlani (Meyer)

ORIGINAL TYPE REFERENCES.—HARLAN, R., 1824, 'On an Extinct Species of Crocodile not before described; and some Observations on the Geology of West Jersey,' Journ. Acad. Nat. Sci. Phila., IV, pp. 15–24, Pl. I ("Crocodile," no species name indicated). MEYER, H. VON, 1832, 'Palæologica,' p. 108 (name "Harlani" with no generic reference or description).

SUBSEQUENT REFERENCES.—HARLAN, R., 1834, 'Critical Notices of Various Organic Remains hitherto discovered in North America,' Trans. Geol. Soc. Pennsylvania, I, Part 1, pp. 76, 77; also 1835, 'Med. and Phys. Res.,' pp. 280, 281. (*Crocodilus macrorhynchus*); also 1835, Edinburgh New Phil. Journ., XVII, between pp. 342 and 362, pp. 29, 40, [not seen]; 1835, 'Description of an Extinct Species of Crocodile, not before described; and some Observations on the Geology of West Jersey,' in 'Med. and Phys. Res.,' pp. 378–380, 1 Pl., (*Crocodilus macrorhynchus*); also 1836, Translation into German, Neues Jahrb. f. Min., Geognos., Geol. u. Petrefakt., p. 105. DE KAY, J., 1842, 'Zoology of New York,' Part 3, p. 27, (*Crocodilus macrorhynchus*). GIEBEL, C. G., 1847, 'Fauna der Vorwelt,' II, p. 122, (*Crocodilus macrorhynchus*). GIBBES, R. W., 1851, 'Memoir on *Mosasaurus* and Three Allied new Genera, *Holcodus*, *Conosaurus*, and *Amphorosteus*,' Smith. Contrib. Knowl., II, Art. 5, p. 7, (*Crocodilus macrorhynchus*). LEIDY, J., 1865, 'Cretaceous Reptiles of the United States,' Smith. Contrib. Knowl., XIV, pp. 12–14, 115, Pl. IV, figs. 19–23, Pl. XVIII, figs. 11–14. COPE, E. D., 1867, 'The Fossil Reptiles of New Jersey,' Amer. Nat., I, p. 26; 1869, 'Synopsis of the Extinct Reptilia found in the Mesozoic and Tertiary Strata of New Jersey,' in 'Geology of New Jersey,' by G. H. Cook, Appendix B, Rept. Geol. Surv. New Jersey, p. 736; 1869, 1870, 'Synopsis of the Extinct Batrachia and Reptilia of North America,' Trans. Amer. Phil. Soc., N. S., XIV, pp. 65–67, (1869), p. 231 (1870); 1871, 'Supplement to the Synopsis of the Extinct Batrachia and Reptilia of North America,' Proc. Amer. Phil. Soc., XII, pp. 48–50, (*Bottosaurus macrorhynchus*). LEIDY, J., 1782, 'Brief Review of a Memoir on the Cretaceous Reptiles of the United States, published in the Fourteenth Volume of the Smithsonian Contributions to Knowledge,' Ann. Rept. Board of Regents Smith. Inst., for 1866, pp. 67, 68. COPE, E. D., 1874, 'Review of the Vertebrata of the Cretaceous Period found west of the Mississippi River,' Bull. U. S. Geol. and Geog. Surv. Terr., F. V. Hayden in Charge, I, No. 2, first series, p. 27, (*Bottosaurus macrorhynchus*); 1874, 'Report on the Vertebrate Paleontology of Colorado,' Ann. Rept. U. S. Geol. and Geog. Surv. Terr. (for 1873), F. V. Hayden in Charge, p. 452, (*Bottosaurus macrorhynchus*);

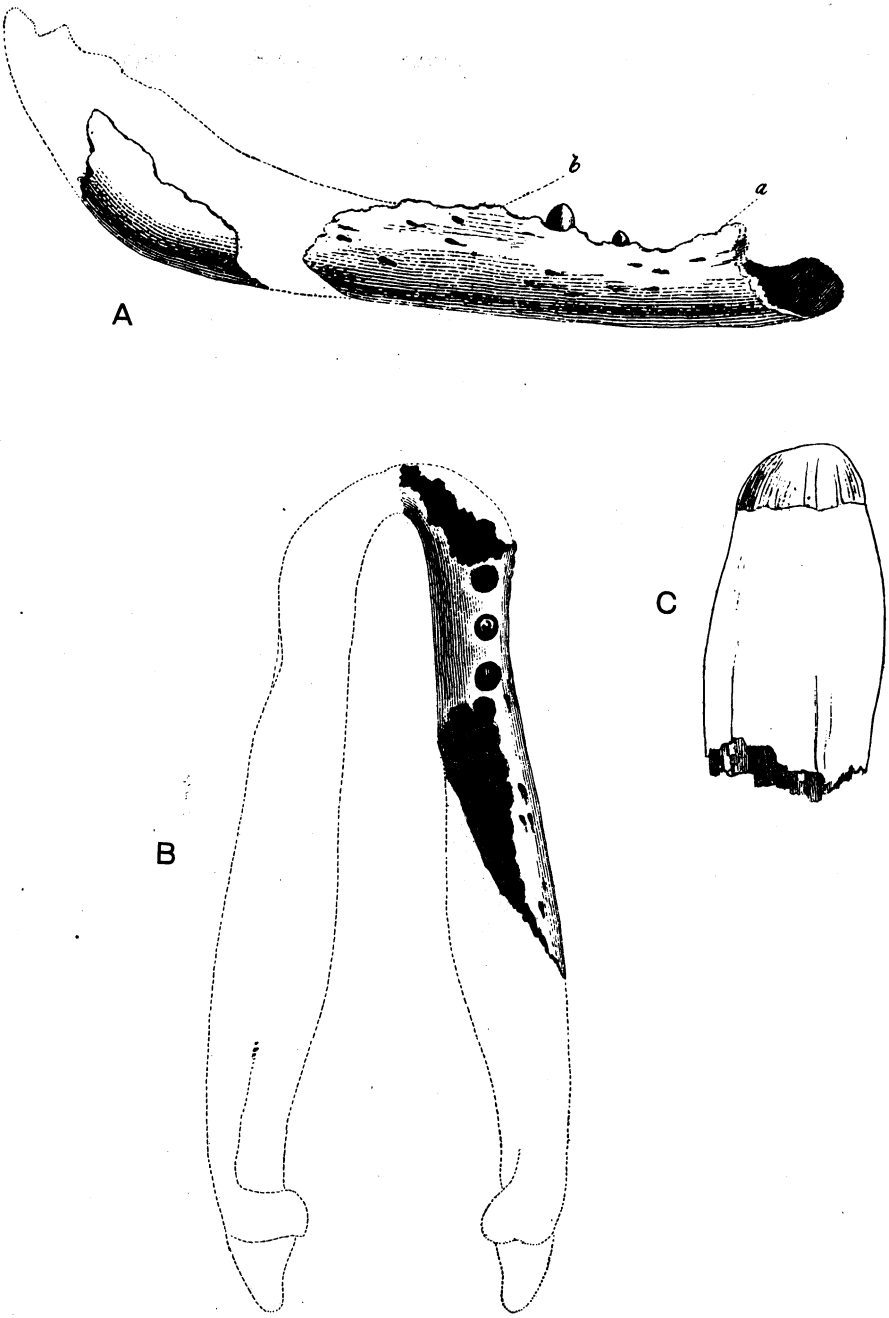

Fig. 6. *Bottosaurus harlani* (Meyer). Type specimen, portions of dentary and angular bones, and paratype specimen, tooth (Acad. Nat. Sci. Phila. Coll.).

A, portions of right dentary and angular bones, with outline restoration of jaw, external view, about one-sixth natural size; B, portion of dentary bone, with outline restoration of jaw, superior view, about one-sixth natural size; C, tooth, external view, natural size. Original type figures. (After Harlan.)

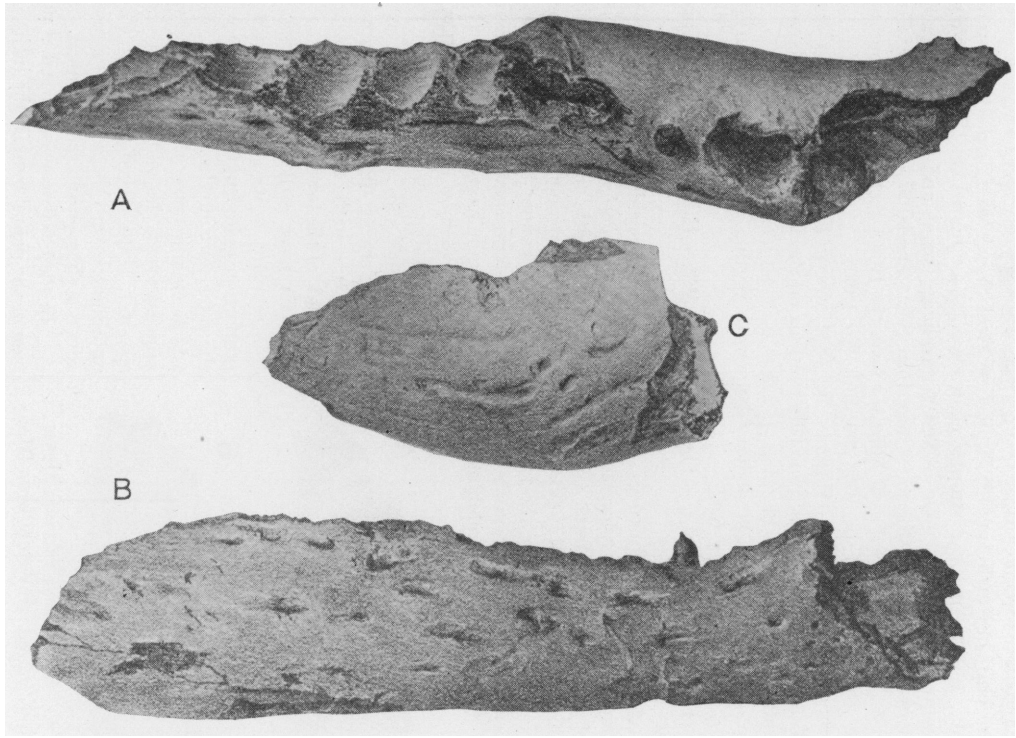

Fig. 7. *Bottosaurus harlani* (Meyer). Type specimens, right dentary and angular bones (Acad. Nat. Sci. Phila. Coll.).

One-third natural size. A, superior view of dentary; B, external view of same; C, external view of angular. (After Leidy.)

1875, 'The Vertebrata of the Cretaceous Formations of the West,' Rept. U. S. Geol. Surv. Terr., F. V. Hayden in Charge, II, pp. 68, 253, (*Bottosaurus macrorhynchus*); TOULA, F., AND KAIL, J. A., 1885, 'Über einen Krokodil-Schädel aus den Tertiärablagerungen von Eggenburg in Niederösterreich,' Denkschr. k. Akad. Wissensch. Wien, p. 354, (*Crocodilus harlani*). HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 514. WILLISTON, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV, No. 1, p. 3. LAMBE, L. M., 1907, 'On a New Crocodilian Genus and Species from the Judith River Formation of Alberta,' Trans. Roy. Soc. Canada, Ser. 3, I, p. 220. GILMORE, C. W., 1911, 'A New Fossil Alligator from the Hell Creek Beds of Montana,' Proc. U. S. Nat. Mus., XLI, pp. 297, 299 (Pub. No. 1860).

ORIGINAL TYPE FIGURES.—HARLAN, R., 1824, 'On an Extinct Species of Crocodile not before Described; and some Observations on the Geology of West Jersey,' Journ. Acad. Nat. Sci. Phila., Pl. I, figs. 1, 2, 8.

TYPE.—Portion of a right dentary bone with portion of angular. Paratype: teeth. Acad. Nat. Sci. Phila. Coll.

TYPE LOCALITY AND LEVEL.—Three miles from White Hill, New Jersey. Upper Cretaceous Greensands.

ORIGINAL TYPE DESCRIPTIONS.—"The fossil, under consideration, is the dental bone of the right side, in a tolerable state of preservation, perfectly fossilized or impregnated with iron, containing the sockets for eleven teeth, in a space of twelve inches; three of the teeth only remain perfect, a portion of the bone is lost posteriorly and interiorly; consequently the total number of teeth cannot be ascertained with perfect accuracy; though, from the great size of the inferior maxillary foramen immediately behind the last remaining tooth, there could not have existed more than one or two more at most. A portion of the angular bone was fortunately preserved, which will enable us to determine the form of the angle, and thus to reconstruct, with sufficient accuracy, the whole of the lower jaw.

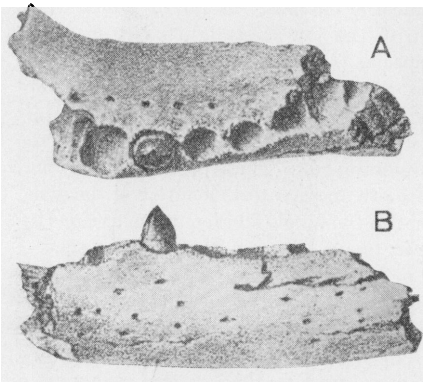

Fig. 8. *Bottosaurus harlani* (Meyer). Left dentary, young individual from Monmouth County, New Jersey.

One-half natural size. A, superior view; B, external view. (After Leidy.)

The most striking peculiarity of this remnant is its great thickness in proportion to its length, compared with the same part in other crocodiles; with which circumstance the structure and appearance of the teeth perfectly correspond; being exceedingly short, thick and blunt, except the very young tooth, which is sharper and more conical.

In the CROCODILUS ACUTUS, a portion of the dental bone, eight inches in length, contains ten teeth; the same measurement taken from the CROCODILUS LUCIUS, thirteen and a half feet long, affords space for thirteen teeth. In our fossil, on the contrary, there is only space allowed for seven teeth; in every instance commencing from the fourth tooth, and enumerating backwards.

In the *C. acutus*, the dental bone, immediately behind the fourth tooth, is one inch, four-tenths, in breadth. In the *C. lucius*, one inch, seven-tenths. In the fossil, two inches, four-tenths. Depth of the same portion of bone, in the *C. acutus*, is one inch, two-tenths; in the *C. lucius*, two inches; in the fossil, two inches, five-tenths. By this measurement, the fossil bone is shown to be nearly cylindrical.

The teeth of the fossil, though very short and thick, are not much worn—the largest tooth of the lower jaw, in the *C. lucius*, thirteen feet long, is twenty-four tenths in circumference; the largest of the fossil teeth is thirty-three tenths. Of one of the loose fossil teeth, the length is two inches; diameter one inch; whilst the portion which projected above the bone, is only half an inch long. The caliber of the tooth at its base is half an inch in diameter. The bodies of the teeth are separated by a plate of bone only four or five-tenths in thickness.

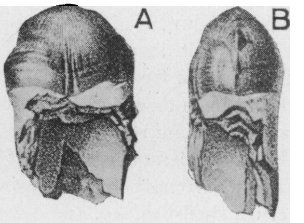

Fig. 9. *Bottosaurus harlani* Meyer. Paratype specimen, tooth (Acad. Nat. Sci. Phila. Coll.).

Natural size. A, external view; B, lateral view. (After Leidy.)

The anterior or alveolar portion of the lower jaw, in all the Crocodiles excepting Cuvier's sub-genus *C. gangeticus*, presents a series of vertical curvatures; there are three in number in the fossil, in which respect it resembles the recent Crocodiles and Alligators; but which will alone separate it from the Gavials as well as all the *fossil* specimens hitherto discovered, which most nearly resemble the Gavials; in all of which this portion of the jaw is straight; but the present species is still further separated from all the sub-genera of Cuvier, by the greater relative thickness and less length of the dental bone, as well as in the peculiarities of the teeth above-mentioned. The space between the fourth tooth and greatest elevation of the dental bone, in the fossil (a.b.) contains five teeth; in the C. *lucius*, nine; in the C. *acutus*, six.

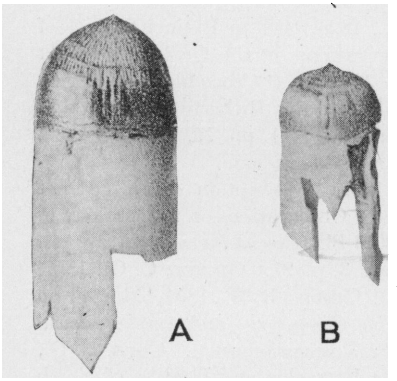

Fig. 10. *Bottosaurus harlani* (Meyer). Teeth referred by Leidy to this species.

A (Burlington County Lyceum of Natural History Coll.), large tooth, external view, natural size; B, small tooth (collection not known), external view, natural size. (After Leidy.)

The distance from the fourth tooth, (which is very large proportionably) to the anterior margin of the symphysis in the fossil, is four inches, two-tenths; in the C. *lucius*, two inches, seven-tenths; in the *acutus*, two inches, six-tenths. The symphysis of the lower jaw extends posteriorly to the fourth tooth in the C. *acutus;* it terminates two inches anteriorly in the fossil; its termination is nearly opposite the fourth tooth in the C. *lucius*. Directly posterior to the fourth tooth, there exists a considerable curvature inwards, in the fossil; directly the reverse is the case in the C. *lucius;* but a similar curvature exists in a very slight degree in the C. *acutus*.

The foramina for the transmission of nerves and blood-vessels are unusually large and numerous in the fossil. By referring to the figures, other differences will be noticed equally remarkable, though not so readily expressed; all of which, taken collectively, constitute, in my opinion, characters sufficient to require for this animal the establishment of a new subgenus.

I am not, as yet, prepared to answer positively to the question, did this animal exist in salt or fresh water? As far as my information extends, no fossil Crocodile has hitherto been discovered in salt water formation. The pretended Crocodiles, said to have been found with fish in the pyritose schistus of Thuringia, are evidently Monitors, as has been demonstrated by Cuvier. However, the form of the teeth, great thickness, and strength of the jaws, in the present instance, would qualify this species to crush shell-fish, &c. and defend itself against powerful enemies.

Numerous vertebræ of Crocodiles have been found in the same locality, none of which, however, are large enough to have belonged to this individual, but very different from any I have been able to compare them with; though very much broken, yet this difference is readily recognized by a very peculiar compression of the lateral and inferior portion of the bodies; as might be anticipated, the vertebræ, already discovered, denote a variety of species." (Harlan).

(Meyer) "—Harlani." No description.

The species may be considered valid.

Bottosaurus (Crocodilus) macrorhynchus Harlan

ORIGINAL TYPE REFERENCES.—HARLAN, R., 1824, 'On an Extinct Species of Crocodile not before described; and some Observations on the Geology of West Jersey,' Journ. Acad. Nat. Sci. Phila., IV, pp. 15–24, Pl. 1, ("Crocodile," no specific name); 1834, 'Critical Notices of Various Organic Remains Hitherto Discovered in North America,' Trans. Geol. Soc. Pennsylvania, I, Part 1, pp. 76, 77; also 1835, 'Med. and Phys. Res.,' pp. 280, 281, (*Crocodilus macrorhynchus*).

SUBSEQUENT REFERENCES.—HARLAN, R., 1835, 'Description of an Extinct Species of Crocodile, not before Described, and some Observations on the Geology of West Jersey,' in 'Med. and Phys. Res.,' pp. 378–380, 1 Pl., (*Crocodilus macrorhynchus*). DE KAY, J. E., 1842, 'Zoology of New York,' Part 3, p. 27. GIEBEL, C. G., 1847, 'Fauna der Vorwelt,' II, p. 122, (*C. macrorhynchus*). GIBBES, R. W., 1851, 'Memoir on *Mosasaurus* and Three Allied New Genera, *Holcodus*, *Conosaurus*, and *Amphorosteus*,' Smith. Contrib. Knowl., II, Art. 5, p. 7, (*Crocodilus macrorhynchus*). COPE, E. D., 1871, 'Supplement to the Synopsis of the Extinct Batrachia and Reptilia of North America,' Proc. Amer. Phil. Soc., XII, p. 48; 1875, 'The Vertebrata of the Cretaceous Formations of the West,' Rept. U. S. Geol. Surv. Terr., F. V. Hayden in Charge, II, pp. 68, 253. TOULA, F., AND KAIL, J. A., 1885, 'Über einen Krokodil-Schädel aus den Tertiärablagerungen von Eggenburg in Niederösterreich,' Denkschr. k. Akad. Wissensch. Wien, p. 354. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 514. WILLISTON, S. W., 1906, 'American Amphiccelian Crocodiles,' Journ. Geol., XIV, p. 3, (*Crocodilus macrorhynchus*).

ORIGINAL TYPE FIGURES.—HARLAN, R., 1824, 'On an Extinct Species of Crocodile not before Described; and some Observations on the Geology of West Jersey,' Journ. Acad. Nat. Sci. Phila., IV, Pl. 1, figs. 1, 2, 8.

TYPE.—Portion of right dentary bone, with portions of angular. Paratype: Teeth. Acad. Nat. Sci. Phila. Coll. The type of *Bottosaurus harlani* Meyer.

ORIGINAL TYPE DESCRIPTION.[1]—"Several fine specimens of the jaw, teeth, vertebræ &c. of an extinct fossil species of crocodile from the New Jersey marl-pits, . . . are contained in the Cab. of the Ac. Nat. Sciences; the most perfect of these is described and figured as above referred to. It consists of the dental bone of the right side, in a good state of preservation, perfectly fossilized, or impregnated with iron, so abundant in the marl-pits of New Jersey; it contains the sockets of eleven teeth in a space of twelve inches.

The most striking peculiarity of this remnant is its great thickness in proportion to its length, compared with the same part in recent crocodiles, with which circumstance the structure and appearance of the teeth perfectly correspond, being exceedingly thick, short, and blunt. Length of one of these teeth, two inches, diameter at base one inch; only one-half an inch projecting beyond the alveole."

Since this species was based upon the type of *Bottosaurus harlani* Meyer, and named later, it is clearly a synonym of that species.

Bottosaurus tuberculatus Cope

ORIGINAL TYPE REFERENCE.[1]—COPE, E. D., 1869, 1870, 'Synopsis of the Extinct Batrachia and Reptilia of North America,' Trans. Amer. Phil. Soc., N. S., XIV, Part 1, pp. 65, 230, 231, (p. 65, referred to *B. harlani* Meyer; pp. 230, 231, *B. tuberculatus*).

SUBSEQUENT REFERENCES.—COPE, E. D., 1871, 'Supplement to the Synopsis of the Extinct Batrachia and Reptilia of North America,' Proc. Amer. Phil. Soc., XII, pp. 48, 49. TOULA, F., AND KAIL, J. A., 1885, 'Über einen Krokodil-Schädel aus den Tertiärablagerungen von Eggenburg in Niederösterreich,' Denkschr. k. Adad. Wissensch. Wien, p. 354. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 514.

ORIGINAL TYPE FIGURE.—No figure of the type has been published.

TYPE.—Twenty-seven vertebræ from the dorsal, lumbar, sacral and caudal series, with large portions of the pelvis and both hind limbs, including two perfect femora; also, about fifty dermal bones.

TYPE LOCALITY AND LEVEL.—Near Birmingham, New Jersey. Greensands, Upper Cretaceous.

ORIGINAL TYPE DESCRIPTION.—"From an examination of additional material, I am disposed to believe that the *Bottosaurus*, described under the head of B. harlani, at page 65, as a smaller individual, really represents a different species which I name above. The material is from the same locality as the above specimen, and consists of twenty-seven vertebræ from the dorsal, lumbar, sacral and caudal series, with large portions of the pelvis and both hind limbs, including two perfect femora; also, about fifty dermal bones.

Cranium and teeth. These are described as above. The acute, conic dental crown, which, I at one time referred to the position of canine of B. harlani, I believe to indicate the specific distinctness of the present animal. The specimen of the latter appears to be mature, as one half the neural arches of the vertebræ are coössified; the size is, therefore, not more than half that of B. harlani.

[1]Harlan's original description of the material is given under *Bottosaurus harlani*.

Vertebræ. A prominent character to be noticed is that none of the dorsal and lumbar series has compressed centrum, as is the case with most of the Holopes; nor have any of the posterior dorsals the compression seen in H. obscurus. Second, the centra never present the parallelogrammic horizontal section seen in the Holopes; on the contrary, they are much contracted just in front of the articular ball, and flare out regularly laterally, to the rim of the socket. The lip of the cup is thin, and the cup inclines to narrow downward, especially anteriorly. This is owing to the fact that the inferior median line becomes pinched or narrowed on approaching the position of the hypapophysis. One vertebra with the latter is preserved; the process is broken off, but had a small basis,

	Lines.		*Lines.*
Width cup first lumbar,	21.2	Width neural canal,	7.4
" " "	17	Antero-posterior length between ends of zygapophyses,	34
Length centrum,	28.6	Expanse of anterior pair of do.,	45
Width cup fifth dorsal,	20.	Width neural canal	6.8
" " "	16.5	Antero-posterior spread of zygapophyses,	33.4
Length centrum do.,	27	Expanse of anterior do.,	38.2

The *Femora* are large in proportion to the size of the vertebræ. The head exhibits the round form characteristic of Holops, not the obliquity of Hyposaurus. What characterizes it is the great prominence of the ridge, rudimental in the latter, which represents the third trochanter of Dinosauria. This prominence is increased by the presence both anteriorly and posteriorly of a strongly marked pit. Another marked characteristic, not seen in other genera, is the truncation of the posterior margin of the shaft close to the head, down to nearly opposite the third trochanter; the surface thus produced is deeply grooved. Inside of the head roughly grooved; outside flatter, more finely grooved; a grooved swell, in the position of the great trochanter of other forms. The shaft, compared with the Holopes and Hyposaurus, figured in the present work (Pl. IV.), is shorter and more curved. The condyles are wide, with narrow posterior prolongations extending on each side of a wide and deep popliteal groove.

	In.	*Lin.*		*In.*	*Lin.*
Length of right femur,	10	8	Expanse condyles,	2	8.6
Width head,	2	9.8	Circumference shaft at middle,	4	4.
Length to 3rd trochanter,	3	11.7			

The *tibia* is stout and slightly curved; the condyloid extremity presents two articular surfaces at right angles to one another, of which the longer is contracted in respect to the length of the bone, and is supported by a thin margin. The proximal extremity is broken from that of one side, but remains with a part of the shaft of the other.

	In.	*Lin.*		*Lin.*
Length (not restored,)	7	11	Diameter median,	14
Diameter proximal,	1	10	" distal,	26

Portions of shafts, etc., of most of the other long bones are preserved.

Both *ilia* remain, one quite perfect. The latter is more prolonged posteriorly than in Cuvier's figure of that bone in *Crocodilus biporcatus*. The anterior half is much like that in a large smooth toothed Holops from Tinton Falls, N. J., but presents a pit just behind the anterior tuberosity not found in it. There is a separate oval articular face below this tuberosity at the usual pubic articulation. The anterior angle of the crest of the ilium is not prominent; more so in the Holops above noted. Crest longitudinally rugose.

	In.	Lin.		Lin.
Length ilium,	6	7	Depth anterior tuberosity,	22.4
Depth behind ischiadic suture,	2	3	Length posterior hook ilium,	32.2
Depth at do	3	5.7		

The *dermal bones* are very characteristic and distinguish the genus. They differ in two points from those of Thoracosaurus and Holops; first, in having no pits; second, in having a prominent median keel. They are rather small, subquadrate, and with a very thick, always obtuse, and sometimes elevated median carina. The latter has rather the form of a knob. Many of the bones consist chiefly of this knob with a small basis. The superior surface is dotted with a few punctæ and grooves. Length of one of the largest 24.1 lines; depth 5 lines; width 11.5. Those probably of the cervical or anterior dorsal region have been described by me under Holops obscurus, p. 78. I believe they should be referred here, as those from the dorsal region of the present specimen approach them very closely. Those referred to the Bottosaurus, p. 66, should be assigned elsewhere." Cope's description of the dermal plates in his description of *Holops obscurus* is as follows: "Of *dermal bones*, those of two species, perhaps of more, were procured from the excavations that produced four species of Gavials, with Bottosaurus, . . . and to which they are to be referred is not very clear. In the one, the pits or fovea are very large and are separated by narrow elevated partitions; in the other they are small and are separated by flat intervals wider than themselves. In the former the fovea extend to the edges of the plate on the bevelled edges; in the latter, the bevelled edges are without fovæ. Leidy says of those of this type, 'plates coarsely foveated.' The first described belong to the median series of the present species, as they usually accompany its bones when they occur alone; and the latter to the external series.

Parallelogrammic dermal bones without pits, and with very high longitudinal crests, standing on more than half the length, frequently accompany remains of this species. They are cervical or nuchal bones, and are of relatively large size, equalling those of the dorsal region. The crests are oblique in the direction of their length. Such bones belong to this species, perhaps to H. cordatus also." This latter description does not, evidently, refer to the type material, but to referred material.

The species may provisionally be considered valid.

Bottosaurus perrugosus Cope

ORIGINAL TYPE REFERENCE.—COPE, E. D., 1874, 'Review of the Vertebrata of the Cretaceous Period found West of the Mississippi River,' Bull. U. S. Geol. and Geog. Surv. Terr., F. V. Hayden in Charge, I, No. 2, first series, pp. 7, 26, 27; also 1874, Rept. U. S. Geol. and Geog. Surv. Terr., F. V. Hayden in Charge, for 1873, pp. 452, 453; also 1875, 'The Vertebrata of the Cretaceous Formations of the West,' Rept. U. S. Geol. Surv. Terr., F. V. Hayden in Charge, II, pp. 68, 69, 253, Pl. VI, figs. 5–8.

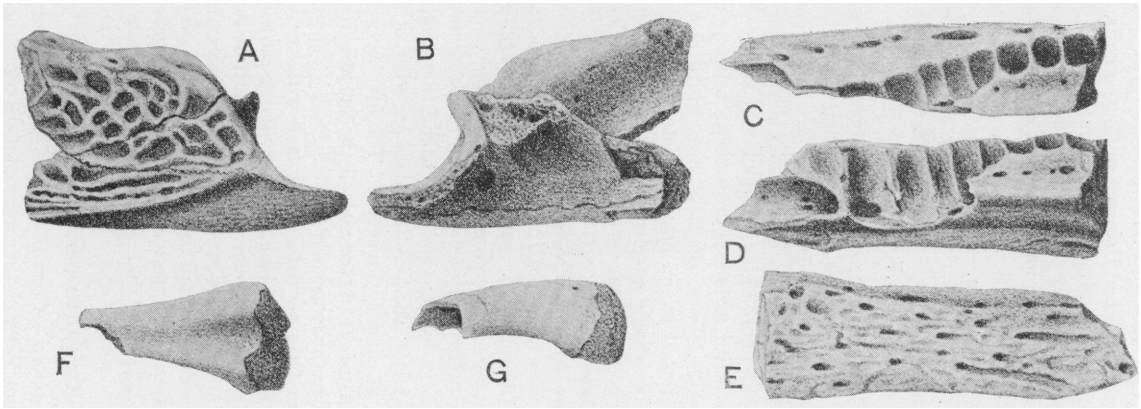

Fig. 11. *Bottosaurus perrugosus* Cope. Type specimen, jaw fragments and femur.

One-half natural size. A, posterior portion of left mandibular ramus, external view; B, the same, internal view; C, portion of dentary bone, superior view; D, the same, internal view; E, the same, external view; F, distal end of femur, anterior view; G, the same, lateral view. Original type figures. (After Cope.)

SUBSEQUENT REFERENCES.—TOULA, J., AND KAIL, J. A., 1885, 'Über einen Krokodil-Schädel aus den Tertiärablagerungen von Eggenburg in Niederösterreich,' Denkschr. k. Akad. Wissensch. Wien, p. 354. LAMBE, L. M., 1899, 'On Reptilian Remains from the Cretaceous of North-Western Canada,' Ottawa Nat., XIII, p. 69. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 514. HATCHER, J. B., 1905, 'Vertebrata' (Judith River Beds), Bull. U. S. Geol. Surv., No. 257, p. 82. LAMBE, L. M., 1907, 'On a New Crocodilian Genus and Species from the Judith River Formation of Alberta,' Trans. Roy. Soc. Canada, Ser. 3, I, pp. 219, 220. GILMORE, C. W., 1911, 'A New Fossil Alligator from the Hell Creek Beds of Montana,' Proc. U. S. Nat. Mus., XLI, p. 298 (Pub. No. 1860), (*Brachychampsa perrugosa*).

ORIGINAL TYPE FIGURES.—COPE, E. D., 1875, 'The Vertebrata of the Cretaceous Formations of the West,' Rept. U. S. Geol. Surv. Terr., F. V. Hayden in Charge, II, Pl. VI, figs. 5–8.

TYPE.—Numerous fragments, with vertebræ and portions of the skull.

TYPE LOCALITY AND LEVEL.—Eastern Colorado, upper Cretaceous, probably Laramie beds.

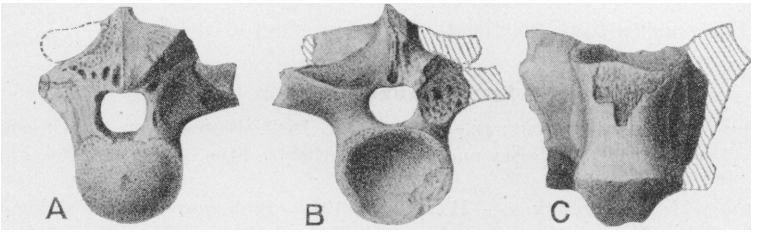

Fig. 12. *Bottosaurus perrugosus* Cope. Type specimen, posterior dorsal vertebra.

One-half natural size. A, posterior view; B, anterior view; C, inferior view. Original type figures. (After Cope.)

ORIGINAL TYPE DESCRIPTION.—"A portion of the left dentary bone containing alveoli for ten teeth shows that this species is not a gavial. The dental series passes in a curve from the inner to the outer sides of the bones, one or two alveoli behind being probably bounded on the inner side by the splenial only, as in *B. macrorhynchus*, when that bone is in place. The dentary is compressed at this point; in front it is depressed. There is a slight difference in the sizes of the alveoli, but not such as is usual in Tertiary crocodiles. The external face of the bone exhibits deep pits in longitudinal lines. The angle of the mandible is depressed; the cotylus of articulation is partially concealed on the outer side of the elevation of the surangular, whose upper border is parallel with the inferior margin of the ramus for two inches to where it is broken off. The outer face of this region marked by irregular coarse ridges more or less inosculating, separated by deep pits. The lower posterior half of the angular bone is smooth.

A posterior dorsal or lumbar vertebra has a depressed cordate articular cup. The zygapophyses are large and widely spread and strengthened by obtuse ridges running from the base of the neural spine to the posterior margin of the anterior and the posterior outer angle of the posterior. One pit at basis of neural spine in front; two before. Ball prominent; sides of centrum concave.

Measurements.

	M.
Length of fragment of ramus	.100
Width in front	.034
Depth behind	.032
Length of eight alveoli	.069
Diameter of largest alveolus	.012
Diameter of smallest	.007
Width of base of angle of ramus	.048
Depth at surangular	.034
Length of centrum of vertebra	.045
Width of articular cup	.031
Vertical diameter of cup	.025
Vertical diameter of neural arch	.011
Expanse of anterior zygapophyses	.056

The specimen is adult, and indicates an animal about the size of the alligator of the Southern States. Its reference to the present genus is provisional only."

The species may provisionally be considered valid.

Sphenosaurus Agassiz

Original Type Reference.—Agassiz, L., 1849, [Remarks on the Crocodiles of the Greensand of New Jersey and on Atlantochelys], Proc. Acad. Nat. Sci. Phila., IV, p. 169.

Subsequent References.—Hay, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 515.

Type.—*Crocodilus* (*Gavialis*) *clavirostris* Morton.

Original Type Description.—"Professor Agassiz made some observations upon the *Crocodilus clavirostris* of Morton, and characterized it as a distinct genus under the proposed name of *Sphenosaurus.*" (Minutes of meeting of the Academy of Natural Sciences of Philadelphia for March 13, 1849.)

The genus may provisionally be considered synonymous with *Bottosaurus* Agassiz.

Sphenosaurus clavirostris (Morton)

Original Type Reference.—Morton, S. G., 1844, 'Description of the Head of a Fossil Crocodile from the Cretaceous Strata of New Jersey,' Proc. Acad. Nat. Sci. Phila., II, pp. 82–85, ((*Crocodilus* (*Gavialis*) *clavirostris*)).

Subsequent References.—Morton, S. G., 1845, 'Description of the Head of a Fossil Crocodile from the Cretaceous Strata of New Jersey,' Amer. Journ. Sci. and Arts, Ser. 2, XLVIII, pp. 265–267, ((*Crocodilus* (*Gavialis*?) *clavirostris*. Almost identical with the above)). Giebel, C. G., 1847, 'Fauna der Vorwelt,' I, p. 122, (*Cr. clavirostris*). Agassiz, L., 1849, [Remarks on the Crocodiles of the Greensand of New Jersey and on *Atlantochelys*], Proc. Acad. Nat. Sci. Phila., IV, p. 169. Gibbes, R. W., 1851, 'A Memoir on *Mosasaurus* and the three Allied New Genera, *Holcodus*, *Conosaurus*, and *Amphorosteus*,' Smith. Contrib. Knowl., II, p. 11. Toula, F., and Kail, J. A., 1885, 'Über einen Krokodil-Schädel aus den Tertiärablagerungen von

Eggenburg in Niederösterreich,' Denkschr. k. Akad. Wissensch. Wien, p. 354. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 515.

ORIGINAL TYPE FIGURE.—MORTON, S. G., 1844, 'Description of the Head of a Fossil Crocodile from the Cretaceous Strata of New Jersey,' Proc. Acad. Nat. Sci. Phila., II, p. 83.

TYPE.—Skull.

TYPE LOCALITY AND LEVEL.—"This remarkably large and admirably preserved relic was found in the cretaceous limestone which overlies the ferruginous marl near Vincentown, in New Jersey."

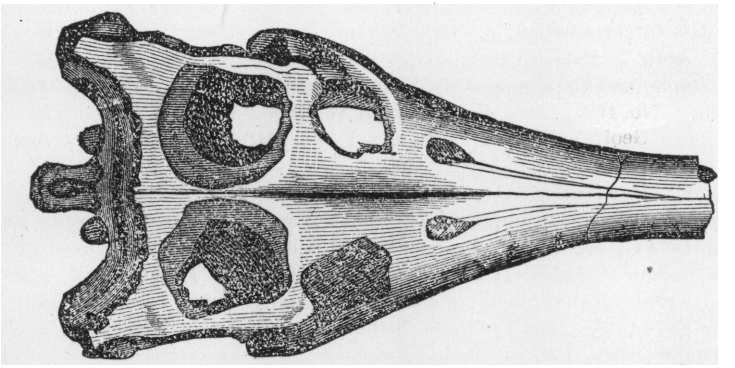

Fig. 13. *Sphenosaurus clavirostris* Morton. Type specimen, skull. Between one-seventh and one-eighth natural size. Superior view. Original type figure. (After Morton.)

ORIGINAL TYPE DESCRIPTION.—"Skull very broad posteriorly, whence it tapers in a gradual and triangular manner to a narrow, elongated snout. Orbits very large, oblique, and with but slight marginal elevation. Temporal fossæ of great size, and the spiracles? placed immediately below and before the inner margin of the orbit. Length of the head from the superior margin of the occiput to the broken end of the snout 23 inches: width of the occiput behind, 12½ inches; lateral diameter of orbit 3½ inches; lateral diameter of temporal fossæ 4½ inches. Remaining teeth 13 on each side. Lateral diameter of terminal end of the snout 3¼ inches.

This species is wholly unlike any other, fossil or recent, with which I have been able to compare it. It seems to form an intermediate link between the Gavials and true Crocodiles, for the snout, though long and narrow, is gradually and not abruptly produced from the head, and has probably been from eight to twelve inches longer than it now is."

Provisionally considered synonymous with *Thoracosaurus neocesariensis* De Kay.

HYPOSAURUS Owen

ORIGINAL TYPE REFERENCE.—OWEN, R., 1849, 'Notes on Remains of Fossil Reptiles discovered by Prof. Henry Rogers of Pennsylvania, U. S., in Greensand Formations of New Jersey,' Quart. Journ. Geol. Soc. London, V, p. 383.

SUBSEQUENT REFERENCES.—GIBBES, R. W., 1851, 'A Memoir on *Mosasaurus*, and the three Allied New Genera, *Holcodus*, *Conosaurus*, and *Amphorosteus*,' Smith. Contrib. Knowl., II, Art. 5, p. 13. COPE, E. D., 1866, 'On the Structure and Distribution of Arciferous Anura,' Journ. Acad. Nat. Sci. Phila., Ser. 2, IV, p. 111; 1869, 'Synopsis of the Extinct Batrachia and Reptilia of North America,' Trans. Amer. Phil. Soc., N.S., XIV, Part 1, Art. 1, p. 80; 1875, 'On Green-Sand Vertebrata,' Proc. Acad. Nat. Sci. Phila., XXVII, p. 19. MARSH, O. C., 1877, 'Introduction and Succession of Vertebrate Life in America,' Amer. Journ. Sci. and Arts., Ser. 3, XIV, Art. 42, p. 347. LYDEKKER, R., 1888, 'Catalogue of the Fossil Reptilia and Amphibia in the British Museum,' Part 1, p. 90. NICHOLSON, H. A., AND LYDEKKER, R., 1889, 'A Manual of Palæontology for the Use of Students with a General Introduction on the Principles of Palæontology,' p. 1190. ZITTEL, K. VON, 1890, 'Handbuch der Palæontologie,' Abth. 1, Palæozoologie, III, Vertebrata, pp. 672, 676. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 516. WILLISTON, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV, pp. 1–7. BERRY, E. W., 1916, 'Vertebrata,' Maryland Geol. Surv., Upper Cretaceous, p. 349.

TYPE.—*Hyposaurus rogersii* Owen.

ORIGINAL TYPE DESCRIPTION.—"The degree of concavity of the two articular extremities of the centrum corresponds with that in the *Teleosauroids*, to which family of amphicœlian *Crocodilia* these vertebræ are referable. They indicate, however, a particular genus in that family, of which, from their stratum, it would seem to be the latest representative; and I propose the name *Hyposaurus* for this *genus*, in reference to the characteristic process—the hypapophysis, and suggest that the species, when its characters are more fully worked out, should be called after the distinguished and amiable geologist to whom we are indebted for our knowledge of the existence of such a Teleosauroid in the cretaceous æra."

The genus may provisionally be considered as synonymous with *Goniopholis* Owen.

Hyposaurus rogersii Owen

ORIGINAL TYPE REFERENCE.—OWEN, R., 1849, 'Notes on Remains of Fossil Reptiles discovered by Prof. Henry Rogers of Pennsylvania, U. S., in Greensand Formations of New Jersey,' Quart. Journ. Geol. Soc. London, V, p. 383, Pl. XI, figs. 7–10.

SUBSEQUENT REFERENCES.—GIBBES, R. W., 1851, 'A Memoir on *Mosasaurus* and the three Allied New Genera, *Holcodus*, *Conosaurus*, and *Amphorosteus*,' Smith. Contrib. Knowl., II, Art. 5, p. 9, Pl. III, figs. 6, 7, 8, 13, (*Holcodus acutidens*). LEIDY, J., 1865, 'Cretaceous Reptiles of the United States,' Smith. Contrib. Knowl., XIV, pp. 18–21, 116, Pl. III, figs. 4, 16–21; Pl. IV, figs. 1–12; 1872 (date on title-page), 'Brief Review of a Memoir on the Cretaceous Reptiles of the United States, Published in the Fourteenth Volume of the Smithsonian Contributions to Knowledge,' Ann. Rept. Board of Regents Smith. Inst. for 1864 (1865 according to Hay). COPE, E. D., 1867, 'The Fossil Reptiles of New Jersey,' Amer. Nat., I, p. 26, (*Hyposaurus Rodgersi*); 1869, 'Synopsis of the Extinct Reptilia found in the Mesozoic and Tertiary Strata of New Jersey,' in 'Geology of New Jersey,' by G. H. Cook, Appendix B, Rept. Geol. Surv. New Jersey, p. 736, (*Hyposaurus Rogersi*); 1869, 'Synopsis of the Extinct

Batrachia, Reptilia and Aves of North America,' Trans. Amer. Phil. Soc., N.S., XIV, pp. 80–82, Pl. IV, figs. 10, 11; 1875, 'The Vertebrata of the Cretaceous Formations of the West,' Rept. U. S. Geol. Surv. Terr., F. V. Hayden in Charge, II, p. 250. WILLISTON, S. W., 1894, 'On Various Vertebrate Remains from the Lowermost

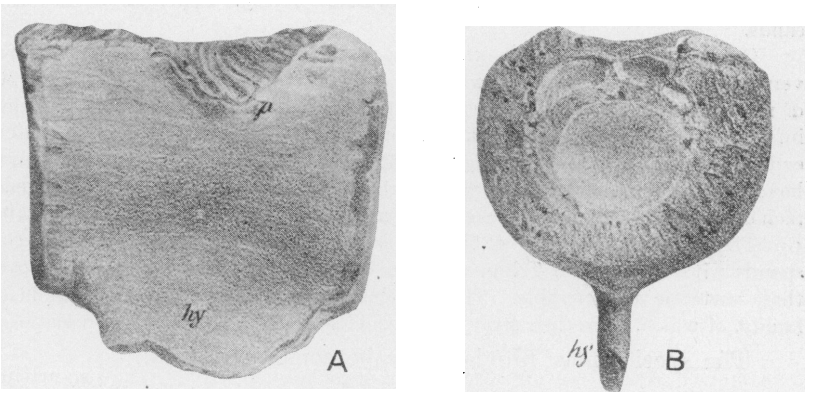

Fig. 14. *Hyposaurus rogersii* Owen. Type specimen, anterior dorsal centrum.
Natural size. A, lateral view, right side; B, inferior view; *hy*, base of hypapophysis; *p*, base of parapophysis. Original type figures. (After Owen.)

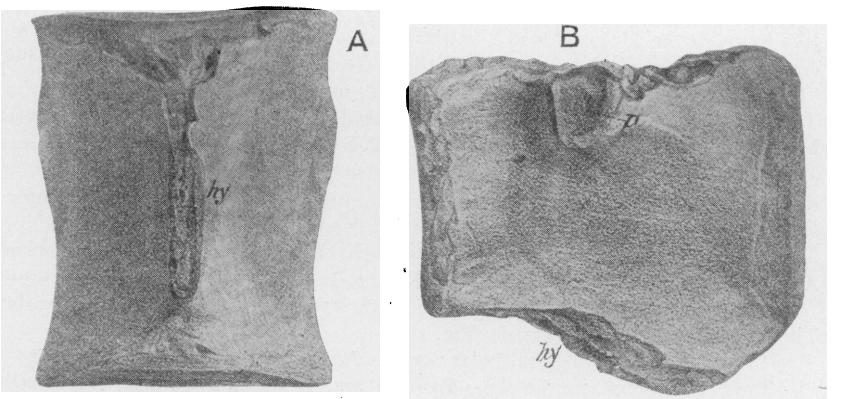

Fig. 15. *Hyposaurus rogersii* Owen. Type specimen, anterior dorsal centrum.
Natural size. A, lateral view, right side; B, posterior view; *hy*, base of hypapophysis; *p*, base of parapophysis. Original type figures. (After Owen.)

Cretaceous of Kansas,' Kans. Univ. Quart., III, p. 4, Pl. I, figs. 4, 5, (*Hyposaurus rodgersi*); 1898, 'Crocodiles,' Kans. Univ. Quart., IV, Part 1, pp. 76–78, figs. 3, 4. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 516. WILLISTON, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV, p. 4. BERRY, E. W., 1916, 'Vertebrata,' Maryland Geol. Surv., Upper Cretaceous, p. 349, Pl. VIII, figs. 3, 4.

ORIGINAL TYPE FIGURES.—OWEN, R., 1849, 'Notes on Remains of Fossil Reptiles discovered by Prof. Henry Rogers of Pennsylvania, U. S., in Greensand Formations of New Jersey,' Quart. Journ. Geol. Soc. London, V, Pl. XI, figs. 7–10.

TYPE.—Two anterior dorsal vertebral centra.

TYPE LOCALITY AND LEVEL.—Southern New Jersey. Upper Cretaceous Greensands.

ORIGINAL TYPE DESCRIPTION.—"The peculiar and distinctive character of these vertebræ is shown in the large size, and especially in great antero-posterior extent of the hypapophysis. Its base occupies the whole extent of the median line of the inferior surface between the prominent borders of the anterior and posterior articular ends of the centrum; and the length of this large lamelliform hypapophysis seems to have been considerable, since, in the vertebra, figs, 8, 10, in which upwards of half an inch of its base is retained, there is little diminution of thickness at the fractured base.

The degree of concavity of the two articular extremities of the centrum corresponds with that in the *Teleosauroids*, to which family of amphicælian *Crocodilia* these vertebræ are referable. They indicate, however, a particular genus in that family, of which, from their stratum, it would seem to be the latest representative."

The species may provisionally be considered valid.

Hyposaurus fraterculus Cope

ORIGINAL TYPE REFERENCE.—COPE, E. D., 1869, 'Synopsis of the Extinct Batrachia and Reptilia of North America,' Trans. Amer. Phil. Soc., XIV, N.S., Part 1, p. 82.

SUBSEQUENT REFERENCES.—COPE, E. D., 1869, 'Synopsis of the Extinct Reptilia found in the Mesozoic and Tertiary Strata of New Jersey,' in 'Geology of New Jersey,' by G. H. Cook, Appendix B, Rept. Geol. Surv. New Jersey, p. 736; 1875, 'The Vertebrata of the Cretaceous Formations of the West,' Rept. U. S. Geol. Surv. Terr., F. V. Hayden in Charge, II, p. 254, (*Gavialis fraterculus*); 1875, 'On Greensand Vertebrata,' Proc. Acad. Nat. Sci., Phila., XXVII, p. 19. TOULA, F., AND KAIL, J. A., 1885, 'Über einen Krokodil-Schädel aus den Tertiärablagerungen von Eggenburg in Niederösterreich,' Denkschr. k. Akad. Wissensch. Wien, p. 354, (*Gavialis fraterculus*). HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 515. WILLISTON, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV, p. 1.

ORIGINAL TYPE FIGURE.—No figure of the type has previously been published. The type is figured in this article (Fig. 16).

TYPE.—Portion of a mandibular ramus. Amer. Mus. Cope Coll. No. 2198.

TYPE LOCALITY AND LEVEL.—Birmingham, Burlington County, New Jersey. Middle Greensand beds, Cretaceous.

ORIGINAL TYPE DESCRIPTION.—"This small species seems to be clearly indicated by a portion of the ramus mandibuli containing three and half a fourth alveoli, and two perfect teeth. These parts are less than half the size of those of the smaller individual of H. rogersi, whose maxillary bone and teeth are described in the preceding article. The crowns of the teeth are shorter and more compressed than those in the corresponding part of the jaws in H. rogersi; they are marked with a coarse obtuse fluting to near the tip, with a finely striate enamel as in Holops glyptodon; in those of H. rogersi, the enamel is smooth and ridged by fine keels, which do not extend more than half the length of the crown.

That the animal of which I describe this fragment was not the young of the larger Hyposaurus, is, I think, indicated by the deep grooving and strong ridging of the dense layer of bone of the ramus; by the minute pulp cavity of the crowns of the teeth, and by the well developed successional tooth in the fang of one of the latter, whose apex has nearly reached the alveolar margin. That the individual is not fully grown is probable, but that it is of smaller species than the H. rogersi, there appears to be little room for doubt.

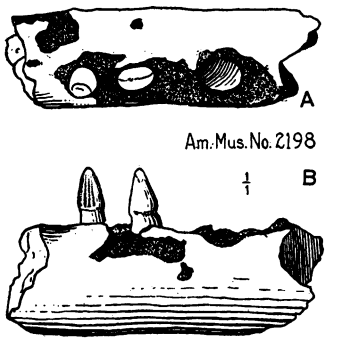

Fig. 16. *Hyposaurus fraterculus* Cope. Type specimen, part of mandibular ramus (Amer. Mus. Cope Coll. No. 2198).
Natural size. A, superior view; B, external view.

The ramus is scarcely flattened below, as is the case with most gavials, and the depth at the symphysis is equal the width of each ramus. Sculpture in deep longitudinal grooves slightly inosculating. Teeth directed very little outwards: their fangs and crowns are considerably compressed; the antero-posterior cutting edge is stronger than the ridges, and does not diminish to the base of the crown. Viewed from within the form is symmetrical and straight; from behind the crown is greatly incurved. The outline of the crown from within is an isosceles triangle, the width, more than .66 the height. Ribs on the inner face, seven, on the outer, eight. A few teeth in the jaws of H. rogersi are as short and broad as those here described, but they are not found in the middle of the series as in this species, but probably belong in the posterior alveoli, as occurs in some alligators.

	Lines.
Length of fragment,	19.3
Width at middle,	6.
No. of alveolæ in an inch; three and half and interspace.	
Length tooth above alveolus,	4.
" crown of tooth,	2.75
Width " " " at base,	1.75"

The species may provisionally be considered valid.

Hyposaurus ferox Marsh

ORIGINAL TYPE REFERENCE.—MARSH, O. C., 1871, [Communication on some new Reptiles and Fishes from the Cretaceous and Tertiary], Proc. Acad. Nat. Sci., Phila., XXIII, p. 104.

SUBSEQUENT REFERENCES.—HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 516. WILLISTON, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV, p. 4.

ORIGINAL TYPE FIGURE.—No figure of the type has been published.

TYPE.—Two teeth, Yale Mus.

TYPE LOCALITY AND LEVEL.—Birmingham, New Jersey. Middle marl bed of the Cretaceous Greensands.

ORIGINAL TYPE DESCRIPTION.—"Professor Marsh, of Yale College, made a communication on some new reptiles and fishes from the Cretaceous and Tertiary formations. . . Another new Cretaceous reptile was indicated by two teeth, which were found together in the middle marl bed at Birmingham, New Jersey. They apparently belonged to a Crocodilian, probably allied to *Hyposaurus*. One of the teeth, apparently from the anterior part of the jaw, is long, pointed, nearly round, and covered with strong angular but smooth ridges, except just at the apex, where they disappear. The posterior cutting edge is sharp and prominent, and extends the entire length of the crown. The anterior edge is only distinct a short distance near the apex. The second tooth has the crown short and compressed, with irregular ridges, and resembles somewhat the posterior teeth of *Hyposaurus*. These specimens indicate a species considerably larger than *H. Rogersii*, which, until its generic characters are more fully determined, may be called *Hyposaurus ferox*." (Records of meeting of the Academy of Natural Sciences of Philadelphia).

The species may provisionally be considered valid.

THORACOSAURUS Leidy

ORIGINAL TYPE REFERENCE.—LEIDY, J., 1852, [Descriptions of *Delphinus conradi* and *Thoracosaurus grandis*], Proc. Acad. Nat. Sci. Phila., VI, p. 35.

SUBSEQUENT REFERENCES.—LEIDY, J., 1865, 'Cretaceous Reptiles of the United States,' Smith. Contrib. Knowl., XIV, p. 5. COPE, E. D., 1869, 'Synopsis of the Extinct Batrachia and Reptilia of North America,' Trans. Amer. Phil. Soc., N.S., XIV, Part 1, Art. 1, p. 79. MARSH, O. C., 1877, 'Introduction and Succession of Vertebrate Life in America,' Amer. Journ. Sci. and Arts, Ser. 3, XIV, Art. 42, p. 346. TOULA, F., AND KAIL, J. A., 1885, 'Über einen Krokodil-Schädel aus den Tertiärablagerungen von Eggenburg in Niederösterreich,' Denkschr. k. Akad. Wissensch. Wien, p. 354. LYDEKKER, R., 1886, 'Siwalik Crocodilia, Lacertilia, and Ophidia,' Mem. Geol. Surv. India, Palæontologia Indica, Ser. 10, III, Part 7, pp. 3 (211), 12 (220), 27 (235). LUCAS, F. A., 1898, 'Contributions to Paleontology. 1. A New Crocodile from the Trias of Southern Utah,' Amer. Journ. Sci., Ser. 4, VI, p. 399. COPE, E. D., 1900, 'The Crocodilians, Lizards and Snakes of North America,' Rept. U. S. Nat. Mus. for 1898, p. 161. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 515. ANDREWS, C. W., 1906, 'A Descriptive Catalogue of the Tertiary Vertebrata of the Fayûm, Egypt,' p. 269, Brit. Mus. WILLISTON, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV, pp. 2, 17; 1914, 'Water Reptiles of the Past and Present,' p. 207. SELLARDS, E. H., 1915, 'A New Gavial from the Late Tertiary of Florida,' Amer. Journ. Sci., Ser. 4, XL, p. 137. BERRY, E. W., 1916, 'Vertebrata,' Maryland Geol. Surv., Upper Cretaceous, pp. 347, 348, Pl. VIII, fig. 11.

TYPE.—*Thoracosaurus grandis* Leidy = *Gavialis neocesariensis* De Kay.

ORIGINAL TYPE DESCRIPTION.—The characters of the genus were not separated from those of the type species by Leidy. See *Thoracosaurus grandis*.

The genus may provisionally be considered valid.

Thoracosaurus neocesariensis (De Kay)

ORIGINAL TYPE REFERENCES.—DE KAY, J. E., 1833 (according to Hay), 'Observations on a Fossil Jaw of a Species of Gavial, from West Jersey,' Ann. Lyc. Nat.

Hist. N. Y., III, 1827–1833, pp. 156–165, Pl. III, figs. 7–11, ("Gavial," with no specific designation). DE KAY, J. E., 1842, 'Zoology of New York,' Part 3, Reptiles and Amphibia, p. 28, Pl. XXII, fig. 59, (*Gavialis neocesariensis*).

SUBSEQUENT REFERENCES.—MORTON, S. G., 1844, 'Description of the Head of a Fossil Crocodile from the Cretaceous Strata of New Jersey,' Proc. Acad. Nat. Sci. Phila., II, pp. 82–85, 1 fig, ((*Crocodilus* (*Gavialis*?) *clavirostris*. This is described as a new species. Hay treats it as a synonym of *T. neocesariensis*)). MORTON, S. G., 1845, 'Description of the Head of a Fossil Crocodile from the Cretaceous Strata of New Jersey,' Amer. Journ. Sci. and Arts, XLVIII, pp. 265–267, 1 fig, (identical, with the exception of the spelling of a word, with the preceding). GIEBEL, C. G., 1847, 'Fauna der Vorwelt,' p. 122, (*Crocodilus clavirostris*, referring to Morton's species). AGASSIZ, L., 1849, [Remarks on the Crocodiles of the Greensand of New Jersey and on *Atlantochelys*], Proc. Acad. Nat. Sci. Phila., IV, p. 169, (*Sphenosaurus clavirostris* for Morton's *Crocodilus clavirostris*). OWEN, R., 1849, 'Notes on Remains of Fossil Reptiles Discovered by Prof. Henry Rogers of Pennsylvania, U. S., in Greensand Formations of New Jersey,' Quart. Journ. Geol. Soc. London, V, p. 381, Pl. X, figs. 1, 2, (*Crocodilus basifissus* considered by Hay equivalent to *T. neocesariensis*). GIBBES, R. W., 1851, 'Memoir on Mosasaurus and the three Allied New Genera, *Holcodus*, *Conosaurus*, and *Amphorosteus*,' Smith. Contrib. Knowl., II, pp. 7, 13, (*Sphenosaurus clavirostris* and *Crocodilus basifissus*). LEIDY, J., 1852, [Descriptions of *Delphinus conradi* and *Thoracosaurus grandis*], Proc. Acad. Nat. Sci. Phila., VI, p. 35, (*Thoracosaurus grandis* treated by Hay as a synonym of *T. neocesariensis*); 1852, 'Description of a new Species of Crocodile from the Miocene of Virginia,' Journ. Acad. Nat. Sci. Phila., Second Series, II, pp. 135, 136, (*Crocodilus Dekayi* proposed for *T. neocesariensis* De Kay. *Sphenosaurus clavirostris*). OWEN, R., 1860, 'On the Orders of Fossil and Recent Reptilia, and their Distribution in Time,' Rept. Brit. Assoc. Adv. Sci. for 1859, p. 165, (*Crocodilus basifissus*). LEIDY, J., 1865, 'Cretaceous Reptiles of the United States,' Smith. Contrib. Knowl., XIV, Art. 6, pp. 5–12, 115, Pl. I, figs. 1–6; Pl. II, figs. 1–3; Pl. III, figs. 5–11; 1865, 'Brief Review of a Memoir on the Cretaceous Reptiles of the United States, published in the Fourteenth Volume of the Smithsonian Contributions to Knowledge,' Ann. Rept. Board of Regents Smith. Inst. for 1864, p. 67. COPE, E. D., 1867, 'The Fossil Reptiles of New Jersey,' Amer. Nat., I, p. 26. (*T. neocæsariensis*); 1869, 'Synopsis of the Extinct Reptilia found in the Mesozoic and Tertiary Strata of New Jersey,' in 'Geology of New Jersey,' by G. H. Cook, Appendix B, Rept. Geol. Surv. New Jersey, p. 736, (*T. neocæsariensis*); 1869, 'Synopsis of the Extinct Batrachia and Reptilia of North America,' Trans. Amer. Phil. Soc., N.S., XIV, Part 1, pp. 68, 79, 80, (*T. neocæsariensis*); 1875, 'The Vertebrata of the Cretaceous Formations of the West,' Rept. U. S. Geol. Surv. Terr., F. V. Hayden in Charge, II, p. 250, (*T. neocæsariensis*); TOULA, F., AND KAIL, J. A., 1885, 'Über einen Krokodil-Schädel aus den Tertiärablagerungen von Eggenburg in Niederösterreich,' Denkschr. k. Akad. Wissensch. Wien, p. 354. KOKEN, E., 1888, 'Thoracosaurus macrorhynchus Bl. aus der Tuffkreide von Maastricht,' Zeitschr. d. Deutsch. Geol. Gesellsch. (Jahrg. 1888), pp. 754–773, (*T. neocæsariensis*). WOODWARD, A. SMITH, 1890, 'Vertebrate Palæontology in some American and Canadian Museums,' Geol. Mag., N.S., Dec. 3, VII, p. 393, (*T. neocæsariensis*). ZITTEL, K. VON, 1890, 'Handbuch der Palæontologie,' Abth. 1, Palæozoologie, III, Vertebrata, p. 673. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 515. WILLISTON, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ.

Geol., XIV, p. 2. ANDREWS, C. W., 1906, 'A Descriptive Catalogue of the Tertiary Vertebrata of the Fayûm, Egypt,' p. 269, Brit. Mus. BERRY, E. W., 1916, 'Vertebrata,' Maryland Geol. Surv., Upper Cretaceous, pp. 347, 348, Pl. VIII, figs. 1, 2.

ORIGINAL TYPE FIGURES.—DE KAY., J. E., 1833 (according to Hay), 'Observations on a Fossil Jaw of a Species of Gavial, from West Jersey,' Ann. Lyc. Nat. Hist., N. Y., III, 1827–1836, pp. 156–165, Pl. III, figs. 7–10.

TYPE.—Fragments of the jaw.

TYPE LOCALITY AND LEVEL.—Southern part of New Jersey. Upper Cretaceous Greensands.

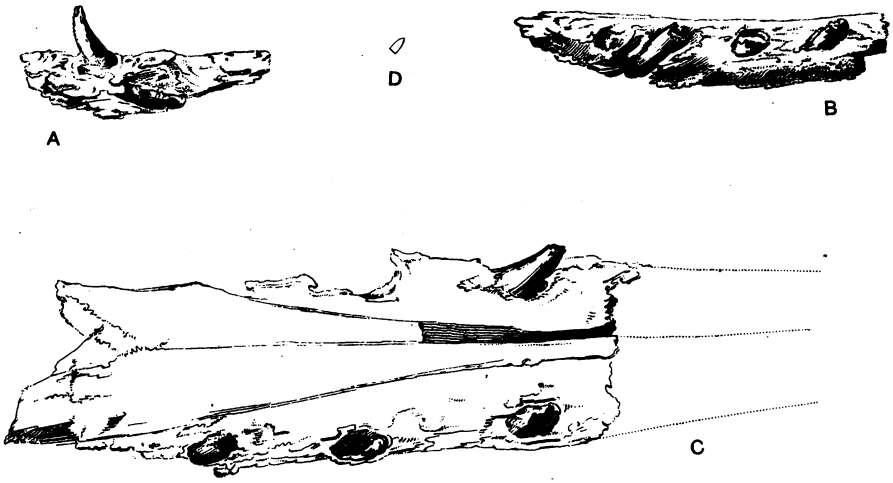

Fig. 17. *Thoracosaurus neocesariensis* De Kay. Type specimen, jaw fragments.

About one-third natural size. A, portion of left dentary, oblique view; B, portion of right dentary, oblique view; C, portions of dentary and splenial bones, superior view; D, immature tooth. Original type figures. (After De Kay.)

ORIGINAL TYPE DESCRIPTION.—"*Dimensions of Fragment, . . of left Dental Bone.*
Length 4.1 Extreme breadth 1.5 nearly.
Distance between sockets .8.
Depth of sockets 1.5.
Projection of tooth above the alveole 1.1.
Transverse diam. of tooth above the socket .5.
Longitud. diam. .6.
Diameter within the socket .65.

In order to understand the structure and arrangement of these teeth, it may be necessary to recur to the process of dentition, as it exists among these animals. Their number never varies with age; and although they are formed by superimposed coats, yet their interior is always hollow. At the bottom of the socket is to be found the replacing tooth, which gradually increasing, ascends into the hollow of the old tooth, presses upon, and of course destroys, the pulpy nucleus within, which has furnished nutriment to the old tooth. This latter tooth, of course, easily falls out, is replaced by the new one, which, in its turn, makes way for another; and this is often

repeated during the whole life-time of the animal. Hence, at any period, if we examine the teeth of these animals we shall find always the replacing tooth either within the old one or in a rudimentary form, or at the bottom of the socket. Among the loose fragments, to which I regret being unable to assign its proper place, but which is near the bottom of a socket, is a small replacing tooth, .25 in length. It is of a conical form, and blunt at its summit. . . It is worthy of remark, that this tooth, instead of originating from the centre of the bottom of the socket, lies near the inferior and anterior side. Are we authorized to infer, that the individual species under examination belonged not to an adult animal, but to one which had not yet attained its full growth, and that the position of this replacing tooth indicates that the outer edge of the alveole would be advanced farther with the growth of the animal? According to Cuvier, the replacing tooth generally commences near the inner surface; and hence it is on this side, by its compression, that the old tooth frequently exhibits, near the upper edge of the alveole, a notch or indentation on its inner side, proving that absorption has taken place.

The sockets and parts of sockets are .8 apart on the superior surface of this dental bone, and approach nearer at their bases. The central socket contains the most perfect tooth in all the fragments. Fig. 7 [Fig. 17A of this work] represents its appearance, describing a segment of a circle whose diameter is four inches. The whole length of the tooth is 2.6. The direction of this curve is forward and outwardly; or, in other words, its lower extremity is near the internal plane of the dental bone, while the external portion of the tooth is not far from the outer edge of the same bone. Within the socket the tooth is cylindrical, and, as is common among animals of this class, it is larger than the exposed portion. It is hollow, and filled with the soil in which it was found. The upper part of the tooth is much injured, but enough remains to enable us to describe its general form, which is conical, recurved, and rather broader in the transverse axis of its base than in the longitudinal direction of the dental bone. A very minute portion is all that is left of its external coat; but from this we may state, that it is of a brown colour, very minutely striated, and, in a proper light, appears divided into a number of minute facets. We cannot, however, from this small fragment, aver that the same appearance pervades the whole crown of the tooth; nor can we pronounce with certainty that the teeth were furnished with edges.

. . . *right Dental Bone.*

This fragment, in fact, consists of portions of three bones; but in the figure, the right dental bone only is shown, in order to exhibit the figure and direction of the sockets. Its principal dimensions are as follows:—

Total length 5.7.
Breadth undetermined, on account of the imperfection of the fragment.
Depth at symphysis 2.1.
Depth, just anterior to the second tooth, 1.7.
Depth of socket behind, 1.6.
Depth of jaw at anterior portion 1.6.
Distance between first and second alveole .9.
between 2d and 3d .7.
between 3d and 4th .4.

Of the fourth, or posterior socket, only a portion remains.—The third is filled up with the body of a tooth, which is visible in its whole length, and exhibits its base

compressed in the direction of the vertical plane of the jaw. The second and first alveoles are likewise filled with the body of teeth, but are concealed in consequence of the perfect state of the bone in these places. At the anterior part of this bone is a portion of another socket, which cannot be exhibited in the figure. Connected with the dental bone are two others, which will be better understood when we connect these fragments in their original position. We shall then have fig. 10,—[Fig. 17C of this work] a large and important portion of the lower jaw of a fossil reptile.

In this figure *a* represents the fragments of the left, and *b* of the right dental bones already described, as seen from above.

At *c c* are seen portions of two bones which are peculiar to animals of this family, and were termed, by Adrian Camper, opercular bones: they form the symphysis of the lower jaw, and the dental bones repose against them, and go off posteriorly to form the branches of the lower maxillary.

The total length of the fragment of the opercular bone of the right side is 7.8.

From the symphysis to the anterior termination of the same bone is 6.2.

Breadth of both operculars, just before the symphysis, is 2.4.

Presumed breadth at symphysis 4.

Breadth of jaw, at outer extremity 2.7.

Thickness at same place 1.7.

The upper surface of the opercular bones is smooth, and its substance is very compact. The surface of the right dental bone is likewise tolerably even; but its side, and particularly its inferior surface, has the same corroded and worm-eaten appearance noticed in its companion on the left side.

We are now furnished with sufficient data to pronounce that the fragments under consideration are a portion of the lower jaw of some species of animal belonging to a family of reptiles which includes the crocodiles." (De Kay, 1833.)

(De Kay, 1842) "With from fifteen to eighteen distant, conical teeth. Length 9–10 feet."

The species may provisionally be considered valid.

Thoracosaurus (Crocodilus) basifissus (Owen)

ORIGINAL TYPE REFERENCE.—OWEN, R., 1849, 'Notes on Remains of Fossil Reptiles Discovered by Prof. Henry Rogers of Pennsylvania, U. S., in Greensand Formations of New Jersey,' Quart. Journ. Geol. Soc. London, V, pp. 380, 381, Pl. x, figs. 1, 2, (*Crocodilus basifissus*).

SUBSEQUENT REFERENCES.—LEIDY, J., 1852, 'Description of a new Species of Crocodile from the Miocene of Virginia,' Journ. Acad. Nat. Sci. Phila., II, Ser. 2, p. 135, (*Crocodilus basifissus*). OWEN, R., 1860, 'On the Orders of Fossil and Recent Reptilia, and their Distribution in Time,' Rept. Brit. Assoc. Adv. Sci., Meeting at Aberdeen, 1859, p. 165, (*Crocodilus basifissus*). TOULA, F., AND KAIL, J. A., 1885, 'Über einen Krokodil-Schädel aus den Tertiärablagerungen von Eggenburg in Niederösterreich,' Denkschr. k. Akad. Wissensch. Wien, p. 354, (*Alligator basifissus*). HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 515. WILLISTON, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV, p. 2, (*Crocodilus basifissus*).

ORIGINAL TYPE FIGURES.—OWEN, R., 1849, 'Notes on Remains of Fossil Reptiles Discovered by Prof. Henry Rogers of Pennsylvania, U. S., in Greensand

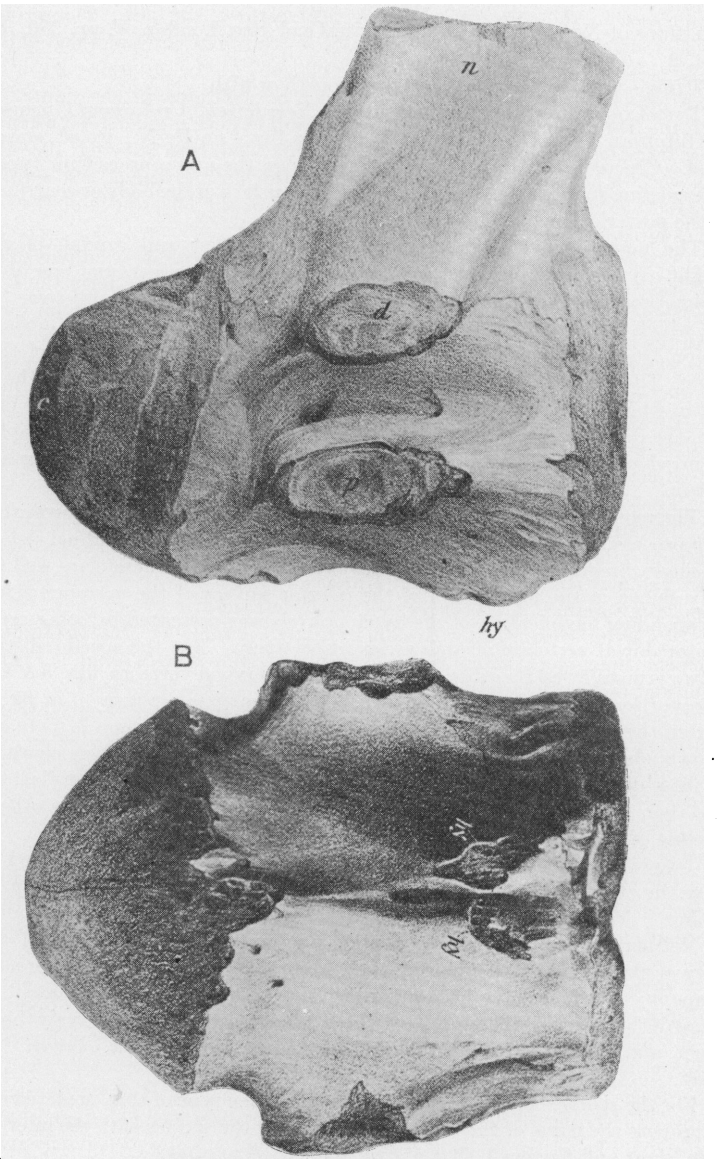

Fig. 18. *Thoracosaurus* (*Crocodilus*) *basifissus* (Owen). Type specimen, cervical vertebra.

Natural size. A, lateral view, right side; B, inferior view; *d*, diapophysis; *hy*, hypapophysis; *n*, neural arch; *p*, parapophysis. Original type figures. (After Owen.)

Formations of New Jersey,' Quart. Journ. Geol. Soc. London, V, pp. 380, 381, Pl. x, figs. 1, 2.

TYPE.—A middle cervical vertebra, fourth or fifth.

TYPE LOCALITY AND LEVEL.—Southern New Jersey. Cretaceous Greensand beds.

ORIGINAL TYPE DESCRIPTION.—"Figures 1 to 4, in Pl. X., are of cervical vertebræ of a Crocodile or Alligator, constructed upon the same (procælian) type as those of the existing species; *i.e.*, having the anterior surface of the body or centrum concave and the posterior one (*c*, figs. 1 & 3) convex.

The numerous vertebræ, cervical, dorsal, lumbar and caudal, of this type, brought over by Prof. Rogers, were divisible into two series; and one of the most characteristic specimens of each of these series is here selected to illustrate the difference, which shows that there were two species of the same genus as the modern Crocodiles or Alligators, which left their remains in the greensand deposits of the United States. The vertebra in question is one of the middle cervical, probably the fourth or fifth, in which the parapophysis (*p*) is still near the lower part of the side of the centrum, the diapophysis (*d*) wholly developed from the base of the neurapophysis (*n*), and in which also a hypapophysis (*hy*) is developed from the under surface of the centrum.

The most marked difference between the vertebræ figs. 1 & 3 is presented by the latter process: in fig. 1 it is double, or divided by a median longitudinal cleft; in fig. 2 it is single, broad, flattened and smooth below. These characters are well and accurately shown in the figs. 2 & 4 of the inferior surface of the vertebræ selected. A corresponding modification of the hypapophysis was presented by other cervical and anterior dorsal vertebræ of each series respectively. But the specific distinction of the two is manifested by other characters. The cervical vertebra, figs. 3 & 4, is longer in proportion to its breadth than figs. 1 & 2; the parapophysis, *p* in fig. 1, comes off from the middle of the side of the centrum: in fig. 3 its origin is more advanced, and extends to the border of the anterior articular cup. And these characters were not those distinguishing different positions of the vertebræ in the cervical series, any more than those of the hypapophyses, but were characteristic of the other cervical vertebræ of each series respectively.

Two species, therefore, of Crocodile or Alligator, were thus established, equalling in size the existing *Alligator lucius* of the Southern States, or the *Crocodilus acutus* of Jamaica.

Neither these, nor any other existing Crocodile of which I have had the opportunity of examining and comparing the vertebræ, presents the same characters of the hypapophyses which have been described and figured in the above fossil vertebræ. I regard the species, therefore, to which these vertebræ respectively belonged as extinct, and agreeably with actual knowledge, the oldest of the modern Crocodilian family.

For the species characterized by vertebræ of the type of that depicted in figs. 1 & 2, I propose the name of *Crocodilus basifissus;* for the species with the inferior process single, short and flattened, that of *Crocodilus basitruncatus*: . . . .

The proportions of the vertebræ of the *Crocodilus basifissus* resemble those of the vertebræ of the *Alligator*."

Leidy considered this form as possibly belonging to the species which he named *Crocodilus dekayi*, but which had already been named

Gavialis neocesariensis by De Kay. Hay considered it as synonymous with the latter. The characters noted by Owen, however, appear to be of specific value, and provisionally, at least, the species may be considered valid, and may be referred to *Thoracosaurus*.

Thoracosaurus grandis Leidy

ORIGINAL TYPE REFERENCE.—LEIDY, J., 1852, [Description of *Thoracosaurus grandis*], Proc. Acad. Nat. Sci. Phila., VI, p. 35.

SUBSEQUENT REFERENCES.—HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 515. WILLISTON, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV, p. 2.

ORIGINAL TYPE FIGURE.—No figure of the type has been published.

TYPE.—A dermal scute and half of another.

TYPE LOCALITY AND LEVEL.—Mount Holly, New Jersey, Cretaceous Greensands.

ORIGINAL TYPE DESCRIPTION.—"The other specimens consist of an entire dermal scale and the half of a second, from the Green Sand formation of Mount Holly, New Jersey. These belong to some Crocodilian reptile of large size. They are deeply sculptured, but possess no carina, as in the existing Crocodiles. Possibly they may belong to the Saurian, characterized from some vertebræ under the name of Cimoliasaurus magnus . . *Leidy*, but at present I prefer referring them to a new genus and species under the name of *Thoracosaurus grandis*.

Long diameter of the entire scale,.....3½ inches.
Short " .....3 "
Greatest thickness.....7 lines."

Provisionally referred to *T. neocesariensis* (De Kay), following Hay.

Thoracosaurus (Crocodilus) dekayi (Leidy)

ORIGINAL TYPE REFERENCE.—LEIDY, J., 1852, 'Description of a new Species of Crocodile from the Miocene of Virginia,' Journ. Acad. Nat. Sci. Phila., II, Ser. 2, p. 135, (*Crocodilus dekayi*).

SUBSEQUENT REFERENCES.—DE KAY, J. E., 1833, 'Observations on a Fossil Jaw of a Species of Gavial, from West Jersey,' Ann. Lyc. Nat. Hist., N. Y., III, pp. 156–165, Pl. III, figs. 7–10, ("Gavial"). TOULA, F., AND KAIL, J. A., 1885, 'Über einen Krokodil-Schädel aus den Tertiärablagerungen von Eggenburg in Niederösterreich,' Denkschr. k. Akad. Wissensch. Wien, p. 354, (*Crocodilus DeKayi*). HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 515, (*Thoracosaurus neocesariensis*).

ORIGINAL TYPE FIGURES.—DE KAY, J. E., 1833, 'Observations on a Fossil Jaw of a Species of Gavial, from West Jersey,' Ann. Lyc. Nat. Hist. N. Y., III, Pl. III, figs. 7–10.

TYPE.—Parts of a jaw. The type of *Thoracosaurus neocesariensis* (De Kay).

TYPE LOCALITY AND LEVEL.—Southern New Jersey, Cretaceous marls.

ORIGINAL TYPE DESCRIPTION.—"Dr. Dekay . . . has described several fragments of an inferior maxilla of a species of Gavial found in the Green-sand formation of the

southern part of New Jersey. It is undoubtedly different from the Crocodilus macrorhynchus, *Harlan*, and also the gavial-like Crocodilus clavirostris, *Morton*. It may probably belong to one of two species of Crocodilus, since characterised by Mr. Owen, . . of London, from several vertebræ found in the same formation, which of course can only be inferred from relations of size. In the present state of uncertainty whether these fragments of fossil jaw belong to an animal different from any before characterised, it will not be improper to apply to it the name Crocodilus Dekayi, in honor of Dr. Dekay, who has so well described the specimens, because a synonyme, should the species on further discovery prove not to be new, would produce much less inconvenience, than a want of a name at present for convenient reference."

Synonym of *Thoracosaurus neocesariensis* (De Kay), which was founded on the same type specimen.

PLIOGONODON Leidy

ORIGINAL TYPE REFERENCE.—LEIDY, J., 1856, 'Notices of Remains of Extinct Vertebrated Animals discovered by Professor E. Emmons,' Proc. Acad. Nat. Sci. Phila., VIII, p. 255; also 1857, Amer. Journ. Sci. and Arts, Ser. 2, XXIII, pp. 271, 272.

SUBSEQUENT REFERENCE.—HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 517.

TYPE.—*Pliogonodon priscus* Leidy.

ORIGINAL TYPE DESCRIPTION.—No distinction was made by Leidy between the characters of the genus and those of the type species. See *Pliogonodon priscus*.

The position of this genus is uncertain.

Pliogonodon priscus Leidy

ORIGINAL TYPE REFERENCE.—LEIDY, J., 1856, 'Notices of Remains of Extinct Vertebrated Animals discovered by Professor E. Emmons,' Proc. Acad. Nat. Sci. Phila., VIII, pp. 255, 256; also 1857, Amer. Journ. Sci. and Arts, Ser. 2, XXIII, pp. 271, 272.

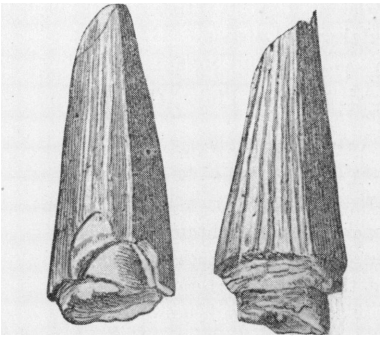

Fig. 19. *Pliogonodon priscus* Leidy. Type specimen, teeth. Natural size. Original type figures. (After Emmons.)

SUBSEQUENT REFERENCES.—EMMONS, E., 1858, 'Report of the North Carolina Geological Survey. Agriculture of the Eastern Counties; together with Descriptions of the Fossils of the Marl Beds,' North Carolina Geol. Surv., pp. 223, 224, figs. 43, 44, (*Pliogonodon nobilis*). LEIDY, J., 1865, 'Cretaceous Reptiles of the United States,' Smith. Contrib. Knowl., XIV, pp. 103, 119. COPE, E. D., 1875, 'Report of the Geological Survey of North Carolina Volume I, by W. C. Kerr,' Appendix B, p. 33, North Carolina Geol. Surv., I. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 517.

ORIGINAL TYPE FIGURES.—EMMONS, E., 1858, 'Report of the North Carolina Geological Survey. Agriculture of the Eastern Counties; together with Descriptions of the Fossils of the Marl Beds,' North Carolina Geol. Surv., figs. 43, 44.

TYPE.—Two mutilated teeth.

TYPE LOCALITY AND LEVEL.—Cape Fear, North Carolina. Miocene (?) Beds.

ORIGINAL TYPE DESCRIPTION.—"Teeth elongated conical, nearly straight or only slightly curved inwardly, in section circular, with a pair of opposed carinæ on the inner side; surfaces divided into numerous narrow planes, with a few vertical interrupted plicæ, which are more numerous on the inner side. Enamel finely wrinkled; and the dentine concentric. Base of crown hollowed. Probable length of crown when perfect 2 inches, breadth of base ¾ of an inch.

The teeth differ from those of *Mosasaurus* in their narrower proportion, straightness, circular section, and the plicæ of the enamel; from those of *Polyptychodon* in the possession of divisional planes and opposed carinæ; and from those of *Pleiosaurus* in the former character and the circular section."

No adequate determination can be made at the present time.

HOLOPS Cope

ORIGINAL TYPE REFERENCE.—COPE, E. D., 1869, [Remarks on *Holops brevispinus*, *Ornithotarsus immanis*, and *Macrosaurus proriger*], Proc. Acad. Nat. Sci. Phila., XXI, p. 123.

SUBSEQUENT REFERENCES.—COPE, E. D., 1869, 'Synopsis of the Extinct Batrachia and Reptilia of North America,' Trans. Amer. Phil. Soc., N.S., XIV, Part 1, Art. 1, pp. 26, 27, 28, 231. HUXLEY, T. H., 1875, 'On Stagonolepis robertsoni, and on the Evolution of the Crocodilia,' Quart. Journ. Geol. Soc. London, XXXI, pp. 423–438. MARSH, O. C., 1877, 'Introduction and Succession of Vertebrate Life in America,' Amer. Journ. Sci. and Arts, Ser. 3, XIV, Art. 42, p. 346. LYDEKKER, R., 1886, 'Siwalik Crocodilia, Lacertilia, and Ophidia,' Mem. Geol. Surv. India, Palæontologia Indica, Ser. 10, III, Part 7, pp. 3 (211), 12 (220), 17 (225), 27 (235). NICHOLSON, H. A., AND LYDEKKER, R., 1889, 'A Manual of Palæontology for the Use of Students with a General Introduction on the Principles of Palæontology,' p. 1193. ZITTEL, K. VON, 1890, 'Handbuch der Palæontologie,' Abth. 1, Palæozoologie, III, Vertebrata, p. 673. COPE, E. D., 1900, 'The Crocodilians, Lizards, and Snakes of North America,' Rept. U. S. Nat. Mus. for 1900, p. 162. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 515. WILLISTON, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV, pp. 2, 17; 1914, 'Water Reptiles of the Past and Present,' p. 207. SELLARDS, E. H., 1915, 'A New Gavial from the Late Tertiary of Florida,' Amer. Journ. Sci., Ser. 4, XL, p. 137.

TYPE.—*Thoracosaurus brevispinus* Cope.

ORIGINAL TYPE DESCRIPTION.—"Prof. Cope exhibited some specimens of extinct reptiles of interest. One of these was the cranium, minus a portion of the muzzle of a gavial, from the New Jersey Green Sand, previously described under the name of *Thoracosaurus brevispinus*, but which this specimen demonstrated to belong to another genus, since it did not present the lachrymal foramina of the former. He applied the name Holops to it, and stated that he had evidence that Crocodilus tenebrosus Leidy, and probably C. obscurus L., also belonged to it." (Minutes of meeting of the Academy of Natural Sciences of Philadelphia for June 1, 1869).

The genus may provisionally be considered valid.

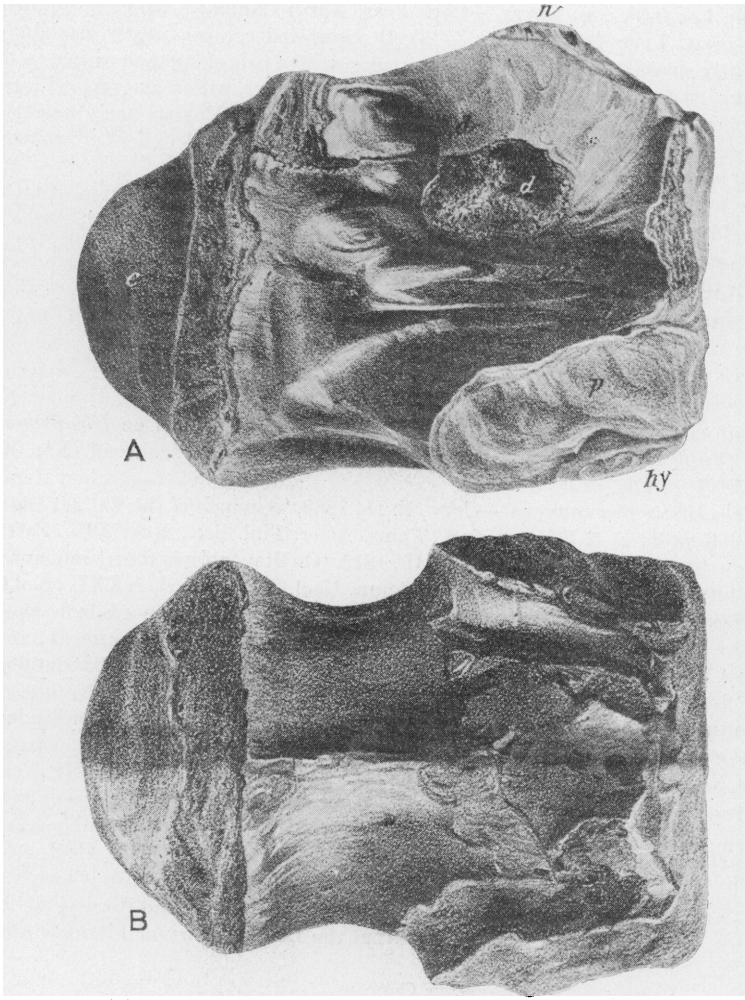

Fig. 20. *Holops basitruncatus* (Owen). Type specimen, fourth or fifth cervical vertebra.

Scale not indicated by Owen, and no measurements are given. Presumably the figures are natural size. A, lateral view, right side; B, inferior view; *c*, posterior ball of centrum; *d*, base of diapophysis; *hy*, base of hypapophysis; *n*, base of neural arch; *p*, base of parapophysis. Original type figures. (After Owen.)

Holops basitruncatus (Owen)

ORIGINAL TYPE REFERENCE.—OWEN, R., 1849, 'Notes on Remains of Fossil Reptiles discovered by Prof. Henry Rogers of Pennsylvania, U. S., in Greensand Formations of New Jersey,' Quart. Journ. Geol. Soc. London, V, p. 381, Pl. x, figs. 3, 4, (*Crocodilus basitruncatus*).

SUBSEQUENT REFERENCES.—GIBBES, R. W., 1852, 'A Memoir on *Mosasaurus* and the three Allied New Genera, *Holcodus*, *Conosaurus*, and *Amphorosteus*,' Smith. Contrib. Knowl., II, Art. 5, p. 13, (*Crocodilus basitruncatus*). LEIDY, J., 1852, 'Description of a new Species of Crocodile from the Miocene of Virginia,' Journ. Acad. Nat. Sci. Phila., VI, p. 135, (*Crocodilus basitruncatus*). OWEN, R., 1860, 'On the Orders of Fossil and Recent Reptilia, and their Distribution in Time,' Rept. Brit. Assoc. Adv. Sci. for 1859, p. 165, (*Crocodilus basitruncatus*). LEIDY, J., 1865, 'Cretaceous Reptiles of the United States,' Smith. Contrib. Knowl., XIV, pp. 14, 115, Pl. III, figs. 12–15, (*Crocodilus basitruncatus*, *C. tenebrosus*). COPE, E. D., 1869, 'Synopsis of the Extinct Reptilia found in the Mesozoic and Tertiary Strata of New Jersey,' in 'Geology of New Jersey,' by G. H. Cook, Appendix B, Rept. Geol. Surv. New Jersey, p. 736, (*T. tenebrosus*); 1869, [Remarks on *Holops brevispinus*, *Ornithotarsus immanis* and *Macrosaurus proriger*], Proc. Acad. Nat. Sci. Phila., XXI, p. 123, (*Crocodilus tenebrosus*); 1869, 1870, 'Synopsis of the Extinct Batrachia and Reptilia of North America,' Trans. Amer. Phil. Soc., N.S., XIV, pp. 67, 77–79, 231, fig. 19 (according to Hay), Pl. IV, figs. 8, 9 (according to Hay), 1869 (pp. 67, 77–79), 1870 (p. 231), (*Crocodilus basitruncatus* and *Holops tenebrosus*); 1875, 'The Vertebrata of the Cretaceous Formations of the West,' Rept. U. S. Geol. Surv. Terr., F. V. Hayden in Charge II, pp. 253. TOULA, F., AND KAIL, J. A., 1885, 'Über einen Krokodil-Schädel aus den Tertiärablagerungen von Eggenburg in Niederösterreich,' Denkschr. k. Akad. Wissensch. Wien, p. 354. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 515.

ORIGINAL TYPE FIGURES.—OWEN, R., 1849, 'Notes on Remains of Fossil Reptiles discovered by Prof. Henry Rogers of Pennsylvania, U. S., in Greensand Formations of New Jersey,' Quart. Journ. Geol. Soc. London, V, Pl. x, figs. 3, 4.

TYPE.—Cervical vertebra, fourth or fifth, selected by Owen from a large series.

TYPE LOCALITY AND LEVEL.—New Jersey, Upper Cretaceous Greensands.

ORIGINAL TYPE DESCRIPTION.—"The most marked difference between the vertebræ figs. 1 & 3 is presented by the latter process [hypapophysis]: in fig. 1 it is double, or divided by a median longitudinal cleft; in fig. 2 it is single, broad, flattened and smooth below. These characters are well and accurately shown in the figs. 2 & 4 of the inferior surface of the vertebræ selected. A corresponding modification of the hypapophysis was presented by other cervical and anterior dorsal vertebræ of each series respectively. But the specific distinction of the two is manifested by other characters. The cervical vertebra, figs. 3 & 4, is longer in proportion to its breadth than figs. 1 & 2: the parapophysis, *p* in fig. 1, comes off from the middle of the side of the centrum: in fig. 3 its origin is more advanced, and extends to the border of the anterior articular cup. And these characters were not those distinguishing different positions of the vertebræ in the same cervical series, any more than those of the hypapophyses, but were characteristic of the other cervical vertebræ of each series respectively.

Two species therefore, of Crocodile or Alligator, were thus established, equalling in size the existing *Alligator lucius* of the Southern States, or the *Crocodilus acutus* of Jamaica.

. . . . . .

For the species characterized by vertebræ of the type of that depicted in figs. 1 & 2, I propose the name of *Crocodilus basifissus;* for the species with the inferior process single, short and flattened, that of *Crocodilus basitruncatus.*"

The species may provisionally be considered valid.

Holops obscurus (Leidy)

ORIGINAL TYPE REFERENCE.—LEIDY, J., 1865, 'Cretaceous Reptiles of the United States,' Smith. Contrib. Knowl., XIV, pp. 15, 16, 115, Pl. II, figs. 4, 5, (*Crocodilus obscurus*).

SUBSEQUENT REFERENCES.—COPE, E. D., 1867, 'The Fossil Reptiles of New Jersey,' Amer. Nat., I, p. 26, (*Thoracosaurus obscurus*); 1869, 'Synopsis of the Extinct Reptilia found in the Mesozoic and Tertiary Strata of New Jersey,' in 'Geology of New Jersey,' by G. H. Cook, Appendix B, Rept. Geol. Surv. New Jersey, p. 736, (*Thoracosaurus obscurus*); 1869, [Remarks on *Holops brevispinus, Ornithotarsus immanis* and *Macrosaurus proriger*], Proc. Acad. Nat. Sci. Phila., XXI, p. 123, (*Crocodilus obscurus*); 1869, 1870, 'Synopsis of the Extinct Batrachia and Reptilia of North America,' Trans. Amer. Phil. Soc., N.S., XIV, Part 1, pp. 68, 75–78, 231, Pl. IV, figs. 1–3; 1875, 'The Vertebrata of the Cretaceous Formations of the West,' Rept. U. S. Geol. Surv. Terr., F. V. Hayden in Charge, II, p. 253. TOULA, F., AND KAIL, J. A., 1885, 'Über einen Krokodil-Schädel aus den Tertiärablagerungen von Eggenburg in Niederösterreich,' Denkschr. k. Akad. Wissensch. Wien, p. 354,

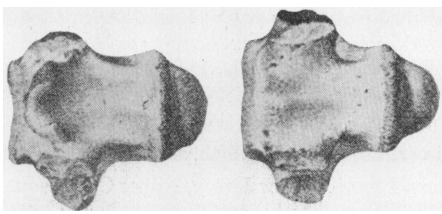

Fig. 21. *Holops obscurus* (Leidy). Cotype specimen, cervical vertebræ, probably fourth and fifth (Geol. Mus. Rutgers College Coll.).

One-half natural size, inferior views. Original type figures. (After Leidy.)

(*Crocodilus obscurus*). LYDEKKER, R., 1886, 'Siwalik Crocodilia, Lacertilia, and Ophidia,' Mem. Geol. Surv. India, Palæontologia Indica, Ser. 10, III, Part 7, p. 211. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 516.

ORIGINAL TYPE FIGURES.—LEIDY, J., 1865, 'Cretaceous Reptiles of the United States,' Smith. Contrib. Knowl., XIV, Pl. II, figs. 4, 5 (Leidy figures on Pl. I, figs. 7–9, some teeth with the caption "Gavial from New Jersey." Hay subsequently referred to these as *H. obscurus*).

COTYPES.—Four vertebræ, the shaft of a femur, and four dermal bones, from Barnesboro, New Jersey, in Geol. Mus. Rutgers College; two posterior dorsal or lumbar vertebræ, from Arneytown, New Jersey, in Acad. Nat. Sci. Phila. Coll.

TYPE LOCALITIES AND LEVEL.—The first specimen from Barnesboro, Gloucester County, the second from Arneytown, Burlington County, New Jersey. Upper Cretaceous Greensands.

ORIGINAL TYPE DESCRIPTIONS.—"Recently Prof. Cook has sent to me for examination a small collection of Crocodile bones belonging to the collection of Rutger's College. The specimens were obtained from near Barnesboro', Gloucester County, N. J., and consist of four vertebræ, the shaft of a femur, and four broken dermal bones, apparently all from the same individual.

The vertebræ have had their arches fully coossified with the bodies, so that they may be considered as having belonged to an animal of mature age. They belonged to a smaller individual than the specimens above described, and perhaps to a different species, for several present some peculiarities of form.

Two of the vertebræ, Figs. 4, 5, Plate II, belonged in the cervical series between the fourth and last, and are probably the fourth and fifth. The bodies measure an inch and three-quarters in length, independent of their posterior convexity, and correspond in general form with those of the Alligator. The hypapophysis of the fourth, Fig. 4, is a thick semicircular ridge extending between and below the level of the parapophyses. In the fifth, Fig. 5, it is a longer, straighter, and less well developed ridge, slightly notched in the middle.

The other two vertebræ are the first and fifth dorsal, and have their body about as long as the cervicals. The first dorsal has lost its hypapophysis, spinous process, and portions of the others, but so far as it is preserved it corresponds in form with that of the Alligator. The fifth dorsal has its body more compressed laterally than in the specimen above described from Timber Creek, and the hypapophysis is absolutely very much more robust than in the latter, though the vertebra is smaller. In the Barnesboro' specimen the anterior articular concavity of the body is quadrilateral, whereas it is broadly cordiform in the Timber Creek specimen. In the former the hypapophysis is excavated in front; in the latter it is plane. These differences in two characteristic vertebræ are, perhaps, sufficient to indicate that they belong to two species.

Comparative measurements of the two vertebræ are as follows:—

	BARNESBORO' SP. Lines.	TIMBER CREEK SP. Lines.
Length of body inferiorly	20	22
Length of body laterally	20	22
Height of body anteriorly	17	18
Width of body anteriorly	16	22
Thickness of body at middle	12	17
Thickness of hypapophysis	9	6
Breadth of vertebral arch laterally	17	20
Width of vertebral canal	6	7
Height of vertebral canal	7	8

The specimen of the shaft of a femur is three inches and a third in circumference, and resembles the corresponding portion of the same bone in the Alligator.

The dermal bones are square, differ in size, and are coarsely foveated. Two of them form a median elevation without being carinated; the others are flat. One of the more perfect measures two inches by twenty lines; another measures two inches eight lines by two inches.

The museum of the Academy contains two mutilated bodies of posterior dorsal or of lumbar vertebræ, of mature age, from Arneytown, Burlington County, N. J., presented by T. A. Conrad. The specimens, excepting in being devoid of the hypapophysis, agree with the bodies of the dorsals above described, and are like those in the living Alligator."

The species may provisionally be considered valid.

Holops (Crocodilus) tenebrosus (Leidy)

ORIGINAL TYPE REFERENCE.—LEIDY, J., 1865, 'Cretaceous Reptiles of the United States,' Smith. Contrib. Knowl., XIV, pp. 14, 15, 115, Pl. III, figs. 12–15, (*Crocodilus tenebrosus*).

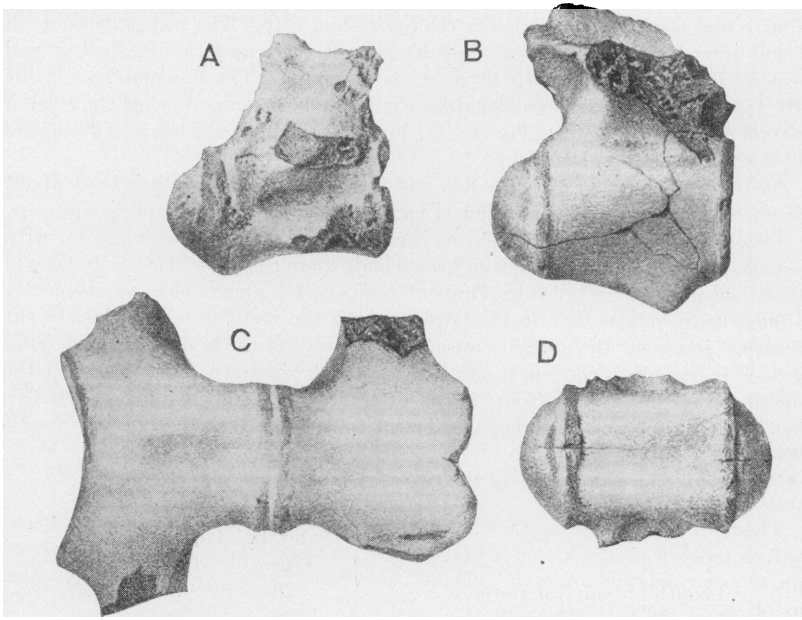

Fig. 22. *Holops* (*Crocodilus*) *tenebrosus* (Leidy). Type specimen, vertebræ (Acad. Nat. Sci. Phila. Coll.).

One-half natural size. A, sixth cervical vertebra, lateral view, right side; B, fifth dorsal vertebra, lateral view, right side; C, sacral vertebræ, inferior view; D, first caudal vertebra, inferior view. Original type figures. (After Leidy.)

SUBSEQUENT REFERENCES.—COPE, E. D., 1869, 'Synopsis of the Extinct Reptilia found in the Mesozoic and Tertiary Strata of New Jersey,' in 'Geology of New Jersey,' by G. H. Cook, Appendix B, Rept. Geol. Surv. New Jersey, p. 736, (*Thoracosaurus tenebrosus*); 1869, 'Synopsis of the Extinct Batrachia and Reptilia of North

America,' Trans. Amer. Phil. Soc., N.S., XIV, Part 1, p. 78. TOULA, F., AND KAIL, J. A., 1885, 'Über einen Krokodil-Schädel aus den Tertiärablagerungen von Eggenburg in Niederösterreich,' Denkschr. k. Akad. Wissensch. Wien, p. 354. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 515, (*Holops basitruncatus*).

ORIGINAL TYPE FIGURES.—LEIDY, J., 1865, 'Cretaceous Reptiles of the United States,' Smith. Contrib. Knowl., XIV, Pl. III, figs. 12–15.

TYPE.—Two cervical, a dorsal, a sacral and two caudal vertebræ, and portions of both humeri. Acad. Nat. Sci. Phila. Coll.

TYPE LOCALITY AND LEVEL.—Timber Creek, Gloucester County, New Jersey. Cretaceous Greensand beds.

ORIGINAL TYPE DESCRIPTION.—"Of other remains of Crocodiles, with vertebræ constructed on the same plan as the living representatives of the family, I have seen a number of specimens from the Green-sand of New Jersey apparently indicating several species different from the preceding [*Bottosaurus harlani*]. Among these is a collection of bones belonging to the same individual, from Timber Creek, Gloucester County, N. J., presented to the Academy by W. P. Foulke. They consist of two cervical, a dorsal, the sacral, and two caudal vertebræ, and portions of both humeri. The vertebræ indicate an adult animal, as the arches are completely united with their respective bodies, and those of the sacrum are firmly coossified. Their comparatively small size renders it improbable that they should belong to either of the species previously indicated [*Thoracosaurus neocesariensis* and *Bottosaurus harlani*].

The bones are black, heavy, and firm, but unfortunately the vertebræ have had most of their processes broken off since their discovery.

The least mutilated of the cervical vertebræ, apparently the sixth, represented in Fig. 12, Plate III, is rather less than two inches in length, independent of the articular convexity of its body. Inferiorly, the latter is divided by a median carina expanding in front into a broad flat space without a distinct hypapophysis, otherwise the specimen presents nothing remarkable by which to characterize it. The other vertebræ of the neck, apparently a fourth or fifth, has the inferior carina of the body almost obsolete—commencing in a small tubercle behind, and fading away as it approaches a concavity extending between the parapophyses or inferior transverse processes. The latter are more robust than in the former specimen, and appear to have been conjoined by a ridge-like hypapophysis, though this is too much broken to judge of its true character.

The dorsal vertebra, Fig. 13, Plate III, the fifth of the series, has about the same length as those of the neck, and is nearly as broad anteriorly as it is long. Its hypapophysis is a robust mammillary tubercle, but it is otherwise like the corresponding bone of the common Alligator.

The conjoined bodies of the sacral vertebræ, represented in Fig. 14, Plate III, relate in size with the preceding, and differ in no important point with the homologous parts of the Alligator.

Of the caudal vertebræ, one is the first of the series, distinguished by the double articular convexity of the body, as seen in Fig. 15, Plate III. Unlike that of the Alligator, it is broad and flattened beneath, resembling in this respect more the condition of the bodies of the sacral vertebræ. The second specimen, from near the middle of the tail, is much mutilated. It measures rather more than two inches in length, and appears to have had the same form as in the Alligator.

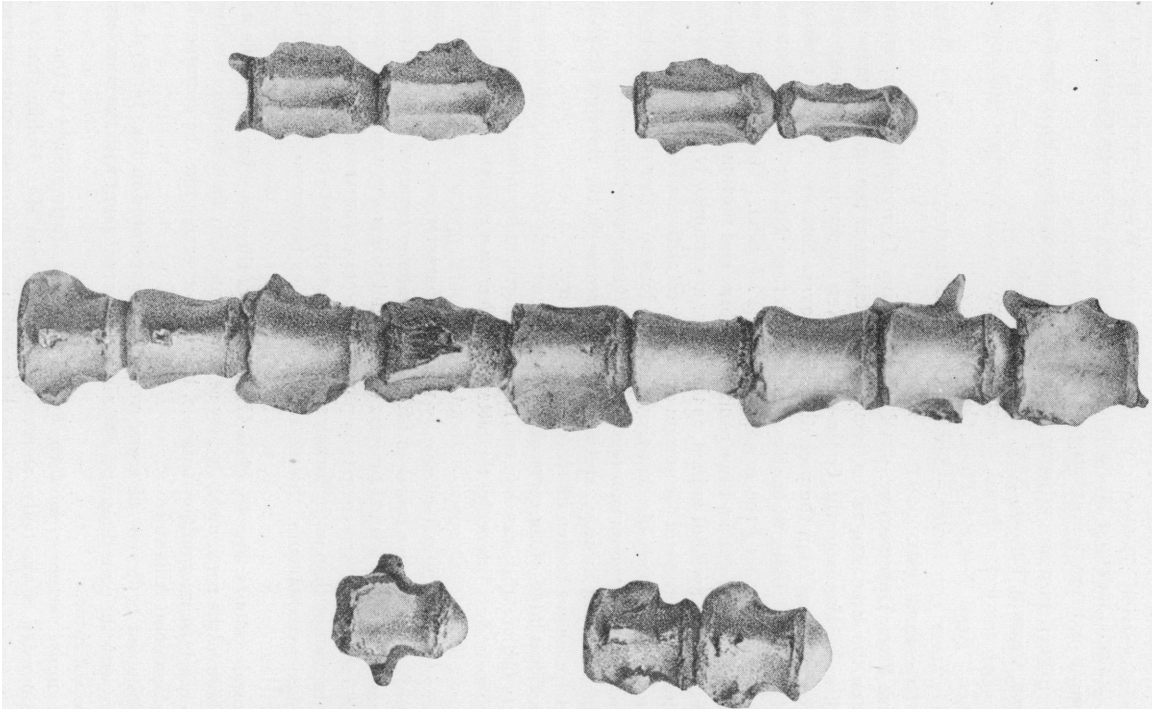

Fig. 23. *Holops brevispinus* (Cope). Type specimen, vertebræ from various parts of the column.
One-half natural size. Inferior views. Original type figures. (After Cope.)

Of the fragments of humeri, one consists of a portion of the shaft of that of the right side, and measures three inches in circumference; the other is the proximal extremity of the left humerus, and does not differ from the corresponding part in the Alligator. Its head measures rather more than two inches in its greater diameter, and a little more than one inch in its lesser diameter."

Hay lists this species under *Holops basitruncatus;* this determination may be followed provisionally.

Holops brevispinus (Cope)

ORIGINAL TYPE REFERENCE.—COPE, E. D., 1867, [Note on *Thoracosaurus brevispinus*], Proc. Acad. Nat. Sci. Phila., XIX, p. 39, (*Thoracosaurus brevispinus*).

SUBSEQUENT REFERENCES.—COPE, E. D., 1869, 'Synopsis of the Extinct Reptilia found in the Mesozoic and Tertiary Strata of New Jersey,' in 'Geology of New Jersey,' by G. H. Cook, Appendix B, Rept. Geol. Surv. New Jersey, p. 736, (*Thoracosaurus brevispinus*); 1869, [Remarks on *Holops brevispinus, Ornithotarsus immanis,* and *Macrosaurus proriger*], Proc. Acad. Nat. Sci. Phila., XXI, p. 123; 1869, 'Synopsis of the Extinct Batrachia and Reptilia of North America,' Trans. Amer. Phil. Soc., N.S., XIV, Part 1, pp. 68–73, Pl. I, fig. 13, Pl. IV, figs. 4–6, (*Holops brevispinus*); 1875, 'The Vertebrata of the Cretaceous Formations of the West,' Rept. U. S. Geol. Surv. Terr., F. V. Hayden in Charge, II, p. 252. TOULA, F., AND KAIL, J. A., 1885, 'Über einen Krokodil-Schädel aus den Tertiärablagerungen von Eggenburg in Niederösterreich,' Denkschr. k. Akad. Wissensch. Wien, p. 354. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 516, (*Holops brevispinis*).

ORIGINAL TYPE FIGURES.—COPE, E. D., 1875, 'Synopsis of the Extinct Batrachia and Reptilia of North America,' Trans. Amer. Phil. Soc., N.S., XIV, part 1, Pl. I, fig. 13, Pl. IV, figs. 4–6.

TYPES.—(Cope, 1867) "several vertebræ of a Gavial from the cretaceous marl of Burlington Co., N. J., and proposed for the new species the name of Thoracosaurus brevispinus"; (Cope, Trans. Amer. Philos. Soc., 1869) "The specimens on which this species are established are, a cervical vertebra in the Museum of the Academy of Natural Sciences, procured by Timothy A. Conrad at St. George's, Delaware, and one cervical, six dorsal, four lumbar, one sacral and four caudal vertebræ from the Greensand of Burlington County, N. J., which have been liberally placed at my disposal by the Burlington County Lyceum of Natural and Civil History. The last series is from the same individual apparently, and is more complete than that of any other cretaceous Crocodile hitherto brought to light. Also on a seventh dorsal, two lumbars and a humerus from the marl excavations of Samuel Engle, near Medford, Burlington County, New Jersey." The vertebræ submitted by the Burlington County Lyceum evidently constitute the material referred to in Cope's original announcement in 1867. Cope's first description, however, refers to a cranium, which is discussed in the article in the transactions of the American Philosophical Society as follows: "A mass of indurated marl, with vivianite and oxide of iron from Monmouth County, N. J., submitted to me by Prof. G. H. Cook, contains the posterior part of the cranium of this species, with cervical, dorsal, lumbar and caudal vertebræ, dermal plates and coracoids. The individual was immature, as shown by the non-anchylosis of the centrum of the atlas, the neural arches, etc." In the first adequate description of this

material and of this species (the 1869 article in the Transaction of the American Philosophical Society), all the material was described.

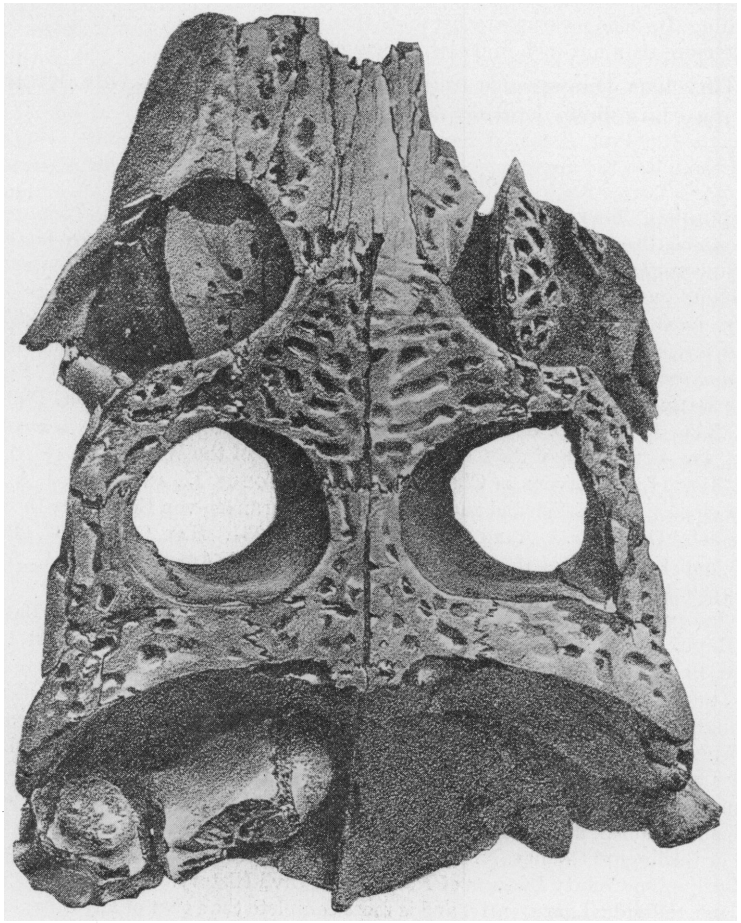

Fig. 24. *Holops brevispinus* (Cope). Hypotype specimen, posterior part of skull (Geol. Mus. Rutgers College Coll.).
Three-fourths natural size. Superior view. Original type figure. (After Cope.)

The vertebræ of the Burlington County Lyceum may be considered as the type, the vertebra from Delaware, and the vertebræ and humerus from near Medford as paratypes, and the cranium and associated material from Monmouth County as hypotype.

TYPE LOCALITIES AND LEVELS.—The type is from Burlington County, New Jersey; the paratypes are from St. George's, Delaware, and Burlington County,

New Jersey; and the hypotype is from Monmouth County, New Jersey; all from upper Cretaceous Greensands.

ORIGINAL TYPE DESCRIPTIONS.—Cope's 1867 account consists merely of notes in the minutes of the meeting of the Philadelphia Academy of April 9, 1867: "Prof. Cope exhibited several vertebræ of a Gavial from the cretaceous marl of Burlington Co., N. J., and proposed for the new species the name of Thoracosaurus brevispinus." In the proceedings of the Academy the following notes on the meeting of June 1, 1869, are recorded: "Prof. Cope exhibited some specimens of extinct reptiles of interest. One of these was the cranium, minus a portion of the muzzle of a gavial, from the New Jersey Green Sand, previously described under the name of *Thoracosaurus brevispinus*, but which this specimen demonstrated to belong to another genus, since it did not present the lachrymal foramina of the former. He applied the name Holops to it, and stated that he had evidence that Crocodilus tenebrosus Leidy, and probably C. obscurus L., also belonged to it."

The first adequate description of the species by Cope is found in the 1869 article in the Transactions of the American Philosophical Society. It is quoted in full as follows:

"The last are from an adult, while the more perfectly preserved is not fully grown, since the neural arches of many of the dorsal vertebræ have separated at their sutures, yet its approach to maturity is indicated by the persistence of this arch of the third cervical, of some dorsals, lumbars and caudals. The species is the smallest of the genus, and will furnish reliable data for the estimation of the dimensions of other extinct crocodilia. The vertebræ are relatively more slender than those of the Alligators, and the general proportions are more probably those of the T. neocaesariensis and of the Gavials. This will give a basis of estimation for the head and tail.

	Inches.
Length of cervical series,	7.75
" dorsal "	15.
" lumbar "	6.25
" sacral "	2.33
Total body,	31.33
Caudal series (part estimated),	35.
Head (estimated),	13.
Total,	6 ft. 7⅓ inches.

Cervical vertebræ.—Characteristic of the two of these before us, is the deep concavity of the inferior aspect of the centrum with only a trace of a keel, and the steep elevation of the same surface to the rim of the articular cup. The latter does not form a well defined ridge, but rather a plane, connecting the anterior extremities of the parapophyses, which, in the sixth, supports two short acuminate hypapophyses. In both cervicals the parapophyses look outwards at right angles to the centrum, but as in existing species, possess shorter articular surfaces on the third, whose body is also rather more elongate behind them. In the sixth, which will be typical of the posterior four of the species of the series, from the crest of the posterior shoulder to the posterior outline of the parapophysis, is one-half the distance from the latter point to the margin of the anterior cup, and somewhat less than the articular face of the parapophysis

The posterior shoulder is elevated in both, and the articular globe is contracted and projecting.

The vertical diameter of the neural canal of the third is four-fifths the same as the anterior cup. The latter is small, its vertical diameter being only double the depth of the osseous elevation between the parapophyses. The neural spine is little elevated, compressed, its anterior margin subacute, and obliquely turned backwards to a posterior apex.

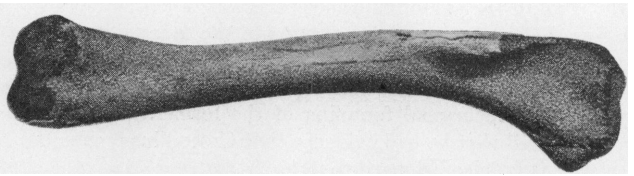

Fig. 25. *Holops brevispinus* (Cope). Paratype specimen, right humerus.

One-half natural size. Anterior view. Original type figure. (After Cope.)

Measurements.

	In.	Lin.
Third cervical, total length,	1	5.
Crest of shoulder to outer angle parapophysis,		6.5
Last point to plane of cup rim,		6.5
From middle ball of apex neural spine,	1	7.
Least width of base of centrum,		6.25
Sixth cervical (larger individual), length,	1	7.5
Vertical diameter between rims of cup,		10.5

The expanded bases of the neurapophyses leave only the cariniform epapophysis between them.

Dorsal vertebræ.—The first, third and fourth with the paraphysis on the centrum have lost only their neural arches. The parapophyses have convex articular surfaces, which have a very posterior direction and are followed by a deep depression in the side of the centrum; in the first they are a little behind the middle of the side of the body. The hypapophyses of all are distinguished by their lack of compression and their obtuseness. They are directed vertically downwards, the anterior face posteriorly. That of the first is bifid as broad as long, the others simple, longer than broad on the third. They are preceded by a depression behind the rim of the cup, and succeeded by a second, simple, small hypapophysis near the shoulder, which is finely many-grooved; it exists as a trace on the third, which of all the dorsals, may alone be said to present a very obtuse carina below. The surface in the first three is striate next the rim of the cup; on the shoulder on the first two. The sixth dorsal is more compressed and smoother; its cup is more produced upwards and outwards, while that of the first is more nearly round and the others are intermediate.

The articular cups of dorsals near the seventh and eighth are nearly round, slightly deeper than broad. The horizontal width of the diapophyses is considerable, and the transverse extent of the articular (inferior) surface of the posterior zygapophysis is equal one-half the length of the centrum between shoulder and cup.

The seventh dorsal of the adult is perhaps twice as large as the above, without being half as large as the same in the H. obscurus. Though the centrum is as much compressed as that of the sixth, the cup is still broader than deep vertically. The centrum has a lateral longitudinal obtuse ridge. The hypapophysis is remarkably large for the position in the vertebral column. It is trigonal in profile with truncate planes before and behind, the anterior concave. The costal articular face is half way to the extremity of the diapophysis on its anterior margin. It is transverse, not vertical as in the sixth in H. tenebrosus.

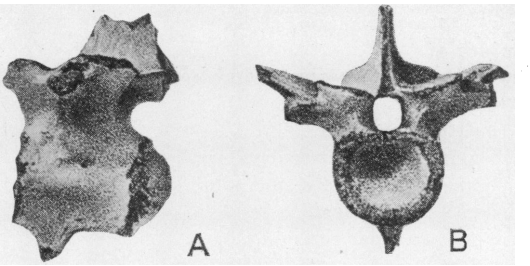

Fig. 26. *Holops brevispinus* (Cope). Paratype specimen, anterior dorsal vertebra.

One-half natural size. A, lateral view, left side; B, anterior view. Original type figures. (After Cope.)

Sacral.—The first exhibits a longitudinal concavity on the posterior half of the centrum below.

Caudals.—The body of an anterior caudal is not compressed, those of three others, but slightly so; the cup of the first is round; those of the others deeper than broad. Three have stout diapophyses; of these the two posterior have a concave inferior face separated by a strong angle from the sides, while there is an additional lateral angulation on the anterior part of the side of the more anterior. In the two anterior, the neural spine is twice constricted from base probably to near apex, leaving an anterior laminiform portion, and a median much stouter. In the caudals the suture of the neural arch is much obliterated.

Measurements of Vertebræ.

Of Adult.

		In.	*Lin.*
Seventh dorsal;	total length,	1	8.
	depth articular cup,		10.5
	width,		12.
	longitudinal width neural arch (greatest),	1	8.
	" " diapophysis,		11.

Of Young.

		In.	*Lin.*
Sixth dorsal;	total length,	1	5.
	length to shoulder,	1	1.5
	depth neural canal to end hypapophysis,	1	1.5
	" articular cup,		9.25
	width " "		11.

Measurements of Vertebræ.

Of Young.

		In.	*Lin.*
Eighth ? dorsal;	total length,	1	5.
	length to shoulder,	1	1.
	longitudinal line between zygapophyses,	1	5.5
	horizontal base of neural spine,		11.
	depth of neural canal,		1.5
	" " articular cup,		9.5
	width of " "		9.5
	neural suture to nearest diapophysis,		3.
Third ? lumbar;	total length,	1	5.
	length to shoulder,	1	1.
	longitud. line between zygapophyses,	1	6.
	horizontal base of neural spine,	1	
	depth neural canal,		4.75
	" articular cup,		9.
	width " "		11.
First sacral;	length,	1	2.75
	anterior width centrum,	1	.75
	posterior " "		10.
	depth neural canal,		4.75
	" articulation of diapophysis		11.
	length " " "		9.
	width neural arch between diapophyses,	1	2.5
Anterior caudal;	length,	1	5.
	" to shoulder,	1	1.5
	depth neural canal,		4.5
	" articular cup,		8.
	width " "		8.75
	width inferior plane,		4.
Distal caudal;	length,	1	5.5
	" to shoulder,	1	3.25
	depth cup,[1]		6.
	width "		5.
	length base diapophysis,		3.75

None of the vertebræ exhibit a constriction of the neural canal by a ridge on each of its sides, as is seen in the H. tenebrosus.

This specimen is named from the short longitudinal and vertical extent of its hypapophyses.

A right *humerus* accompanying three vertebræ of the adult, has the same color and mineralization, and was found with them; it probably belongs to the same animal. Compared with a humerus of H. obscurus of medium size, it is three-fifths the length and has more strongly marked articular faces. The head is more transverse, less rounded, and more strongly divided into the scapular and coracoid faces. The width of the head is one-fourth the length, and reaches the summit of the deltoid

"[1]Measurements of the articular cup are always made from middle to middle of the rim."

crest. This crest is lower down in H. obscurus, the above width only reaching its proximal base. The anterior face above the crest is concave in H. brevispinis, nearly flat in H. obscurus. There is a moderate internal tuberosity distally, and the condyles are moderately prominent. Coronoid fossa well marked.

	In.	*Lin.*
Length,	6	8.
" to middle of deltoid crest,	1	8.5
Width of head,	1	7.
" shank at middle,		8.5
" condyles,		17.5

A mass of indurated marl, with vivianite and oxide of iron from Monmouth County, N. J., submitted to me by Prof. G. H. Cook, contains the posterior part of the cranium of this species, with cervical, dorsal, lumbar and caudal vertebræ, dermal plates and coracoids. The individual was immature, as shown by the non-anchylosis of the centrum of the atlas, the neural arches, etc.

The cervical has the small hypapophysis composed of two small separated tubercles slightly prominent. The dorsal, with a prominent hypapophysis which is truncate in front and at the end, has the round cup characteristic of this species and the H. tenebrosus. The dermal plates are large, elongate-quadrate, considerably exceeding the frontal region in width. Their fossæ are in some deep, wider than the interspaces, in others smaller, the plate with a broad smooth bevelled border.

The cranium exhibits the specific and generic characters very well. The muzzle is broken off at the anterior extremity of the pre-frontal bone, showing that there is no foramen as in Thoracosaurus. The acute posterior extremities of the nasals remain. At the anterior border of the orbits the lachrymal is wider than the pre-frontal and the pre-frontal wider than the frontal.

The pre-frontal suture does not extend further back than opposite the middle point of the diameter of the orbit. No part of the orbital margins are everted, except for a shorter distance on the malar bone. The temporal or crotaphite fossae are of about the same area as the orbits. The width separating them is very little less than one-half the distance between the orbits. The anterior wall of the foramen is not quite vertical as in H. tenebrosus, nor very oblique as in other species. The sculpture is less marked than in the latter, and though it would become perhaps more profound with age, it is quite different in pattern from these. There are small pits near the orbital margins, and shallow grooves which incline backwards towards the median line, which is almost smooth. There are no grooves or pits on the interparietal region. In H. obscurus there are large deep pits all over the frontal, which is concave, and broad smooth margins and a median line of pits on the parietal bone. In the third species (figured by Leidy Cret. Rept. II, 8,) the pits are more numerous and the interparietal wider, and with marginal grooves. The anterior face of the crotaphite fossa is very oblique, or thickened inwards below, while it is vertical in the H. obscurus.

	Postfrontal suture, width.	*Frontal width.*	*Parietal width.*
H. brevispinis,	.52	1.23	.6
H. obscurus,	.8	2.	.55
H. ? sp.,	.7	1.95	.68

The surfaces of the malar, postfronto-parietal and post-temporal arches are marked with distant shallow pits. The superior concealed insertion surfaces of the supraoccipital are largely exposed, and rugose.

The basioccipital, sphenoid and pterygoids are more or less exposed. The first is vertical, with latero-inferior processes directed upwards. The sphenoid has a very narrow exposure, but this is horizontal. The posterior-inner processes of the pterygoid lie closely appressed to the sphenoid and basioccipital laterally. This arrangement is much as in the living Gavialis gangeticus. The posterior nares are more anterior, however, and the septum not completed. Their plane is perhaps a little above that of the orifice of the eustachian tubes. The lower extremity of the basioccipital, has a well-marked posterior keel.

Measurements.

	In.
Length (median above) to apex prefrontal,	5.5
" (axial) to front of orbit,	4.15
" " " crotaphite foramen,	2.2
Width between extremities quadrata,	6.2
" " postfrontal angles,	2.
" muzzle at point frontal,	3.32
Length dermal scutum,	2.3
" cervical vertebra (to ball),	1.7
Width crotaphite foramen,	1.7

This species furnishes the generic characters. I have not been able to ascertain the non-existence of the pre-frontal foramen in the following species, but as they bear more resemblance in the cranial sculpture and in size to this species, than to Thoracosaurus neocaesariensis, I refer them at present to Holops."

The species may provisionally be considered valid.

Holops cordatus Cope

ORIGINAL TYPE REFERENCE.—COPE, E. D., 1869, 'Synopsis of the Extinct Batrachia and Reptilia of North America,' Trans. Amer. Phil. Soc., N.S., XIV, Part 1, pp. 69, 73, 74, fig. 18, Pl. IV, fig. 7.

SUBSEQUENT REFERNCES.—COPE, E. D., 1875, 'The Vertebrata of the Cretaceous Formations of the West,' Rept. U. S. Geol. Surv. Terr., F. V. Hayden in Charge, II, p. 253. TOULA, F., AND KAIL, J. A., 1885, 'Über einen Krokodil-Schädel aus den Tertiärablagerungen von Eggenburg in Niederösterreich,' Denkschr. k. Akad. Wissensch. Wien, p. 354, (*Crocodilus cordatus*). HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 516.

ORIGINAL TYPE FIGURES.—COPE, E. D., 1869, 'Synopsis of the Extinct Batrachia and Reptilia of North America,' Trans. Amer. Phil. Soc., N.S., XIV, Part 1, fig. 18, Pl. IV, fig. 7 (the vertebra depicted in the latter figure is not mentioned as part of the type, being captioned "Post-median dorsal of *Holops caudatus* Cope, from Barnesboro, one-half natural size." It probably is part of the type).

TYPE.—(Cope) "Of this species I have only two cervical, two dorsal, and three lumbar vertebræ of one individual, all in a good state of preservation."

TYPE LOCALITY AND LEVEL.—No reference to locality is given, except in the caption referred to above "from Barnesboro." No level is indicated, except the Cretaceous of New Jersey.

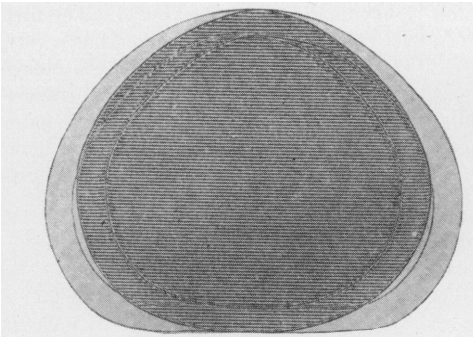

Fig. 27

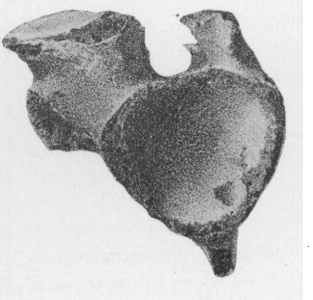

Fig. 28

Fig. 27. *Holops cordatus* Cope. Type specimen, centrum of fourth dorsal vertebra.

Size not indicated, probably natural size. The shaded portion indicates the transverse profile of a corresponding centrum of *H. basitruncatus* (Owen); the outline indicates a similar profile of *H. cordatus*. Original type figure. (After Cope.)

Fig. 28. *Holops cordatus* Cope. Probably part of the type lot. Post-median dorsal vertebra.

One-half natural size. Anterior view. Original type figure. (After Cope.)

ORIGINAL TYPE DESCRIPTION.—"Of this species I have only two cervical, two dorsal, and three lumbar vertebræ of one individual, all in a good state of preservation. They present characters similar to those of H. obscurus in the cervical vertebræ, and intermediate between those of that species and the H. tenebrosus in the dorsals. While the fifth dorsal in the former is deeper than wide in its articular cup and slightly quadrate, the present species presents a broadly cordate cup to the fifth, narrowed below, yet considerably wider than deep; the H. tenebrosus presents a regularly round or transversely oval cup in the same position, much as in H. brevispinis. The accompanying cut exhibits the difference between this species and the H. tenebrosus. The cordate form is distinct on the fourth dorsal, where in H. obscurus the cup is regularly oval. The cervicals are not different from those of H. obscurus, except that the cup is rather more prolonged below, or subquadrate.

The cervical vertebræ referred to this species may be known by the outlines of the anterior extremity outside the cup, of which the latter partakes, which is between quadrate and cordate; by the distinct inferior concavity between the parapophyses, and by the gradual but complete eversion of the latter. In the types the posterior shoulder is remarkably prominent. The inferior carina is little marked on the fourth, while the hypapophyses are small and united. In a fifth, judging from the more posterior position of the parapophysis, it is formed of two partly confluent subacute elevations.

The dorsal vertebræ, from their mineralization, condition, and time and place of of discovery, probably belong to the same animal as the cervicals above described. The breadth of the cup of the fifth is a little greater than the length to the posterior

shoulder, it differs from Leidy's figure of the sixth of tenebrosus, T. III., f. 13, in its large hypapophysis, which stands on nearly the entire centrum, and is very prominent, and concave in front; the sides of the centrum are concave from cup to shoulder. In the third dorsal but a narrow space exists behind and before the hypapophysis, and the vertical diameter of the cup is less than the transverse, and exhibits the same cordate outline. As usual some (the anterior) lumbars are deeper than wide, and in others the bodies are subquadrate in section, and the transverse diameter of the cup greater. Measurements are as follows:

	In.	*Lin.*
Third cervical: length to shoulder,	2	0.75
" " " opposite posterior angle parapophysis,	1	4.5
" " width between latter points,	1	10.5
" " least width behind parapophysis,	1	2.
" vertical diameter cup,	1	5.25
" transverse diameter cup, above,	1	5.25
" " " " below,		11.
Fourth cervical: length to shoulder,	2	
" " " end parapophysis,	1	2.25
Third dorsal: length to shoulder,		23.
" " " opposite posterior angle parapophysis,		10.5
" " " of basis of hypapophysis,		14.25
" " width between ends of parapophyses,		33.75
" " " of neural arch just behind diapophyses,		26.
" " " of anterior cup,		22.5
" " " of neural arch,		5.25
" vertical diameter neural arch,		7.5
" " " cup,		19.
Fifth dorsal: length to shoulder,		21.
" " " basis hypapophysis,		14.
" " width of centrum at middle,		12.25
" " " cup,		21.25
" " vertical diameter at middle,		18.
Lumbar: length to shoulder,		25.5
" vertical diameter cup,		20.
" transverse,		19.

Portions of the frontal and parietal bones of a gavial are figured by Leidy (III., fig. 8). They are shown under the head of H. brevispinis not to be referable to the cranium of that species, or of H. tenebrosus; whether they can be referred to H. obscurus, H. cordatus, or H. glyptodon is as yet uncertain.

This species is no doubt a gavial-like animal, very near the T. obscurus. It is sufficiently different in vertebral structure; probably other differences will be found where other bones are known."

Summary of characters on p. 68: "Large; dorsals about third and fifth, with subcordate outline and thin margins; *i.e.*, widened above, narrowed below, wider than deep; centra 20–25 lines; cervicals with subquadrate cup."

The species may provisionally be considered valid.

Holops glyptodon Cope

ORIGINAL TYPE REFERENCE.—COPE, E. D., 1869, 'Synopsis of the Extinct Batrachia and Reptilia of North America,' Trans. Amer. Phil. Soc., N.S., XIV, Part 1, pp. 68, 74, 231.

SUBSEQUENT REFERENCES.—COPE, E. D., 1869, 'Synopsis of the Extinct Reptilia found in the Mesozoic and Tertiary Strata of New Jersey,' in 'Geology of New Jersey,' by G. H. Cook, Appendix B, Rept. Geol. Surv. New Jersey, p. 736; 1875, 'The Vertebrata of the Cretaceous Formations of the West,' Rept. U. S. Geol. Surv. Terr., F. V. Hayden in Charge, II, p. 253. TOULA, F., AND KAIL, J. A., 1885, 'Über einen Krokodil-Schädel aus den Tertiärablagerungen von Eggenburg in Niederösterreich,' Denkschr. k. Akad. Wissensch. Wien, p. 354. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 515.

ORIGINAL TYPE FIGURES.—No figures of the type have been published.

TYPE.—"This species is indicated by a few teeth only, but they are of so marked a character as to render their recognition and arrangement proper." (Cope).

TYPE LOCALITY AND LEVEL.—Barnesboro, Gloucester County, New Jersey. Cretaceous beds.

ORIGINAL TYPE DESCRIPTION.—"The best preserved specimen indicates a slender, subcylindrical strongly curved crown, with the acute ridge which divides the planes extending to its base. There are probably nine obtuse ridges on the inner or concave face, each about as wide as each interval. Both ridges and grooves are covered with sharp fine longitudinal striæ, which are continually interrupted and irregular.

The pulp cavity, as on others of the genus, is rather small. Length of crown, 12 lines; diameter at base, 4.5l. The apex is slightly compressed and smooth. In an older specimen the minute striæ are less distinct, leaving the fluting.

"From Barnesboro, Gloucester Co., N. J. Not found with or near any of the preceding specimens, but with dermal plates not distinguishable from those of H. obscurus."

The species may provisionally be considered valid.

Holops pneumaticus Cope

ORIGINAL TYPE REFERENCE.—COPE, E. D., 1872, [Description of *Holops pneumaticus*], Proc. Acad. Nat. Sci. Phila., XXIV, pp. 11, 12.

SUBSEQUENT REFERENCES.—COPE, E. D., 1875, 'The Vertebrata of the Cretaceous Formations of the West,' Rept. U. S. Geol. Surv. Terr., F. V. Hayden in Charge, II, pp. 250–252. TOULA, F., AND KAIL, J. A., 1885, 'Über einen Krokodil-Schädel aus den Tertiärablagerungen von Eggenburg in Niederösterreich,' Denkschr. k. Akad. Wissensch. Wien, p. 354. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 516.

ORIGINAL TYPE FIGURE.—No figure of the type has previously been published. See figures 29–34 of this article.

TYPE.—Cope mentions teeth, muzzle, cervical vertebræ and long bones. Amer. Mus. Cope Coll. No. 2217.

TYPE LOCALITY AND LEVEL.—Harrisonville, New Jersey, Greensand No. 5, upper Cretaceous.

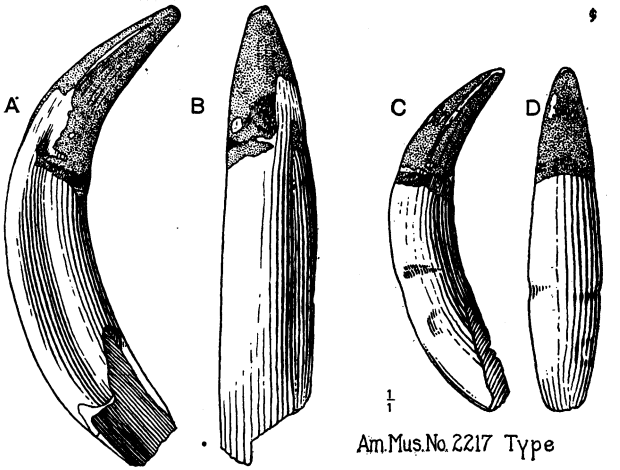

Fig. 29

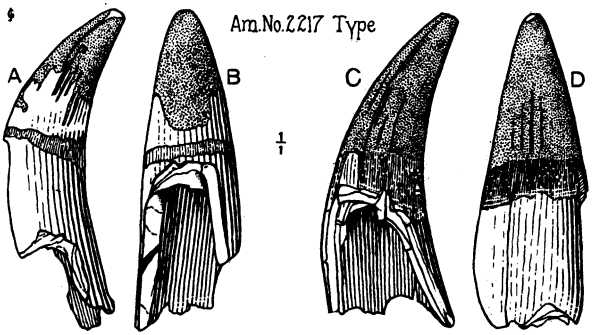

Fig. 30

Fig. 29. *Holops pneumaticus* Cope. Type specimen, teeth (Amer. Mus. Cope Coll. No. 2217).

Natural size. A, tooth, lateral view; B, the same, external view; C, another tooth, lateral view; D, the same, external view.

Fig. 30. *Holops pneumaticus* Cope. Type specimen, teeth (Amer. Mus. Cope Coll. No. 2217).

Natural size. A, tooth, lateral view; B, the same, external view; C, another tooth, lateral view; D, the same, external view.

Fig. 31. *Holops pneumaticus* Cope. Type specimen, cervical vertebra (Amer. Mus. Cope Coll. No. 2217).

One-half natural size. A, superior view; B, lateral view, right side.

Fig. 32. *Holops pneumaticus* Cope. Type specimen, anterior dorsal vertebra (Amer. Mus. Cope Coll. No. 2217).

One-half natural size. A, superior view; B, lateral view, right side.

Fig. 33. *Holops pneumaticus* Cope. Type specimen, anterior dorsal vertebra (Amer. Mus. Cope Coll. No. 2217).

One-half natural size. A, superior view; B, lateral view, right side.

Fig. 34. *Holops pneumaticus* Cope. Type specimen, lumbar vertebra (Amer. Mus. Cope Coll. No. 2217).

One-half natural size. A, superior view; B, lateral view, right side.

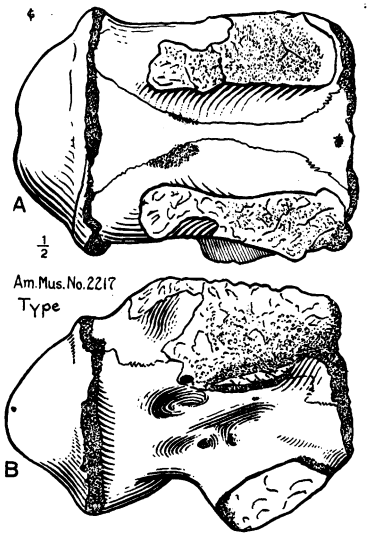

Fig. 31

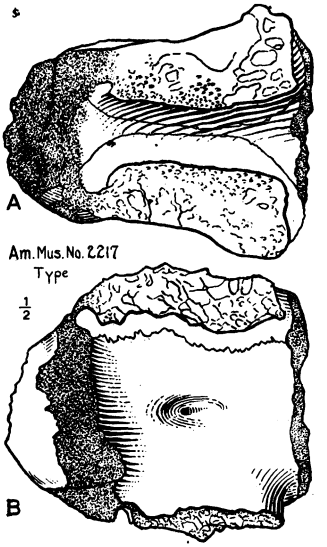

Fig. 32

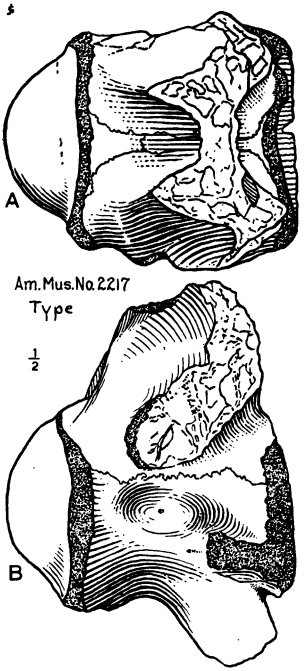

Fig. 33

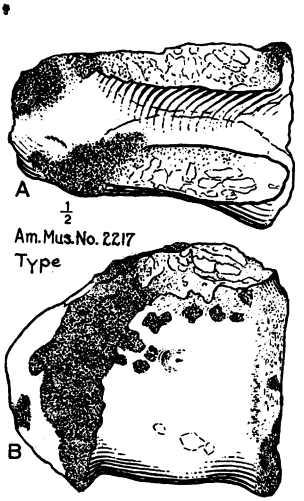

Fig. 34

ORIGINAL TYPE DESCRIPTION.—"Prof. Cope exhibited a portion of the skeleton of a large crocodile from the cretaceous green sand of New Jersey, belonging to the genus *Holops*. The teeth were smooth, cylindric, acute, and much curved, the muzzle gavial-like. The cervical vertebræ were very large, and of depressed form; the walls of the long bones unusually thin, and pneumatic foramina large. He called it *Holops pneumaticus*."

The species may provisionally be considered valid.

POLYDECTES Cope

ORIGINAL TYPE REFERENCE.—COPE, E. D., 1869, [Remarks on *Eschrichtius polyporus, Hypsibema crassicauda, Hadrosaurus tripos* and *Polydectes biturgidus*], Proc. Acad. Nat. Sci. Phila., XXI, p. 192.

SUBSEQUENT REFERENCES.—COPE, E. D., 1870, 'On Some Reptilia of the Cretaceous Formation of the United States,' Proc. Amer. Phil. Soc., XI, p. 271; 1875, 'Synopsis of the Vertebrata whose Remains have been Preserved in the Formations of North Carolina,' Rept. Geol. Surv. North Carolina, I, Appendix B, p. 34. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 514.

TYPE.—*Polydectes biturgidus* Cope.

ORIGINAL TYPE DESCRIPTION.—Not separated from specific description of *P. biturgidus*. See the latter.

Further study is necessary to permit a reliable determination.

Polydectes biturgidus Cope

ORIGINAL TYPE REFERENCE.—1869, [Remarks on Fossil Reptiles], Proc. Acad. Nat. Sci. Phila., XXI, p. 192. (This is an abstract of a verbal communication by Prof. Cope).

SUBSEQUENT REFERENCES.—COPE, E. D., 1870, 'On Some Reptilia of the Cretaceous Formation of the United States,' Proc. Amer. Phil. Soc., XI, p. 271. (This is the first published account by Cope himself); 1875, 'Synopsis of the Vertebrata whose Remains have been Preserved in the Formations of North Carolina,' Rept. Geol. Surv. North Carolina, I, Appendix B, pp. 33, 34, Pl. VIII, figs. 2, 2*a*. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 514.

ORIGINAL TYPE FIGURES.—COPE, E. D., 1875, 'Synopsis of the Vertebrata whose Remains have been Preserved in the Formations of North Carolina,' Rept. Geol. Surv. North Carolina, I, Appendix B, Pl. VIII, figs. 2, 2*a*.

TYPE.—"an elongate conic tooth, and perhaps by others," Geol. Surv. North Carolina Coll.

TYPE LOCALITY AND LEVEL.—Sampson County, North Carolina. In marl pits, probably Cretaceous.

ORIGINAL TYPE DESCRIPTION.—In the record of meetings of the Academy of Natural Sciences of Philadelphia the following note is given: "Another reptile from the same locality was indicated by an elongate, conic tooth, and perhaps by others, which had the cone in cone structure of those of the species of the Crocodilian genus, *Thecachampsa*. It differed from all these in the removal of the usually opposite

dividing cutting ridges to a position near together on the inner face of the crown, and the slight median contraction of the crown, which produced an appearance of enlargements a short distance above the base and below the tip of the crown. Crown conic; length 2 in., 6 lines. He named it *Polydectes biturgidus*." Cope's description of 1870 is as follows: "Crown a slender cone slightly curved near the base. Middle portion constricted, its surface marked with narrow obscure facets. On the inner face, a shallow groove within each of the bounding sulci, the two separated by an indistinct groove. The enamel is smooth and worn, and leaves no traces of other sculpture.

	Lines.
Length of crown.....	30
Diameter at base of do.....	10
" middle.....	6.
" above do.....	6.5

From the marl pits of James King, Sampson co., N. Ca. Discovered by Prof. W. C. Kerr, Director of the Geological Survey of North Carolina."

The species may provisionally be considered valid.

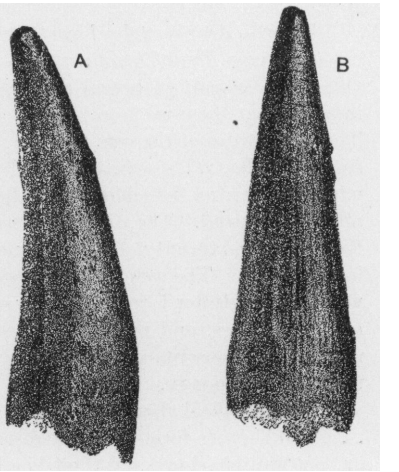

Fig. 35. *Polydectes biturgidus* Cope. Type, tooth (Geol. Surv. North Carolina Coll.).

Slightly less than natural size. A, lateral view; B, external view. Original type figures. (After Cope.)

Diplosaurus Marsh

Original Type Reference.—Marsh, O. C., 1877, 'Notice of Some New Vertebrate Fossils,' Amer. Journ. Sci. and Arts, Ser 3, XIV, p. 254.

Subsequent References.—Marsh, O. C., 1877, 'Introduction and Succession of Vertebrate Life in America,' Amer. Journ. Sci. and Arts, Ser. 3, XIV, Art. 42, p. 346; 1896, 'A New Belodont Reptile (Stegomus) from the Connecticut River Sandstone,' Amer. Journ. Sci., Ser. 4, II, p. 62. Williston, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV, p. 8.

Type.—*Diplosaurus felix* Marsh.

Original Type Description.—The characters of the genus were not separated from those of the type species by Marsh. See *Goniopholis* (*Diplosaurus*) *felix*.

The genus may provisionally be considered as synonymous with *Goniopholis* Owen.

Amphicotylus Cope

Original Type Reference.—Cope, E. D., 1878, 'Descriptions of New Extinct Vertebrates from the Upper Tertiary and Dakota Formations,' Bull. U. S. Geol. Surv. Terr., F. V. Hayden in Charge, IV, No. 2, Art. 16, p. 391.

Subsequent References.—Nicholson, H. A., and Lydekker, R., 1889, 'A Manual of Palæontology for the Use of Students with a General Introduction on the

Principles of Palæontology,' p. 1190. HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv. No. 179, p. 516. WILLISTON, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV, p. 7.

TYPE.—*Amphicotylus lucasii* Cope.

ORIGINAL TYPE DESCRIPTION.—"*Char. gen.*—The portions certainly representing this genus consist of dorsal and lumbar vertebræ, ribs, and dermal bones. These indicate that the form is to be referred to the amphicœlous division of the *Crocodilia*. The extremities of the centrum are regularly cupped, and concavity being separated from the edge of the articular face by a plane border. The neural arch is co-ossified with the centrum, which does not display any lateral fossa. It is, however, considerably compressed. The diapophysis of the dorsal is below the neural arch, and near the anterior extremity of the centrum. On the lumbars it rises from the arch, and is long and flat. The anterior zygapophysis projects but little from its anterior border, while the posterior forms a considerable process. There is no hypapophysis on any of the lumbars, and probably none on the last dorsal vertebra. The tissue of the neural canal presents a shallow excavation at the middle of the centrum, uniform and rather finely spongy.

The technical characters of this genus are somewhat like those of *Symphyrophus*, . . . but the two forms are very distinct. The vertebræ of the latter are amphiplatyan, not amphicœlous, and there is a lateral fossa."

The genus may provisionally be considered a synonym of *Goniopholis* Owen.

HETERODONTOSUCHUS Lucas

ORIGINAL TYPE REFERENCE.—LUCAS, F. A., 1898, 'Contributions to Paleontology. 1. A New Crocodile from the Trias of Southern Utah,' Amer. Journ. Sci., Ser. 4, VI, p. 399.

SUBSEQUENT REFERENCE.—HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 515.

TYPE.—*Heterodontosuchus ganei* Lucas.

ORIGINAL TYPE DESCRIPTION.—Not separated by Lucas from the description of the type species. See *Heterodontosuchus ganei*.

The genus may provisionally be considered valid.

Heterodontosuchus ganei Lucas

ORIGINAL TYPE REFERENCE.—LUCAS, F. A., 1898, 'Contributions to Paleontology. 1. A New Crocodile from the Trias of Southern Utah,' Amer. Journ. Sci., Ser. 4, VI, p. 399.

SUBSEQUENT REFERENCE.—HAY, O. P., 1902, 'Bibliography and Catalogue of the Fossil Vertebrata of North America,' Bull. U. S. Geol. Surv., No. 179, p. 515.

ORIGINAL TYPE FIGURES.—No figures of the type have been published.

TYPE.—An imperfect anterior portion of the mandible. U. S. Nat. Mus. No. 4136.

TYPE LOCALITY AND LEVEL.—Clay Hill, southern Utah. At the top of Bed No. 10 of Newberry, Triassic (?).

ORIGINAL TYPE DESCRIPTION.—"The following genus and species is based upon the imperfect anterior portion of the lower mandible of a crocodile comparable in size with *Tomistoma* among living and *Thoracosaurus* among extinct species. The mandibular symphysis is long, though less than in *Tomistoma*, and includes a considerable portion of the splenial. The teeth are very close to one another, being separated by an extremely thin partition of bone, and the tooth row lies in a broad shallow groove. The teeth are set obliquely, raking decidedly outwards, and they are compressed from before backward, the antero-posterior diameter being slightly less than the transverse. The two anterior teeth are round in section and vastly larger than the others, the end of the jaw being expanded for their accommodation. The surface of the bone is somewhat pitted, there is a deep narrow groove along the side of the jaw and there is no notch for the upper canines and no depressions for the reception of any of the upper teeth. The genus is characterized by the antero-posterior compression of the teeth, their closeness to one another, and by the great size of the two anterior teeth. The name *Heterodontosuchus ganei* is proposed for the genus and species, the specific name being given in honor of the discoverer Mr. H. S. Gane."

The species may provisionally be considered valid.

TELEORHINUS Osborn

ORIGINAL TYPE REFERENCE.—OSBORN, H. F., 1904, '*Teleorhinus browni*—A Teleosaur in the Fort Benton,' Bull. Amer. Mus. Nat. Hist., XX, Art. 21, p. 239.

SUBSEQUENT REFERENCE.—WILLISTON, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV, pp. 5, 6.

TYPE.—*Teleorhinus browni* Osborn.

ORIGINAL TYPE DESCRIPTION.—"Cranium teleosauroid. Nasals continued forward to form roof border of anterior nares. Splenials prolonged into symphysis. Teeth compressed antero-posteriorly, uniformly grooved in front and behind."

The genus may provisionally be considered valid.

Teleorhinus browni Osborn

ORIGINAL TYPE REFERENCE.—OSBORN, H. F., 1904, '*Teleorhinus browni*—A Teleosaur in the Fort Benton,' Bull. Amer. Mus. Nat. Hist., XX, Art. 21, pp. 239, 240.

SUBSEQUENT REFERENCE.—WILLISTON, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV, p. 6.

ORIGINAL TYPE FIGURE.—No figure of the type has previously been published. See figure 36 of this article.

TYPE.—Skull, jaws and considerable part of the skeleton. Amer. Mus. No. 5851.

TYPE LOCALITY AND LEVEL.—Thirty miles southeast of Pryor, Montana. Fort Benton Formation.

ORIGINAL TYPE DESCRIPTION.—"Forty maxillary and premaxillary teeth. Premaxillary teeth straight, maxillary teeth recurved.

The skull (1000 mm.) and jaws (996 mm.) are preserved entire, with a large number of the upper teeth. The skull in the upper view exhibits great breadth between the orbits, which are placed laterally. Large supratemporal fenestræ. Few sutures can be made out. The fronto-prefrontal elements connect anteriorly with the greatly elongated nasals which border the roof of the anterior nares.

The vertebræ are amphicœlous or amphiplatyan.

Nine *cervicals* are preserved. Atlas with hypocentrum, neurocentra (neural arches), and a single transversely extended proatlas with median spine. Axis with firmly united odontoid (pleurocentrum of atlas), with paired hypocentra indicated,

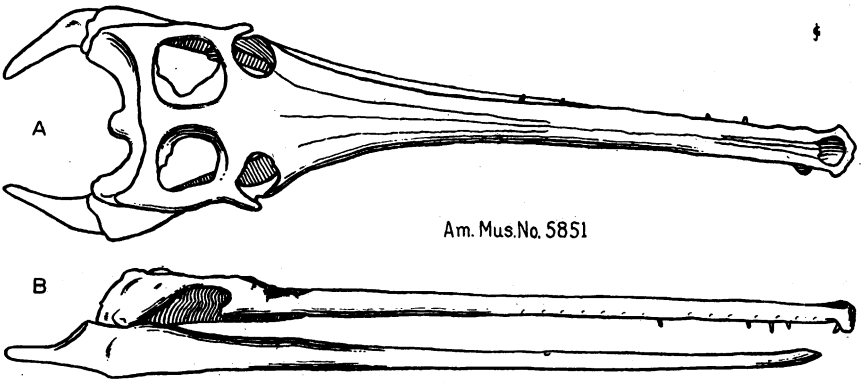

Fig. 36. *Teleorhinus browni* Osborn. Type specimen, skull and jaws (Amer. Mus. No. 5851).

One-tenth natural size. A, superior view; B, lateral view, left side.

but not osseous or preserved; with prominent and elongate spine. Remaining cervicals with very broad ribs, articulating with depressed dia- and parapophyses. At least twelve dorsal centra are preserved, without upper portion or neural spines. The single sacral preserved has a broad sacral rib attachment directly opposite the centrum; the centrum is amphiplatyan and front and back surfaces are of equal size. The mid-caudal centra are laterally compressed, with chevron facets.

Of the limb bones the femur and humerus are preserved complete. Both are much straighter than in *Hyposaurus* and greatly reduced in length. The dermal scutes are elongated and shallow-pitted."

The species may be considered valid.

Cœlosuchus Williston

Original Type Reference.—Williston, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol., XIV, pp. 9–12.

Subsequent Reference.—No subsequent reference is available at the present time.

Type.—*Cœlosuchus reedii* Williston.

Original Type Description.—The generic characters are not separated from those of the type species in Williston's description. See *Cœlosuchus reedii*.

The genus may provisionally be considered valid.

Coelosuchus reedii Williston

Original Type Reference.—Williston, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol. XIV, pp. 9–12, figs. 1–12.

Subsequent References.—None.

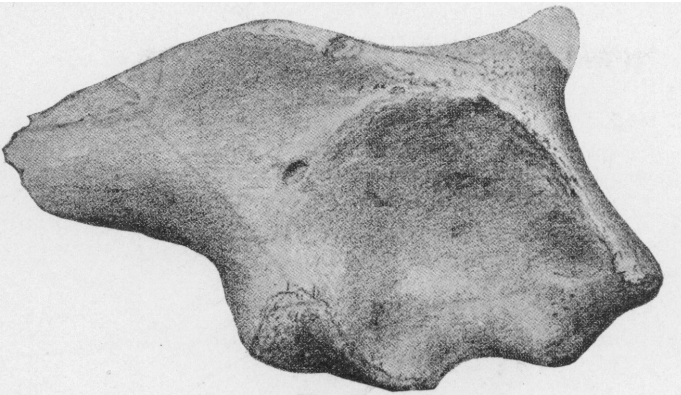

Fig. 37

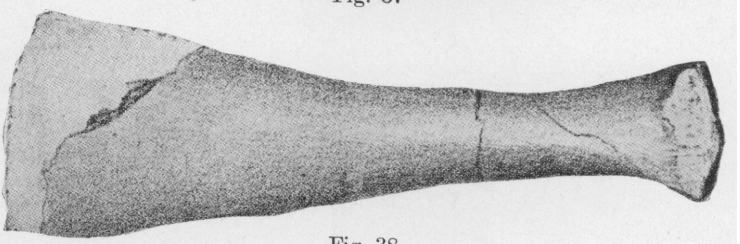

Fig. 38

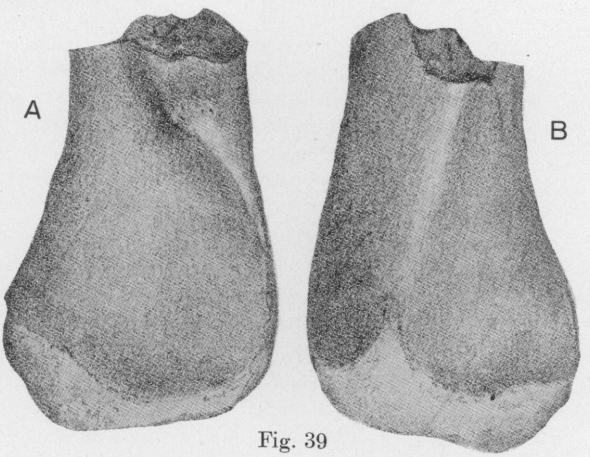

Fig. 39

Fig. 37. *Cœlosuchus reedii* Williston. Cotype specimen, right ilium (Mus. Univ. Wyo. Coll.).
One-half natural size. External view. Original type figure. (After Williston.)

Fig. 38. *Cœlosuchus reedii* Williston. Cotype specimen, right pubis (Mus. Univ. Wyo. Coll.).
One-half natural size. Original type figure. (After Williston.)

Fig. 39. *Cœlosuchus reedii* Williston. Cotype specimen, proximal end of humerus (Mus. Univ. Wyo. Coll.).
One-half natural size. A, posterior view; B, anterior view. Original type figures. (After Williston.)

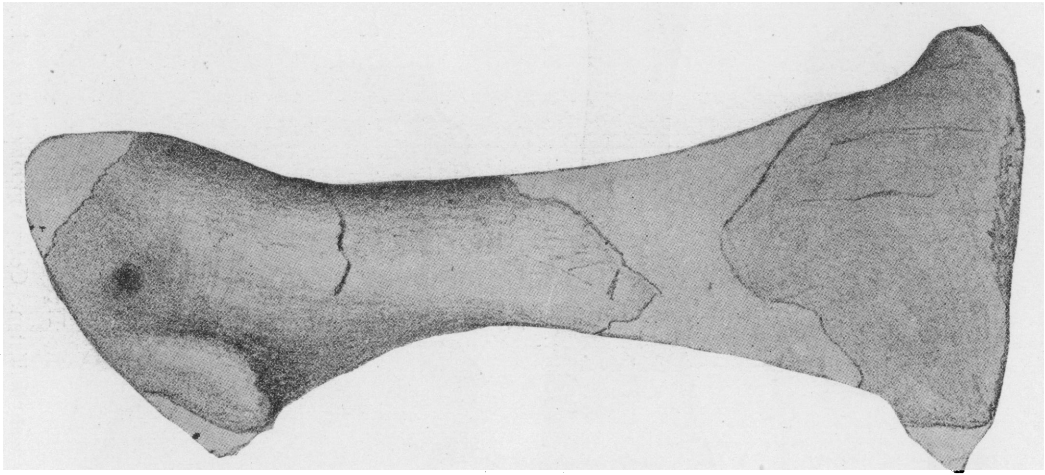

Fig. 40. *Cœlosuchus reedii* Williston. Cotype specimen, right coracoid (Mus. Univ. Wyo. Coll.)
One-half natural size. External view. Original type figure. (After Williston.)

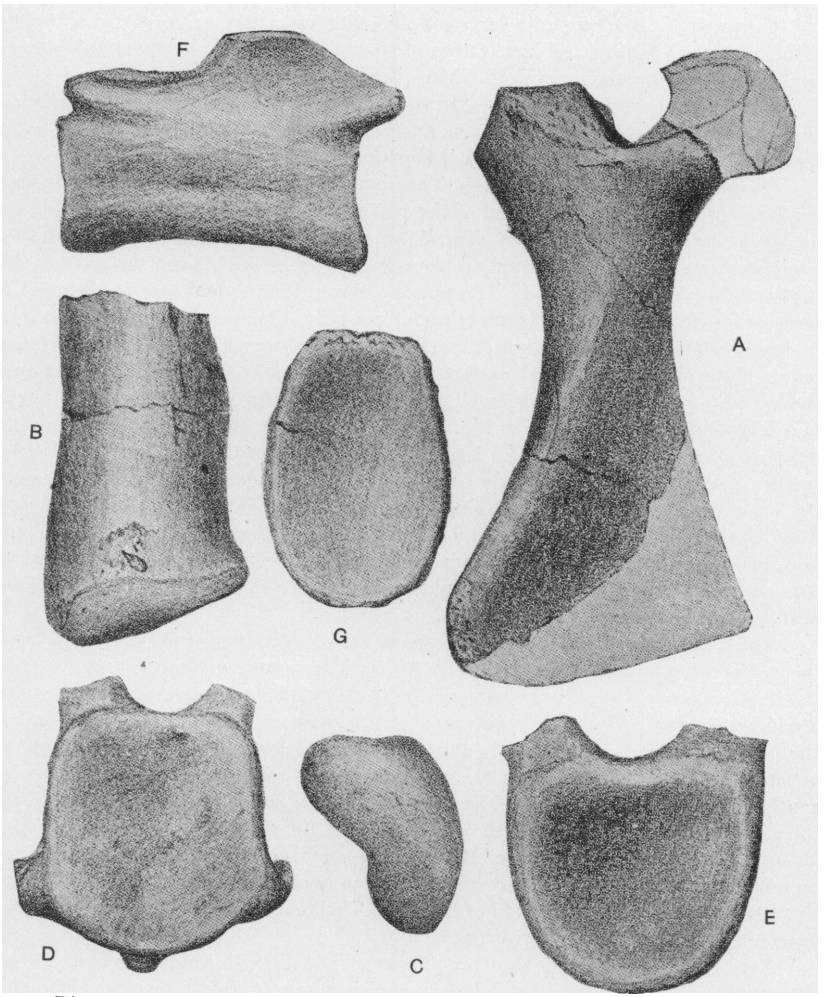

Fig. 41. *Cœlosuchus reedii* Williston. Cotype specimens (Mus. Univ. Wyo. Coll.).

Two-thirds natural size. A, left ischium, internal view; B, left tibia, distal end, external view; C, the same, distal view; D, centrum of cervical vertebra, anterior view; E, centrum of dorsal vertebra, anterior view; F, caudal vertebra, lateral view, left side. G, another caudal vertebra, posterior view. Original type figures. (After Williston.)

ORIGINAL TYPE FIGURES.—WILLISTON, S. W., 1906, 'American Amphicœlian Crocodiles,' Journ. Geol. XIV, figs. 1–12.

COTYPES.—"Remains of a large amphicœlian crocodile, evidently of a brachystomous form." Ilium, ischium, pubes of several individuals, humerus, tibia, coracoids, vertebræ, fragments of skull. Mus. Univ. Wyo.

TYPE LOCALITY AND LEVEL.—"In the vicinity of Wilcox, Wyo., in a dark shale of the Graneros division of the Benton, and below the heavily laminated shales which must be ascribed to the Mowrie beds of Darton."

ORIGINAL TYPE DESCRIPTION.—"The ilium (Fig. 1) differs from that of a modern crocodile in the greater elongation of the posterior process, and in the relatively less width of the bone. An ischium (Fig. 5) of a smaller individual differs in the less expansion of the distal end, its more rounded posterior angle, and the greater obliquity of the shaft of the bone. The pubes of several individuals are represented by more or less fragmentary parts, all of about one size. One nearly complete specimen is shown in Fig. 2. It is also noticeable for the slenderness of the shaft, and the moderate dilatation of the distal extremity, differing markedly in this respect from the known forms of *Goniopholis* and *Bernissartia*. The upper extremity of a humerus of a large individual is shown in Fig. 3. Its curvature is slight, much less than of a humerus of nearly equal size of a longirostrate form from the Hailey shales. Other smaller humeri are present, nearly complete. They are slender and nearly straight, the lower extremity scarcely differing from that of a modern alligator or crocodile. The distal end of a tibia and its distal face are shown in Figs. 6 and 7. The proximal and distal ends of two large coracoids are shown in the figure. I have outlined the connecting part between them as would seem natural. The distal extremity is also noticeable for its moderate expansion.

The numerous vertebræ preserved are of various sizes and from various places in the vertebral column. A cervical (Fig. 8) has its extremities almost amphiplatyan: the hypapophysis is small; the parapophysial articulations are not large and are situated near the end. The neurapophyses are attached by a loose suture. The length of the vertebra is 50 mm.; its width, 44 mm. A dorsal centrum, of which the anterior articular surface is shown in Fig. 9, has a very smooth surface exteriorly, and is but gently concave longitudinally. The posterior central articular surface is nearly flat, the anterior rather deeply cupped. The length of the centrum is 59 mm; its width, 50 mm. Another centrum (Fig. 10) is much more compressed from side to side, presenting a vertically oval figure at the ends and in cross-section. This centrum has a length of 50 mm and a width of but 36 mm. The largest (dorsal) centrum preserved has a length of 65 mm and a width of 70 mm.

Various fragments of the skull are preserved, but no teeth can be detected, though a fragment of a dentary or maxilla has numerous thecæ for their reception. The skull fragments are massive and deeply pitted, conclusively proving, it seems to me, the brachystomous nature of the face. The largest portion preserved is that figured herewith, the posterior part of the left mandible. It measures 155 mm, in its greatest width, and resembles the corresponding part of the mandible of *Goniopholis tenuidens*, as figured by Owen. . . . If the skulls of the two species were of like proportions, the present must have measured over four feet in length. Species of *Goniopholis* have no mandibular foramen, so characteristic of the crocodiles, and its absence in the present species, together with the great width of the bone and its numerous deep pittings, indicates conclusively the brevirostrate character of the form. This is also indicated

by the large size of the anterior extremities, the bones preserved showing that they were fully as large as the posterior ones, a character also seen in *Goniopholis* and *Bernissartia*, and very different from the small fore legs of the longirostrate types."

The species may be considered valid.

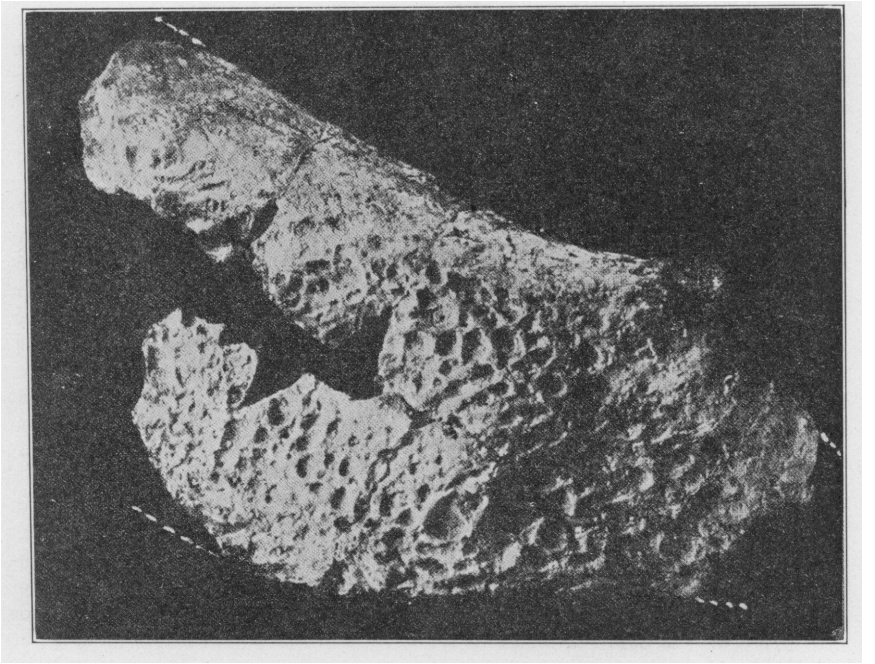

Fig. 42. *Cœlosuchus reedii* Williston. Cotype specimen, posterior portion of left mandibular ramus (Mus. Univ. Wyo. Coll.).
One-eighth natural size. External view. Original type figure. (After Williston.)

LEIDYOSUCHUS Lambe

ORIGINAL TYPE REFERENCE.—LAMBE, L. M., 1908, 'On a New Crocodilian Genus and Species from the Judith River Formation of Alberta,' Trans. Roy. Soc. Canada, Ser. 3, I, p. 221.

SUBSEQUENT REFERENCE.—GILMORE, C. W., 1910, 'Leidyosuchus sternbergii, a New Species of Crocodile from the Ceratops Beds of Wyoming,' Proc. U. S. Nat. Mus., XXXVIII, pp. 485–501 (Pub. No. 1762).

TYPE.—*Leidyosuchus canadense* Lambe.

ORIGINAL TYPE DESCRIPTION.—The characters of the genus were not separated from those of the type species by Lambe. See *Leidyosuchus canadensis*.

The genus may be considered valid.

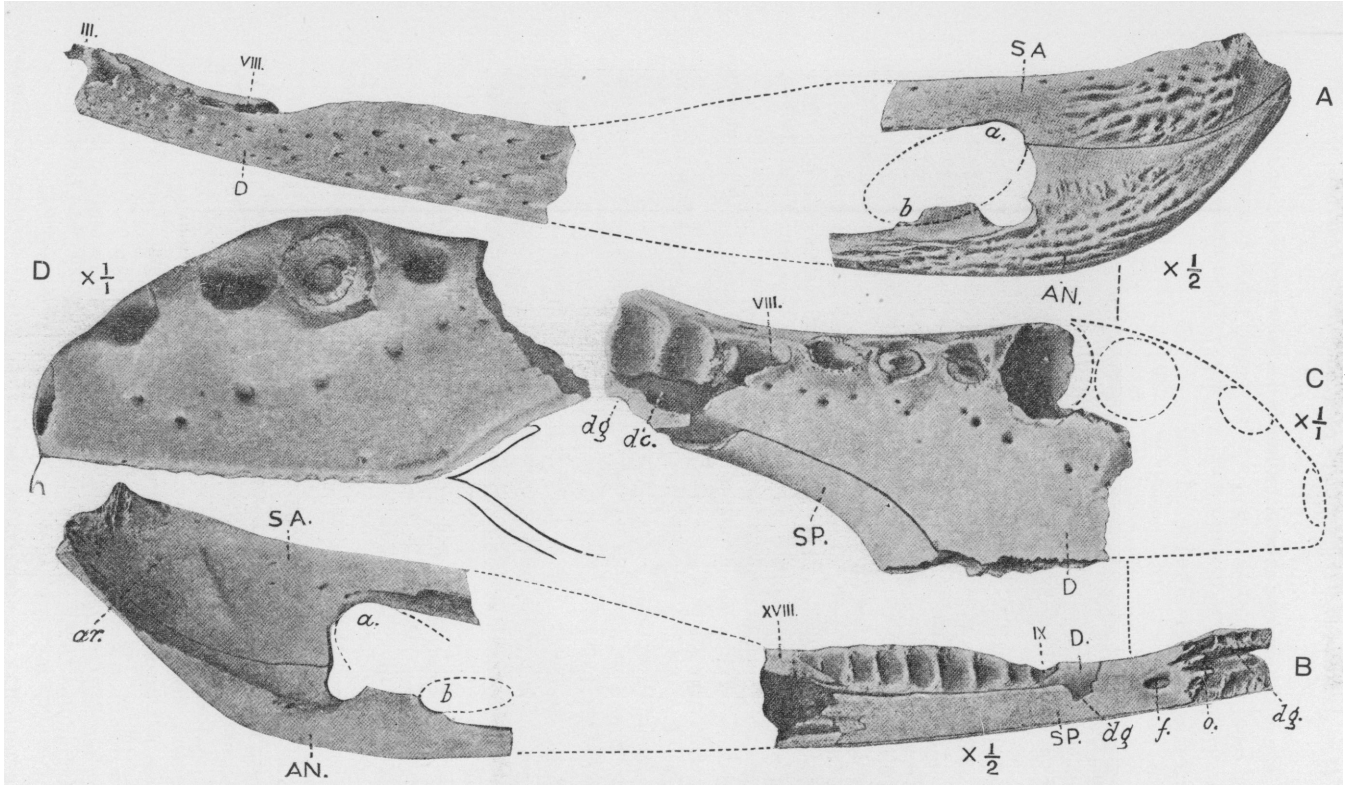

Fig. 43. *Leidyosuchus canadensis* Lambe. Type and paratype specimens; A, B, C, type, left ramus of mandible (Mus. Geol. Surv. Canada No. 338); D, paratype specimen, part of right dentary bone (Mus. Geol. Surv. Canada No. 808).

A, B, one-half natural size; C, D, natural size. A, external view of type; B, internal view of same; C, superior view of same; D, superior view of paratype; AN, angular; D, dentary; SA, surangular; SP, splenial; *a.*, external mandibular foramen; *ar.*, sutural surface for the articular; *b*, internal mandibular foramen; III., VIII., IX., XVIII., alveoli for the third, eighth, ninth and eighteenth teeth respectively; *dc.*, dental canal; *dg.*, dentary groove; *f*, postsymphysial foramen; *o.*, opening in suture between splenial and dentary for passage of dentary groove. Original type figures. (After Lambe.)

Leidyosuchus canadensis Lambe

ORIGINAL TYPE REFERENCE.—LAMBE, L. M., 1908, 'On a New Crocodilian Genus and Species from the Judith River Formation of Alberta,' Trans. Roy. Soc. Canada, Ser. 3, I, pp. 219–244, Pls. I–V.

SUBSEQUENT REFERENCE.—GILMORE, C. W., 1910, 'Leidyosuchus sternbergii, a New Species of Crocodile from the Ceratops Beds of Wyoming,' Proc. U. S. Nat. Mus., XXXVIII, pp. 485-500 (Pub. No. 1762).

ORIGINAL TYPE FIGURES.—LAMBE, L. M., 1908, 'On a New Crocodilian Genus and Species from the Judith River Formation of Alberta,' Trans. Roy. Soc. Canada, Ser. 3, I, Pls. I–V.

TYPES.—Type: the greater part of a left mandibular ramus, Mus. Geol. Surv. Canada No. 338; paratypes: the posterior portion of a cranium, Mus. Geol. Surv. Canada No. 1551; anterior end of a right dentary bone, Mus. Geol. Surv. Canada No. 808; parts of separate dentary bones showing the alveoli for the fifth to twelfth, third to ninth, and first to ninth teeth respectively, Mus. Geol. Surv. Canada Nos. 780, 1141, 1775a; parts of three angulars, Mus. Geol. Surv. Canada Nos. 1339, 1498 and 1702; jugals, Mus. Geol. Surv. Canada Nos. 250, 781, 1006, and 1627; separate frontal bone, Mus. Geol. Surv. Canada No. 1404; right squamosal, an anterior half and a posterior half, apparently parts of the same specimen, Mus. Geol. Surv. Canada Nos. 1765 and 782i; anterior end of a right maxilla, Mus. Geol. Surv. Canada No. 783; cervical, dorsal, sacral and caudal vertebræ; numerous separate teeth; numerous scutes, Mus. Geol. Surv. Canada.

TYPE LOCALITY AND LEVEL.—Red Deer River, Alberta, below the mouth of Berry Creek, Judith River beds.

ORIGINAL TYPE DESCRIPTION.—"The following characters are revealed by the above mentioned specimens:—

1. Mandibular symphysis short, contributed to by the splenial to the extent of about one-fifth of the total symphysial length.
2. Alveolar border of mandible undulating.
3. Teeth of unequal size, conical, slightly curved, almost smooth, with an inner area defined by carinæ, the third lower attaining nearly to the size of the enlarged fourth; apparently eighteen in each ramus.
4. An external mandibular foramen, as well as a smaller internal one, present.
5. A post symphysial foramen in the splenial.
6. Orbits confluent with the lateral temporal fossæ and larger than the supratemporal vacuities.
7. Eustachian canals enclosed.
8. The snout, as indicated by the anterior end of a maxilla, short and broad.
9. Fourth lower tooth received into a notch in the maxilla.
10. Pits of the sculptured bones of the head, and of the scutes, deep and separated by narrow ridges.
11. Vertebræ of the procœlian type.

These characters indicate a form of Eusuchia (procœlian type of vertebra) with a short snout, that differs entirely from the described brevirostrate forms in the entry of the splenial into the formation of the symphysis, a character claimed for the longirostrate forms of the suborder. A resemblance to Diplocynodon, Pomel, from the Lower Tertiaries of Europe is seen in the enlargement of both the third and fourth

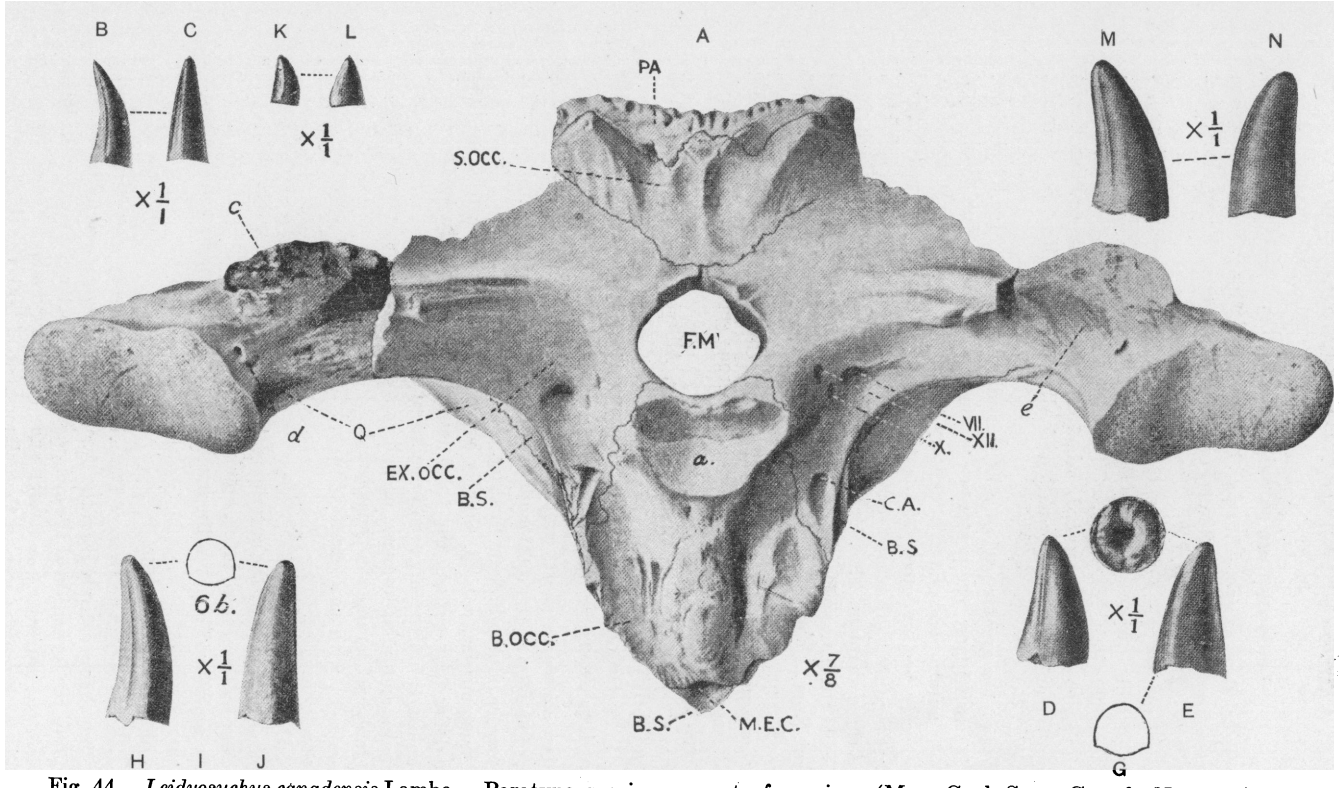

Fig. 44. *Leidyosuchus canadensis* Lambe. Paratype specimens, part of cranium (Mus. Geol. Surv. Canada No. 1551), seven-eighths natural size; and teeth (Mus. Geol. Surv. Canada Coll.), natural size.

A, posterior view of cranium; B, tooth, lateral view; C, the same, internal view; D, tooth, lateral view; E, the same, internal view; F, the same, basal view; G, the same, section at mid-height; H, tooth, lateral view; I, the same, internal view; J, the same, section at mid-height; K, tooth, lateral view; L, the same, internal view; M, tooth, lateral view; N, the same, internal view. B, OCC., basi-occipital; B.S., basisphenoid; EX. OCC., exoccipital; F.M., foramen magnum; M.E.C., opening of median Eustachian canal; PA, parietal; Q, quadrate; S.OCC., supraoccipital; *a*., broken surface of base of occipital condyle; *c*, suture for squamosal; *d*, foramen connecting with tympanic cavity; VII., X., XII., foramina for cranial nerves; C.A., foramen for carotid artery; *e*, canal between quadrate and exoccipital wing. Original type figures. (After Lambe.)

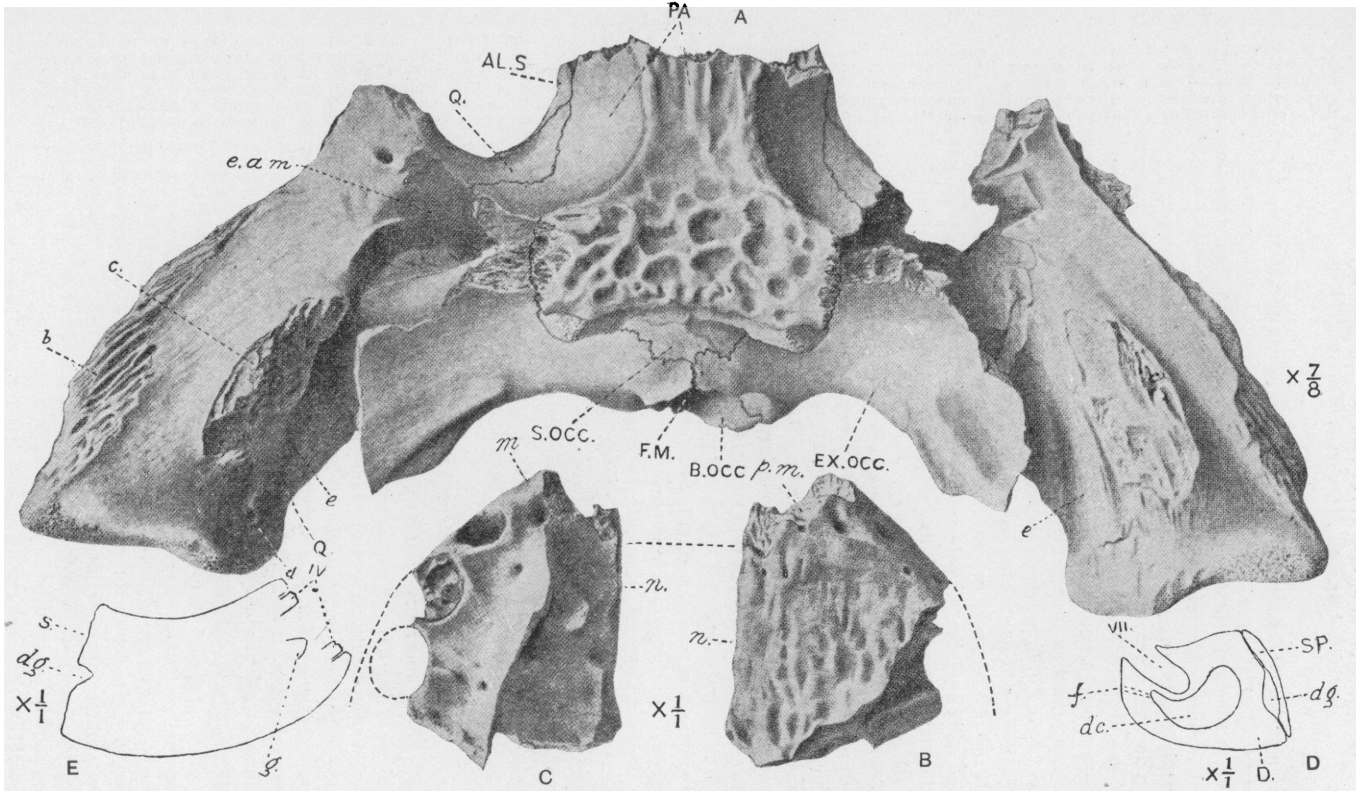

Fig. 45. *Leidyosuchus canadensis* Lambe. Type and paratype specimens, posterior portion of cranium (Mus. Geol. Surv. Canada No. 1551), seven-eighths natural size; anterior end of right maxillary (Mus. Geol. Surv. Canada No. 783), natural size; sections of mandibles, type and paratype specimens (Mus. Geol. Surv. Canada Nos. 338, 808), natural size.

A, posterior portion of cranium, superior view; B, right premaxillary, superior view; C, the same, inferior view; D, section through type mandible; E, section of paratype dentary; ALS., alisphenoid; B.OCC., basioccipital; D., dentary; EX.OCC., exoccipital; F.M., foramen magnum; Q., quadrate; S.OCC., supraoccipital; SP., splenial; *b*, suture for quadrato-jugal; *dc.*, dental canal; *dg.*, dentary groove; *e.a.m.*, external auditory meatus; *f.*, foramen; *g.*, germ tooth; *m.*, notch for fourth mandibular tooth; *n.*, suture for nasal; *p.m.*, suture for premaxillary; *s.*, symphysial surface of dentary; IV, fourth tooth; VII, alveolus for seventh tooth. Original type figures. (After Lambe.)

lower teeth (as shown by the alveoli). As a general rule in alligators the fourth lower tooth fits into a pit in the upper jaw, and in crocodiles into a marginal notch. There are exceptions to the rule, however, in each case. In Diplocynodon, a genus generally referred to the Alligatoridæ (of Zittel's classification), the fourth lower tooth may be received into either a pit or a notch. In the anterior end of the right maxilla from Red Deer river, a decided notch, next to the suture for the premaxilla, is preserved.

The species from Alberta may then be considered as a brevirostrate type of Eusuchia with resemblances to Diplocynodon but with a mandibular symphysis though short yet including the splenial as in some forms of the Goniopholidæ (Goniopholis, Owen). As it differs from any described species the name *canadensis* is considered appropriate and as its characters prohibit its being assigned to any known genus *Leidyosuchus* is proposed as a generic term. The writer has pleasure in associating the name of the celebrated palæontologist with this genus, particularly as Dr. Leidy was the first to record the occurrence of crocodilian remains in the Judith River formation in Montana.

Leidyosuchus occupies an anomalous position in the procœlian group of the Crocodilia. It is apparently a broadnosed form and its dentition suggests an affinity to Diplocynodon. The entry, however, of the splenial into the formation of the symphysis is an unexpected character here and one that has been considered, among the Eusuchia, as belonging to the longirostrate forms (Tomistoma, Gavialis, etc.).

The question arises—may not this species from Alberta be a direct descendant of one of the brevirostrate forms of the amphicœlian Goniopholidæ, (Purbeckian and Wealden), having adopted a procœlian type of vertebra but still retaining the splenial in the symphysis. In the genus Goniopholis for instance the splenial enters the symphysis to a slight extent, also the teeth are longitudinally grooved, a resemblance indicated by the very faint fluting of the teeth of Leidyosuchus. In this connection it is interesting to note that the Judith River (Belly River) fauna harks back in a number of instances to Jurassic forms. It includes turtles of the Jurassic family Pleurosternidæ, Plesiosaurs and specialized Stegosaurs; a species of Ornithomimus (*O. altus*) is probably a successor to the Upper Jurassic Ornitholestes.

Mandible of Leidyosuchus.

The parts of the lower jaw, found together, consist of two pieces from the front and back halves of the left ramus almost completing its length (plate I, figs. 1, 1*a*, 1*b*). A portion at mid-length (restored in the figure) consisting principally of the posterior ends of the dentary and splenial bones, was not recovered. The specimen lacks the articular and coronoid elements, and the anterior end of the dentary, in advance of the alveolus for the third tooth, is missing. The alveoli of the third and succeeding fifteen teeth are preserved and it is possible that another tooth or perhaps two may have occurred posterior to the eighteenth behind which the fracture in the specimen occurs. Judging from the alveoli the fourth tooth was the largest, the third was nearly if not quite the size of the fourth, the fifth to the tenth were small and of nearly equal size, the eleventh, twelfth and thirteenth were slightly and about equally enlarged, posterior to the thirteenth the teeth gradually decreased in size to the eighteenth which was of about the size of those immediately behind the fourth. The bases of the fourth, fifth and sixth teeth are preserved in their sockets. The alveoli are complete apparently to and including the ninth, beyond this the bony divisions separating them are gradually less developed and take the form of ridges,

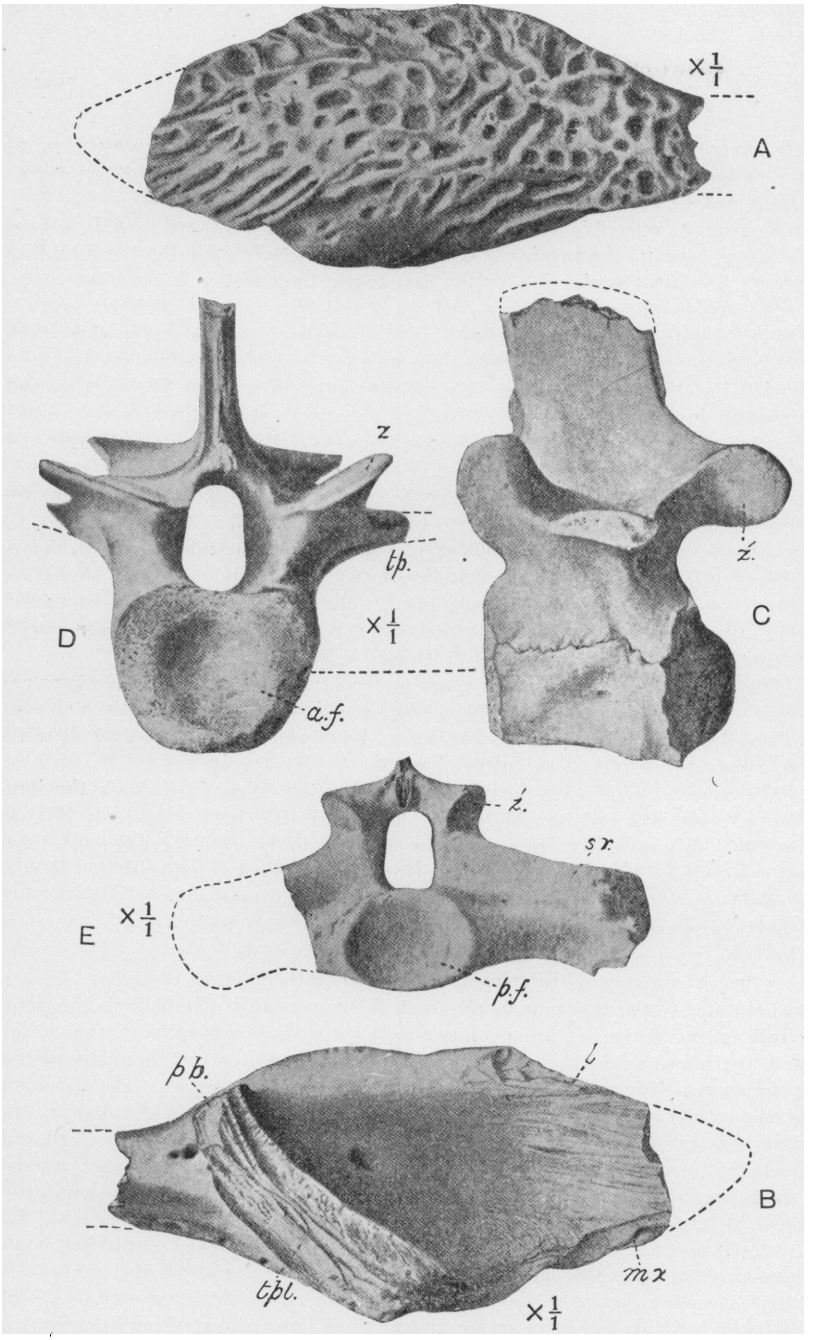

Fig. 46. *Leidyosuchus canadensis* Lambe. Paratype specimens, left jugal (Mus. Geol. Surv. Canada No. 1627); dorsal and sacral vertebræ (Mus. Geol. Surv. Canada Coll.).

Natural size. A, jugal, external view; B, the same, internal view; C, dorsal vertebra, lateral view, left side; D, the same, anterior view; E, second sacral vertebra, posterior view; *a.f.*, anterior surface of centrum; *l*, suture for lachrymal; *mx*, suture for maxillary; *pb.*, base of postorbital bar; *p.f.*, posterior face of centrum; *s.r.*, sacral rib; *tp.*, transverse process; *tpl.*, suture for ectopterygoid; *z*, prezygapophysis; *z'*, postzygapophysis. Original type figures. (After Lambe.)

on the inner side of the outer wall of the dentary. These ridges decrease in prominence backward until, between the last three teeth, there is only a slight indication of separate sockets, an evidence probably of immaturity in the individual.

Viewing the mandible from the side the outline of the dentary below, in advance of the anterior end of the angular, is straight and horizontal to the slight upturn of the extremity beneath the alveolus for the first tooth, the exact form anteriorly being given by the specimen shown in plate I, fig. 2 and by a smaller specimen (cat. No. 1775a) not figured. The alveolar border above is broadly undulating in curves that are more pronounced than in the living alligator (*Caiman latirostris*). The dentary is constricted in the neighborhood of the eighth tooth; in advance of this it expands horizontally inward and outward, attaining its greatest anterior breadth in line with the centre of the fourth tooth; posterior to the constriction the alveolar border rises in a broad convex curve to the position of the twelfth tooth adding considerably to the depth of the dentary whose upper border then continues, parallel to the inferior surface, in an almost horizontal line to the eighteenth tooth. The front teeth, the first to the fourth, were directed obliquely outward, the first and second particularly so, the other teeth had a decided inclination outward up to about the twelfth, back of which a more upright position was assumed. The reader's attention is drawn to a similar outward inclination of the front teeth of the mandible of *Diplocynodon gracile*,[1] Vaillant, from the Lower Miocene of St. Gérard le Puy (Allier) France.

The mandibular symphysis is short and contributed to by the dentary and splenial together, its posterior end being in line with the hinder edge of the alveolus for the sixth tooth. The splenial enters into the formation of the symphysis to the extent of about one-fifth of the latter's length.

A groove (Meckel's), enclosed outwardly by the splenial, channels the inner surface of the dentary at its mid-height, (*dg*, plate I, figs. 1*a*, 1*b*, and plate III, figs. 1*c* and 2*a*). It passes, in its more anterior course, from beneath the splenial forward along the symphysial surface as far as a point opposite the division between the third and fourth teeth. The exit of the dentary groove from under the splenial is made through a transversely oval orifice (3.5 mm. wide and 2 mm. high) at the anterior end of this bone in the suture between it and the dentary (*o*, plate I, fig. 1*a*). The opening is bounded principally by the splenial, the groove in the dentary being here shallow. Thus, anterior to the two splenial elements of the mandible, the dentary grooves of the rami meet and are continued forward in the symphysial surface as a tubular channel between the dentary bones with its termination at about the mid-length of the symphysis. The symphysial surface of the splenial is rugose, that of the dentary is comparatively smooth. Behind the symphysis, the splenial, which is here thin with a convex outer surface, is pierced by a longitudinally elongated foramen (*f*, plate I, fig. 1*a*) that opens into the Meckelian groove. On removing the splenial a small foramen is seen in the dentary, beneath the opening in the splenial and at the lower edge of the groove, leading into the dental canal (*dc*, plate I, fig. 1*b* and plate III, fig. 1*c*). This canal passes forward, from the large cavity in the posterior half of the ramus, longitudinally through the dentary beneath the alveoli for the teeth. The splenial is applied closely to the dentary above and below the dentary groove. Mr. C. W. Gilmore in his able work on the 'Osteology of Baptanodon[2] (Marsh)' refers to a similarly placed opening in the splenial of *B. discus* from the Jurassic of Wyoming.

[1]Ann. Sci. Géol. vol. III, art. 1, p. 18 (1872).'
[2]Memoirs of the Carnegie Museum, Pittsburgh, Vol. I, No. 2, 1905.'

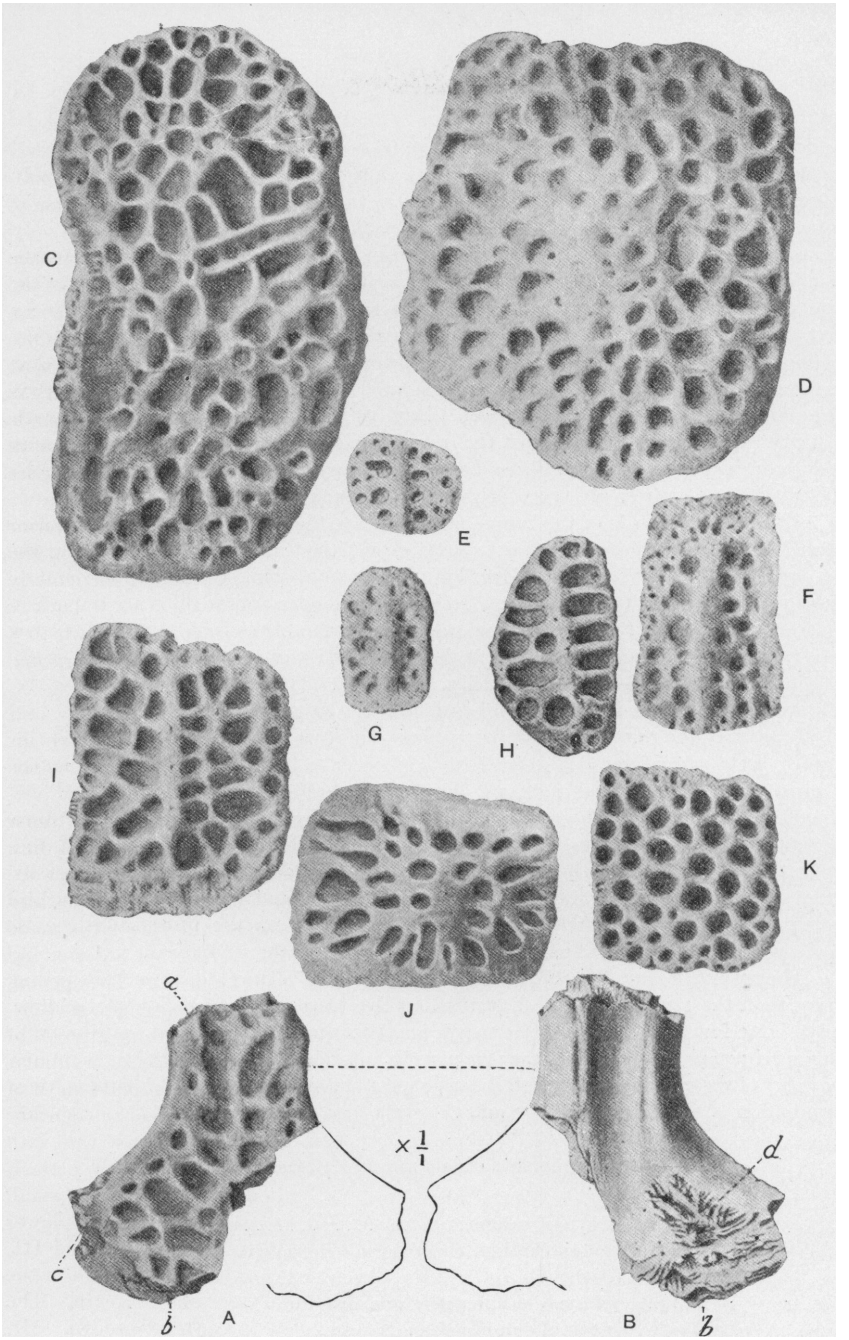

Fig. 47. *Leidyosuchus canadensis* Lambe. Paratype specimens, frontal bone (Mus. Geol. Surv. Canada No. 1404); and scutes (Mus. Geol. Surv. Canada Coll.).

Natural size. A, frontal, superior view; B, the same, inferior view; C–K, scutes, dorsal views; *a*, suture for prefrontal; *b*, suture for parietal; *c*, suture for postorbital; *d*, suture for alisphenoid. Original type figures. (After Lambe.)

In describing the splenial Mr. Gilmore on p. 96 of his memoir says 'On the internal surface, just posterior to the symphysis is an elongated oval foramen that probably represents the internal mandibular foramen of the crocodile, though in this case it appears to be wholly enclosed by the splenial while in the crocodile the splenial only forms the anterior border.' In the mandible from Red Deer river the internal mandibular foramen is shown in its usual posterior position partly enclosed by the angular. A number of small foramina occur anteriorly in the upper surface of the dentary in an irregular line close to the alveoli on their inner side. The inner portion of the dentary behind the eighth tooth is missing but it appears to have enclosed the alveoli as far back as the thirteenth, judging from a portion of a dentary bone (cat. No. 780) that includes the sockets for the fifth tooth to the twelfth. Posterior to the thirteenth tooth the splenial probably formed the inner boundary of the alveoli. In the ramus under consideration the splenial has been broken away above from the eighth tooth backward, but is partly preserved below as far back as the sixteenth.

The other elements of the ramus preserved are the angular and the surangular. These two bones overlap each other to some extent, the thin vertical surangular passing down within the angular, the overlap immediately behind the external mandibular foramen amounting to 13 mm. Both the surangular and angular are imperfect anteriorly, but in the former the upper posterior margin of the large exterior foramen is preserved (*a*, figs. 1 and 1*a*) whilst in the latter the lower posterior half of the small interior foramen is clearly shown (*b*, figs. 1 and 1*a*). The surface of contact for the articular is seen on the inner posterior surface of the surangular.

Exteriorly the ramus exhibits very rugose sculpture in its hinder half. Here the surface of the surangular from near its upper border to its junction with the angular is broken into an irregular network of ridges enclosing deep depressions and pits elongated horizontally. The surface of the angular is also rough but in it the sculpture consists principally of ridges, following the curve of the lower margin of the jaw, and separated by deep and rather irregular grooves. The dentary on the whole of its outer and lower surface exhibits numerous scattered vascular openings leading obliquely forward into the interior of the bone. Its lower surface anteriorly is roughened by numerous longitudinal grooves inclined toward the symphysis.

The specimen (cat. No. 808) shown in plate I, fig. 2, is the anterior end of a ramus larger than the type. The alveoli of the first five teeth are preserved with the base of the large fourth tooth still in its socket and enclosing a successional tooth within. This specimen gives the form of the whole of the anterior end of the ramus and supplies that part of the symphysis in which the type specimen is deficient. It shows the front termination of the dentary groove and the surface to which the spenial was applied.

Measurements of left ramus of mandible.

	MM.
Estimated length of ramus	335
Breadth of ramus through centre of alveolus for fourth tooth	31
Height of symphysis in line with same alveolus	18
Estimated length of symphysis	57
Length of symphysis preserved	33
Length of splenial contribution to symphysis	11.5
Length of postsymphysial foramen	7.5

Measurements of left ramus of mandible. (*Continued*)

Height of same	3.2
Height of splenial behind above foramen	16
Breadth of dentary at alveolus for eighth tooth	18
Height of same in line with same alveolus	17.5
Height of ramus at posterior end of external mandibular foramen	53
Thickness of angular a little above lower border where last measurement was taken	16
Thickness of surangular at upper border ditto	8.5
Length occupied by alveoli from fourth to eighteenth tooth	128

POSTERIOR PORTION OF THE CRANIUM.

The specimen already mentioned as the posterior portion of a cranium (cat. No. 1551) includes that part of the skull behind an imaginary transverse plane passing vertically downward from the frontal suture of the coalesced parietals. The squamosals, post frontals and quadratojugals are missing but the quadrates are preserved almost in their entirety. The sutures are clearly seen and the foramina in the occiput are well preserved. The interior of the brain case is exposed to view from the front showing the sutures of the parietal, the alisphenoids and the pro-otics. The walls of the brain case, however have suffered considerable damage and are broken away in the neighborhood of the internal auditory meatus on both sides. A separate frontal bone and separate jugals admit of some idea being formed of the relative size of the orbits.

Viewing the specimen from above (plate III, fig. 9), the bone formed of the coalesced parietals occupies the central position with the inner halves of the supratemporal vacuities bounding it laterally in front. Posteriorly on either side of the parietal bone is the suture for the squamosal both of which bones are unfortunately missing. The squamosal with the postfrontal (also lost on both sides) apparently completed the margin of the supratemporal vacuity without the intervention of the frontal. This last bone, judging from a specimen found separately, and to be described later, seems to have taken no part in the formation of the opening (or at most reached the border only for a very short distance), the postfrontal and the parietal nearly, if not actually, meeting behind it. In sutural contact with the parietals below are the widely extending quadrates. On the lateral anterior edge of each of these bones is seen the suture for the quadratojugal, *b*, plate III, fig. 9, and on the upper surface the suture for the squamosal, *c*, plate II, fig. 3, and Plate III, fig. 9. Overlapping the quadrate and joined to it in a broad sutural surface behind is the alar extension of the exoccipital, imperfect at its lateral extremity in each case. On the upper surface of the quadrate between this suture and the inner edge of its condyle is the small foramen *d*, figs. 3 and 9, which connects by a canal with the tympanic cavity and also is, in life, in communication with the interior of the articular bone of the mandible.

In a posterior view of the specimen, plate II, fig. 3, the position and relative size of the several elements composing the occiput are clearly shown as the sutures are well preserved and can be traced without difficulty. Comparing the occiput with that of *Diplocynodon hantoniensis* (Wood) as described and figured by Owen in his

Monograph on the Fossil Reptilia of the London Clay,[1] &c., under the name *Crocodilus hastingsiæ* (Eocene of Hampshire), p. 39, plate VI, fig. 2, it is seen to be narrower in proportion to its height. The parietal bone appears to a slight extent in the occipital aspect of the specimen. Beneath it is seen the supraoccipital, of the same breadth above as the parietal is behind, reaching downward to within a short distance of the upper edge of the *foramen magnum*. Meeting in the median line above the foramen magnum and forming the upper and lateral boundaries of that opening are the large exoccipitals which meet the basioccipital below and are produced laterally over the jugals in an extensive sutural union. The exoccipitals are prolonged downward, at their inner ends, exterior to the basioccipital. This latter bone forms the lower boundary of the foramen magnum and is deeper than broad, its upper half lying between the downward extensions of the exoccipitals. In the occipital view the basisphenoid is almost completely hidden by the basioccipital. Between these two bones at their lower extremities is the opening of the median Eustachian canal, M. E. C., plate II, fig. 3. Four foramina pierce the exoccipital; of these, three are close together in line with the mid-height of the foramen magnum. They are, in order receiving from this opening, the foramen for the *hypoglossal nerve*, XII, fig. 3, the foramen for the *vagus* or *pneumogastric nerve*, X, fig. 3, and one, the largest, for the *facial nerve*, VII, fig. 3. Near the lower extremity of the exoccipital is the foramen for the entry of the *internal carotid artery*, C. A., fig. 3.

The position of the *external auditory meatus*, leading into the *tympanic cavity* is seen at *e. a. m.*, plate III, fig. 9. The specimen here has suffered considerable damage so that the intricate structure of this part of the cranium cannot be satisfactorily made out.

Leading back from the tympanic cavity is a canal through which passed the cartilaginous rod that during the life of the animal was continuous with *Meckel's cartilage* in the mandible. The floor of this canal is seen at *e*, plate II, fig. 3 and plate III, fig. 9, in the upper surface of the quadrate. This canal thus has its exit behind between the quadrate and the lateral wing of the exoccipital as in modern alligators and crocodiles.

In side view, the occiput, leaving out of consideration the occipital condyle (which is broken off from the specimen), extends farthest back in the neighborhood of the foramen magnum; the upper half, which is concave, inclines decidedly forward up to the parietal, and the lower half to a somewhat greater extent forward in passing down to the lower extremity of the basioccipital. Viewing the specimen from this standpoint the basisphenoid appears on the surface as a narrow strip of bone between the pterygoid and the basioccipital below, and the quadrate and basioccipital above. It reaches farther down than the basioccipital and ends above, in contact with the quadrate, in line with the floor of the foramen magnum. The quadrate extends downward to meet the pterygoid, its lower extremity being at about the same level as the lower end of the downward extension of the exoccipital.

Anteriorly the quadrate bounds the pro-otic and alisphenoid behind and meets the parietal from below in a horizontal suture. The large *foramen ovale*, the opening for the passage of the *trigeminal nerve*, is preserved. It is bounded behind by the *prootic* and in front by the alisphenoid. Anteriorly the *rostrum* of the basisphenoid is broken off, leaving exposed the pair of foramina that lie immediately beneath the *pituitary fossa*. These two foramina provide for the passage of the carotid arteries.

[1] 'Palæontographical Society, London, 1850.'

In advance of the basisphenoid are the coalesced pterygoids of which only a small portion remains in the median line clasping the anterior face of the basisphenoid. The posterior narial opening is not preserved but a small part of the roof of the narial passages remains in the pterygoid fragment immediately in front of where the opening evidently was. This roof (inclined upward and forward at an angle of 45 degrees to the horizontal) exhibits two longitudinal channels, side by side, each of which consists of a succession of oval or oblong shallowly excavated depressions placed end to end.

Within the brain case the sutures between the parietal and the alisphenoids are well shown as well as those between the latter and the pro-otics. Behind the parietal and bounding the pro-otic above in rear is part of a bone that is evidently the epiotic. The basisphenoid appears in the floor of the brain case in advance of the basioccipital. The pro-otics rise from the superior border of the former posteriorly and reach forward below the foramen for the trigeminal nerve. The roof and sides of the brain case are considerably damaged behind as are also the walls of the tympanic cavities.

Cranial measurements.

	MM
Width between outer edges of quadrates, posteriorly	201
Height of occiput, in median line, from upper surface of parietal to anterior edge of opening of median Eustachian canal	90
Height of foramen magnum	14
Width of same	17
Height of basioccipital, in median line	42.5
Breadth of same at mid-height	39
Height posteriorly of supraoccipital, in median line	21.5
Breadth of condyle of quadrate	39
Height of same at centre	15
Breadth of upper surface of parietal posteriorly	43
Length of upper surface of parietal, in median line	38
Thickness of parietal anteriorly, in median line	12.5
Breadth of exposure of basisphenoid, anteriorly in advance of pro-otics	30
Breadth of coalesced pterygoids at junction with lower extremity of quadrate	40
Width of brain cavity at its mid-height, above foramen for trigeminal nerve	19.5
Height of same at centre, in line with same foramen	26
Height of exposed lateral surface of basisphenoid behind	44
Breadth of same exposed surface at mid-height	11
Length of surface preserved of roof of narial passage	19
Width of same behind	10
Distance of posterior end of same to anterior edge of opening of median Eustachian canal	16

Separate frontal bone.

The separate frontal bone (cat. No. 1404, pl. V, figs. 14 and 14*a*) has a general outline, seen from above, very similar to that of the uppermost plane surface of the parietal bone. It is broad behind and narrow in front with a maximum breadth about equal to its length. Its sides are excavated for a distance of nearly three-fourths of its

length from the front by the inner border of the orbital opening which greatly reduces the anterior breadth of the bone. Laterally in front are the sutures for the prefrontals, *a*, plate V, fig. 14, between which is a small fractured surface indicating apparently where the front forward prolongation of this bone, that probably was partially overlapped on either side by the prefrontals and more anteriorly by the inner back edges of the nasals, is broken off. The suture for the parietal, *b*, figs. 14 and 14*a*, extends the full breadth of the bone posteriorly. On either side behind the orbital emargination is the suture, *c*, fig. 14, for the postfrontal. The upper surface is ornamented with large pits wider than the narrow ridges separating them. These pits occur with a decided bilateral symmetry. The whole of the under surface of the bone is free and smooth with the exception of an area on either side posteriorly for the sutural junction of the alisphenoids, *d*, fig. 14*a*. Between these sutural surfaces is the continuation of the concave roof of the brain cavity which narrows rapidly and extends forward (over the olfactory tract of the brain), as an axial groove, to the prefrontal sutures. Laterally the surface slopes evenly upward and outward to the orbital emarginations of the upper surface.

Separate jugal.

The separate left jugal, plate IV, figs. 11 and 11*a*, is roughly rhomboidal in lateral outline. It is robust behind where it gives off superiorly the process, *pb.*, that contributes with the transpalatine to the formation of the postorbital bar. Behind the process the specimen remains thick but narrows rapidly for a short distance, beyond which in this and in five other jugals of different sizes the part that is applied to the quadratojugal is missing, the fracture in each case being a short distance behind the postorbital bar. On the inner surface of the process and extending downward and forward is the suture the *tpl.*, for the transpalatine. In advance of the suture the bone is excavated and continued forward to a point as a thin plate between the lachrymal and the maxilla which it meets in the long sutures, *l.* and *mx*, defining the anterior end of the bone. Between the posterior end of the lachrymal suture and the process is the free edge that forms part of the outer margin of the orbit. Behind the process the bone aids in the enclosure of the *lateral temporal fossa*. A number of foramina occur in the inner surface of the bone as shown in fig. 11*a*. The convex exterior surface is irregularly and very rugosely sculptured with deep pits enclosed by narrow ridges. One of the jugals is larger than the figured and most perfect specimen and four are smaller, the least being between one-third and one-half the size of the one figured. All agree in general proportions and in the style of sculpture.

Anterior end of maxilla.

The anterior end of a right maxilla (cat. No. 783, plate III, figs. 10 and 10*a*) has preserved in it the alveoli for three teeth behind the suture for the premaxilla which is shown in full. This suture, *pm.*, is short and runs slightly backward in its inward course. On the inner side is a straight suture, *n*, for the nasal. A prominent feature in this specimen is its rapid increase in breadth behind the premaxillary suture indicative of a short and broad snout. In advance of the first of the three alveoli (viz. those for the sixth, seventh and eighth teeth) and between it and the outer end of the suture is a shallow but decided notch, *m*, into which the fourth lower tooth evidently fitted. This notch is not so marked as the one figured by Ludwig in connexion with his description of *Crocodilus ebertsi* from the Lower Miocene (Upper Oligocene) of the

Mayense basin.[1] In many particulars there are points of resemblance between the Alberta species and *C. ebertsi* as well as *Alligator darwini*, Ludwig, also from the Upper Oligocene of the Mayense basin (Weissenau) (op. cit.) both of which species are referred by Lydekker[2] to the genus Diplocynodon. The same authority regards *D. ebertsi* as identical with *D. gracile*, Vaillant, already mentioned in describing the mandible. The upper surface of the maxillary fragment is concave and rises rapidly behind; it is rendered rough by irregular, short, longitudinal ridges. A few vascular foramina occur a short distance above the alveolar border and smaller ones behind the suture for the premaxilla. Beneath, the thin plate-like inward continuation of the bone forming part of the palate, is broken away not far from the alveoli, exposing the longitudinal excavation for the narial passage. Here also are small foramina near the inner alveolar border. The three alveoli are placed close together and are of fair size, the first (that of the sixth tooth) being the smallest. The palatal part of the bone presents a plane surface and there are no pits for the reception of the lower teeth, viz. those behind the fourth which are all of small size, at least up to the tenth. It is probable that all the lower teeth behind the fourth fitted within the upper teeth. The enlarged lower third tooth in addition to the fourth probably was received into a notch of which only half was contributed to by the maxillary bone. The obliquity of the first three alveoli of the mandible is suggestive of an interlocking of the anterior lower and upper teeth. Attention may here be drawn to the fact that the third and fourth lower teeth of *Diplocynodon ebertsi* (Ludwig) are received into a notch in the maxilla behind the premaxillo-maxillary suture. From this specimen it is impossible to tell how far the nasals extended but judging from the straightness of the naso-maxillary suture it is probable that they reached a point in advance of the maxillaries.

Teeth.

The teeth, of which there are over sixty, found separately, are in shape elongato-conical and slightly curved. The crown bears on each side a distinct, sharp-edged ridge placed a little toward its inner surface and extending from the apex to near the base. These ridges define laterally an area on the inner surface that is less convex than the outer surface and in breadth slightly exceeds one-third of the circumference of the tooth.

The Alberta teeth vary considerably in size. The larger ones are broad in proportion to their length; the smaller ones are comparatively slender. Most of them show signs of wear and in many, more particularly the slender ones, a faint longitudinal fluting is observed generally most apparent at the mid-height of the crown on the inner face. The majority of them appear to have been shed. The upper end of the pulp cavity is indicated by a small excavation in the base of the crown.

In the anterior end of the right ramus, shown in pl. I, fig. 2, the base of the fourth tooth is preserved and exceeds in diameter that of any of the teeth found separately. Within this base is a successional tooth (indicated in the figure) that agrees in shape and enamel marking with other germ-teeth in the collection. These show the lateral keels meeting at the apex and have a lustrous surface caused by minute, longitudinal wrinkles in the enamel converging to the point.

The height of the crown relative to the basal breadth in a few of the specimens is given by the following measurements in mm., the height being the first of each pair

'[1]Palæontographica, supplement, vol. III, pt. IV, 1887, p. 31, Pl. III, fig. 5.'
'[2]Catalogue Fossil Reptilia and Amphibia, Brit. Mus., pt. I, 1888, pp. 46 and 50.'

of numbers:—21–10, 20–11, 17–20, 22–9, 17–8, 15–8, 14–7.5, 13–7, 13.5–5, 11.5–6, 11.5–4.5, 11–4, 10–5, 8–4, 7–4.5.

Vertebræ.

The vertebræ from Alberta are of the procœlian type and resemble in general form those of the living Crocodilia. They were found separately and are from the cervical, dorsal, sacral and caudal regions. They include two second sacrals and a first caudal.

The largest and most complete specimen is regarded as a late dorsal, plate IV, figs. 12, 12*a*, although, as the bases only of the transverse processes remain, it is possible that it is one of the lumbar vertebræ. The zygapophyses are preserved as well as the neural spine from which the tip is broken off. The centrum is well excavated in front and is convex behind. Its inferior surface is flat and laterally it is slightly pinched beneath the mid-height. It increases in breadth beneath the suture for the neural arch which is robust and rises from the dorsal surface of the centrum. The neural canal is narrow and high. The neural spine and the zygapophyses present no unusual characters and resemble somewhat those of a living crocodile. The transverse processes are given off well up on the neural arch about on a level with the mid-height of the neural canal. The zygapophyses with the bases of the transverse processes at a slightly lower level, together form an undulating platform of considerable extent.

Measurements of dorsal vertebra, cat. No. 1508,	MM.
Length of centrum	33
Anterior height of same	22
Breadth of anterior end of same above mid-height	27
Distance apart of outer edges of prezygapophyses	47
Width of neural canal	11
Height of same	15

With the exception of a centrum representing a dorsal vertebra about the size of the above, the other specimens from the dorsal (or lumbar) region are smaller and belonged to younger individuals; the only differences noticed would be those resulting from a difference of position in the series.

The cervical vertebræ are represented by centra of small size. The best preserved centrum (cat. No. 1908) is short and deeply excavated laterally. The anterior articular face is concave, the posterior one convex. On each side inferiorly is a facet for the articulation of the capitulum of the cervical rib. The other cervical centra are similar to the above specimen and show the facet for the rib in a like forward position. One of the specimens is larger than the others but otherwise is the same and gives no additional information.

Measurements of cervical centrum, cat. No. 1908.	MM.
Maximum length	19
Anterior breadth	19.5
Height of anterior face in median line	11
Breadth of posterior face	16
Height of posterior face in median line	11.5

The better preserved of the two second sacral vertebræ is shown, viewed from behind, in plate IV, fig. 13, (cat. No. 1010); some measurements taken from it are as follows:—

	MM.
Maximum length of centrum	27
Breadth of posterior articular face of same	16
Height of posterior articular face of same	13
Width between outer edges of postzygapophyses	22
Breadth from median line of centrum to distal end of sacral rib (imperfect)	32
Height of neural canal posteriorly	10.5
Width of same posteriorly at mid-height	8
Breadth of anterior articular face of centrum	16.5
Height of same	11.5

Scutes.

The dermal armour is represented by over fifty pitted scutes none of which with certainty can be said to have belonged to the ventral surface. The majority of the scutes are nearly square or oblong with rounded angles and a smooth, flat or transversely concave under surface. Those that are flat (or somewhat convex) beneath usually have the pits of the upper surface disposed without apparent order, those in which there is a decided transverse curvature to the plate (causing the under surface to be slightly concave) generally have a low, longitudinal keel developed above, from which the pits diverge on either side to a greater or less extent, with a tendency to show a radial pattern. In some specimens the keel extends the full length of the plate, in others it is shorter or it may be reduced to a central raised area in which case the radiating arrangement of the pits becomes more pronounced. The scutes range in breadth from about 15 to over 50 mm. It is thought that those without keels may have belonged to the ventral surface.

The pits are conspicuous, deep depressions separated from each other by a reticulation of smooth, narrow ridges. They vary in size considerably, their outlines being roughly circular, quadrilateral or polygonal with rounded angles, or oval with the major axis of the elongated ones in a direction as a rule at right angles to the margin of the scute. The supposed ventral scutes are ornamented with pits that show little variation in size and are nearly circular in outline.

A dorsal scute is shown in plate V, fig. 15. It is broader than long, with a short longitudinal keel or central raised area from which the pits radiate. It is thickest (4.5 mm) at the centre and thins gradually in all directions outward; the front and hinder borders coming to a sharp edge. The sides retain a thickness of nearly 2 mm., and are rough having probably been in contact with a scute on each side. The surface is smooth for a short distance back from the front edge forming a marginal tract that was overlapped by the scute immediately in front. The under surface is quite smooth and in a transverse direction slightly concave.

Figures 16, 17 and 19 give representations of the scutes in which the keel extends almost their full length. These scutes have not a well defined smooth area indicative of having been overlapped. The edges in front and behind are thin but the lateral edges are rough particularly in the two smaller specimens (figs. 17 and 19) which exhibit sutural surfaces of some thickness (about 4.5 in fig. 17). The under surface, in the three, is transversely concave.

A small almost circular scute (fig. 20) has a very decidedly concave under surface. Its front and back edges are sharp, the lateral ones comparatively thick.

The long very deeply pitted scute represented in fig. 18, has a slightly convex under surface. Its edges are slightly irregular, not very thin and nowhere exhibit what would constitute a sutural surface.

A supposed ventral scute, fig. 23, has no keel; it is almost square and slightly convex above and below. It thins toward the edges but much less toward one side (the left in the figure) where the edge is, at its mid-length, about 2.5 mm. thick and evidently forms a definite sutural surface. This scute may be one of two pieces composing a compound ventral plate similar to those of species of Diplocynodon.

Two scutes, plate V, figs. 21 and 22, are conspicuous on account of their size. One fig. 21, is very decidedly bent so as to be transversely very concave beneath. A short longitudinal keel is developed and laterally the edges remain thick and rugose. The other is flat below, is without a keel, and no evidence of sutural contact with other scutes is recognizable; it is possible that this scute is from the upper surface of the neck and formed part of a neck-shield.

The maximum thickness of each of the scutes figured in plate V is given in the following measurements:—fig. 15, (cat. No. 1146), 4.5 mm.; fig. 16, (cat. No. 1705) 7.5 mm.; fig. 17, (cat. No. 1527), 5 mm.; fig. 18, (cat. No. 975), 4.5 mm.; fig. 19, (cat. No. 1837), 3 mm.; fig. 20 (cat. No. 1614), 3 mm.; fig. 21 (cat. No. 377), 9 mm.; fig. 22, (cat. No. 960), 9.5 mm.; fig. 23, (cat. No. 869), 4 mm."

The species may be considered valid.

Leidyosuchus sternbergii Gilmore

ORIGINAL TYPE REFERENCE.—GILMORE, C. W., 1910, 'Leidyosuchus sternbergii, a New Species of Crocodile from the Ceratops Beds of Wyoming,' Proc. U. S. Nat. Mus., XXXVIII, pp. 408–502, 2 figs., Pls. XXIII–XXIX (Pub. No. 1762).

SUBSEQUENT REFERENCE.—None exists at the present time to the best of the writer's knowledge.

ORIGINAL TYPE FIGURES.—GILMORE, C. W., 1910, 'Leidyosuchus sternbergii, a New Species of Crocodile from the Ceratops Beds of Wyoming,' Proc. U. S. Nat. Mus., XXXVIII, pp. 405–502, figs. 1, 2, Pls. XXIII–XXIX.

TYPE.—Greater portion of the skull, left mandibular ramus, anterior part of right ramus, eight vertebræ, both humeri, right fibula, second left metatarsal and fragmentary parts of skeleton. U. S. Nat. Mus. No. 6533.

TYPE LOCALITY AND LEVEL.—North side of Cheyenne River, Converse County, Wyoming. Ceratops Beds.

ORIGINAL TYPE DESCRIPTION.—"Viewed from above the form of the skull resembles that of the living crocodile, although compared with *Crocodilus 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 parts 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

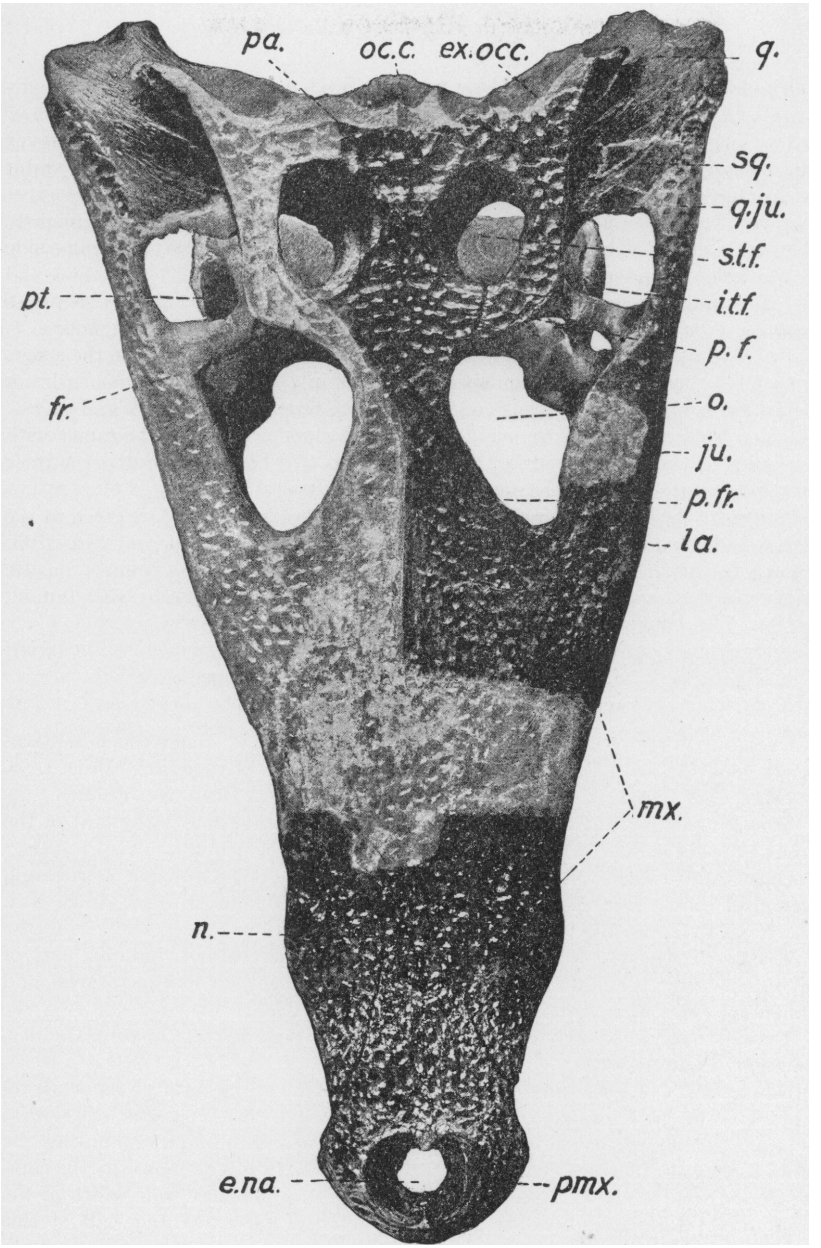

Fig. 48. *Leidyosuchus sternbergii* Gilmore. Type specimen, skull (U. S. Nat. Mus. No. 6533).

One-half natural size. Superior view; *e. na.*, external nares; *ex. occ.*, exoccipital; *fr.*, frontal; *i.t.f.*, infratemporal fenestra; *ju.*, jugal; *la.*, lachrymal; *mx.*, maxillary; *n.*, nasal; *o.*, orbit; *oc.c.*, occipital condyle; *pa.*, parietal; *p.f.*, postorbital (postfrontal in Gilmore's caption); *p.fr.*, prefrontal; *pmx.*, premaxillary; *pt.*, pterygoid; *q.*, quadrate; *q.ju.*, quadratojugal; *s.t.f.*, supratemporal fenestra; *sq.*, squamosal. Original type figure. (After Gilmore.)

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, [evidently referring to the postorbital] 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 lachrymals 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

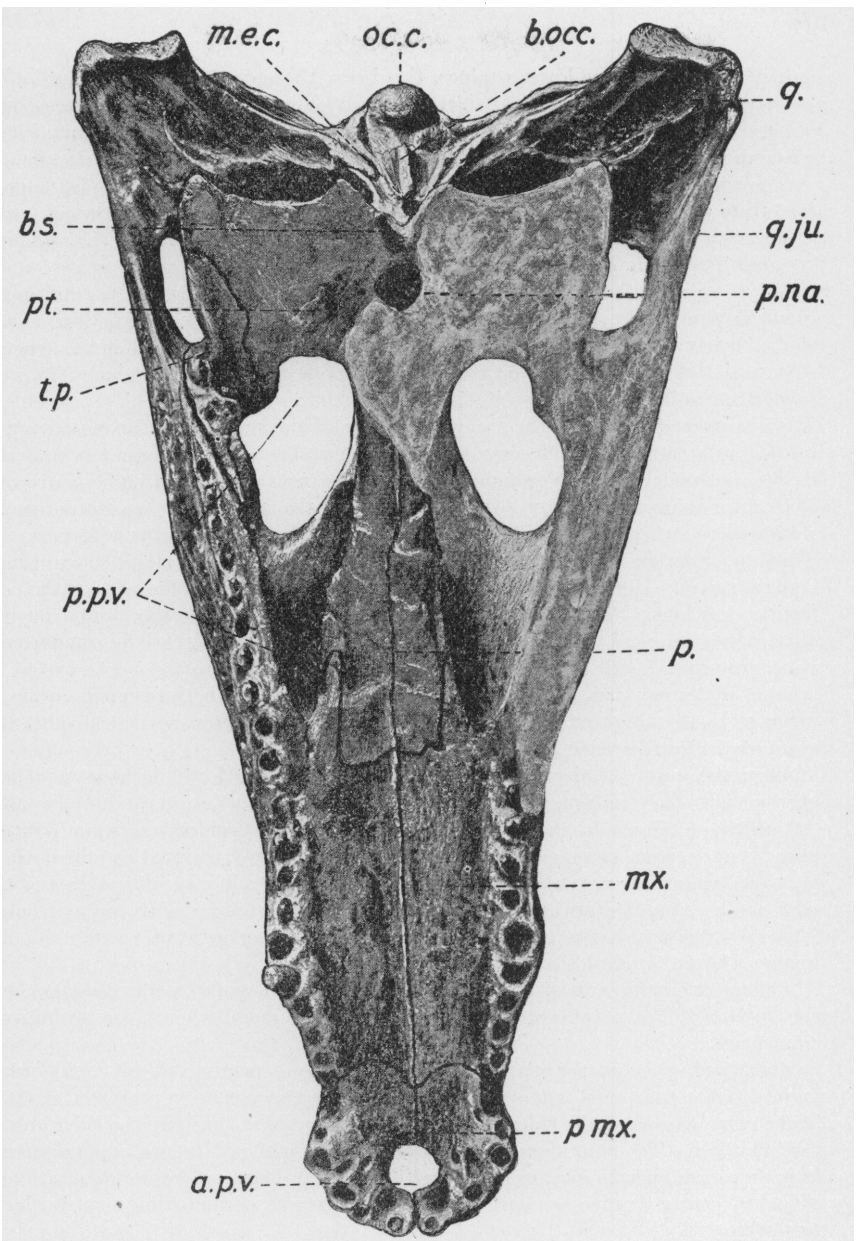

Fig. 49. *Leidyosuchus sternbergii* Gilmore. Type specimen, skull (U. S. Nat. Mus. No. 6533).

Inferior view; *a.p.v.*, premaxillary foramen; *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.*, palatine fenestra; *pt.*, pterygoid; *q.*, quadrate; *q.ju.*, quadratojugal; *t.p.*, ectopterygoid. Original type figure. (After Gilmore.)

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 . . . under the name *Crocodilus 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 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

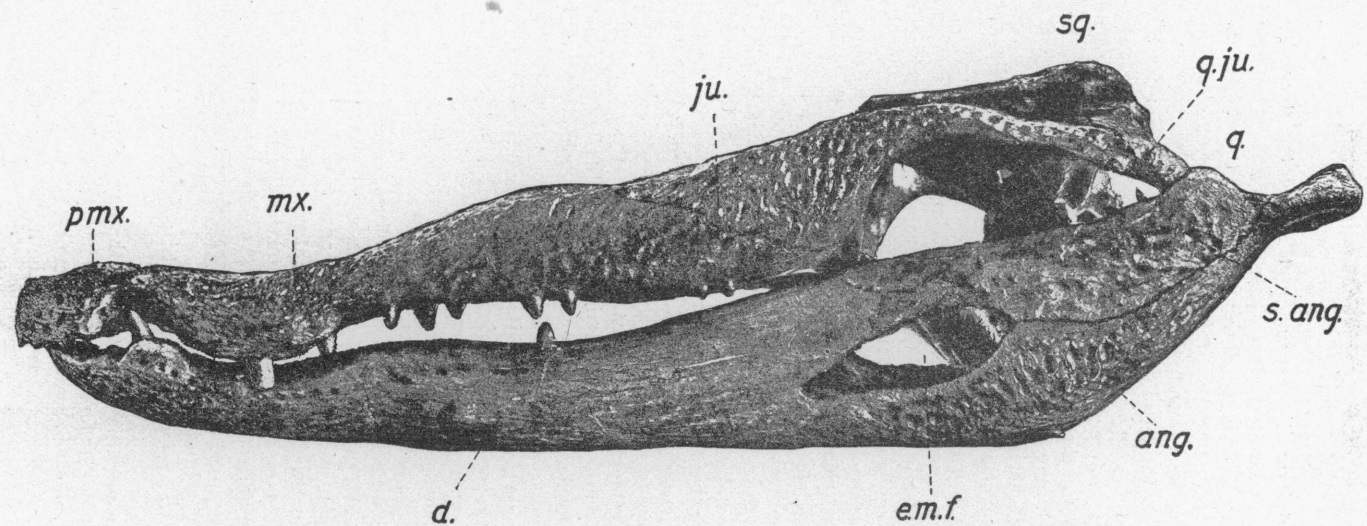

Fig. 50. *Leidyosuchus sternbergii* Gilmore. Type specimen, skull and jaws (U. S. Nat. Mus. No. 6533).

One-half natural size. Lateral view, left side; *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. Original type figure. (After Gilmore.)

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 hautoniensis* 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 pronounced 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 pneumogastric, and (VII) the largest of the three, which gives passage to the facical 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 *Crocodilus 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.

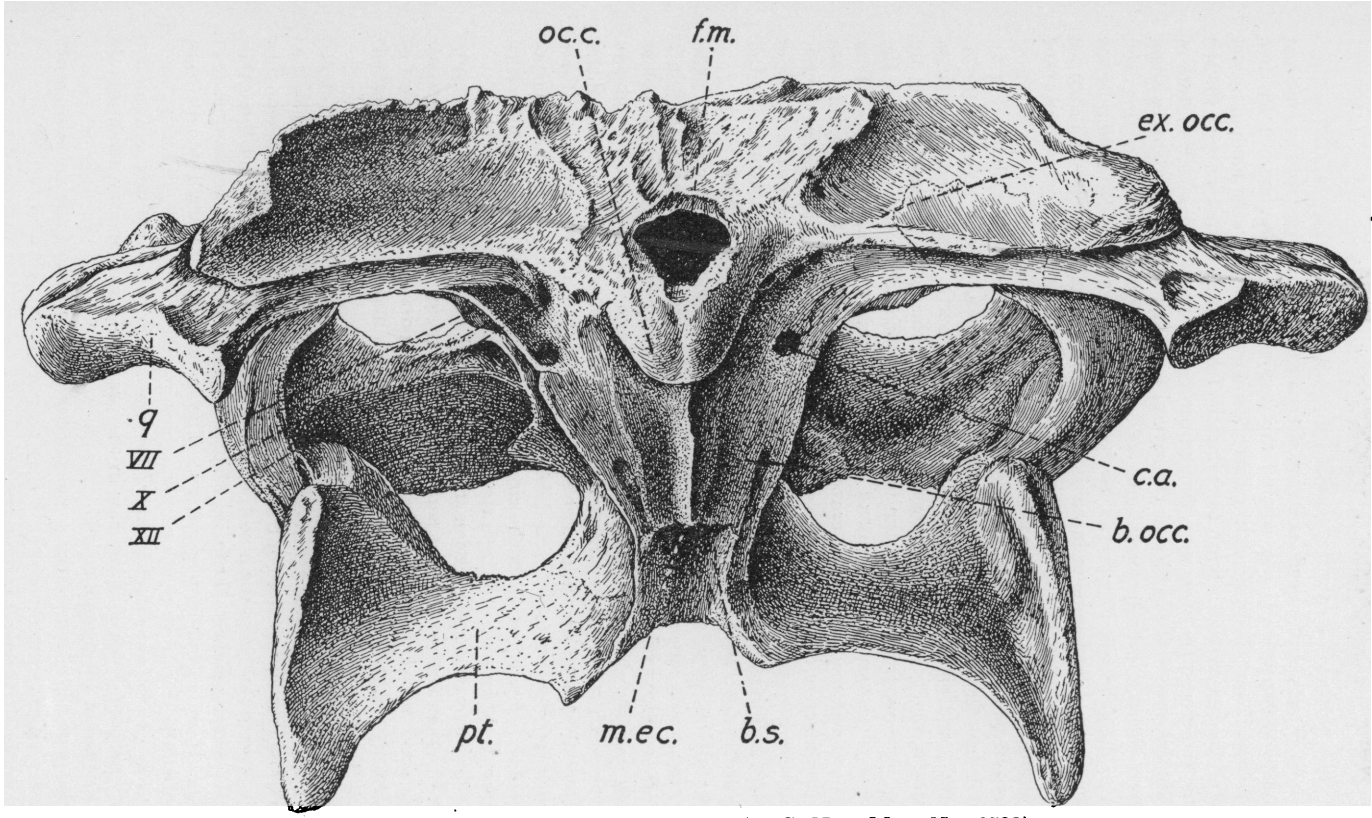

Fig. 51. *Leidyosuchus sternbergii* Gilmore. Type specimen, skull (U. S. Nat. Mus. No. 6533).

Natural size. Posterior view; *b.occ.*, basioccipital; *b.s.*, basisphenoid; *c.a.*, foramen for carotid 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. Original type specimen. (After Gilmore.)

On account of the damaged condition of the brain case, the elements comprising it cannot be differentiated, although all the important foramina can be located. Taken in order from back to front they are: *Foramen ovali* 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 crocodilians.

The teeth.—The dental formula of *Leidyosuchus sternbergii* is $\frac{2}{2}\frac{4}{1}-\frac{2}{2}\frac{4}{1}=90$. 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 proportionately 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 symphysial 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 *Leidyosuchus sternbergii*	Paratype of *Leidyosuchus canadensis*
	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....	*a*40	43
Length of upper surface of parietal, in median line.....	*a*40	38
Distance of posterior end of preserved surface of narial passage to anterior edge of opening of median eustachian canal.....	12	16

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 *Crocodilus*

"*a*. Estimated."

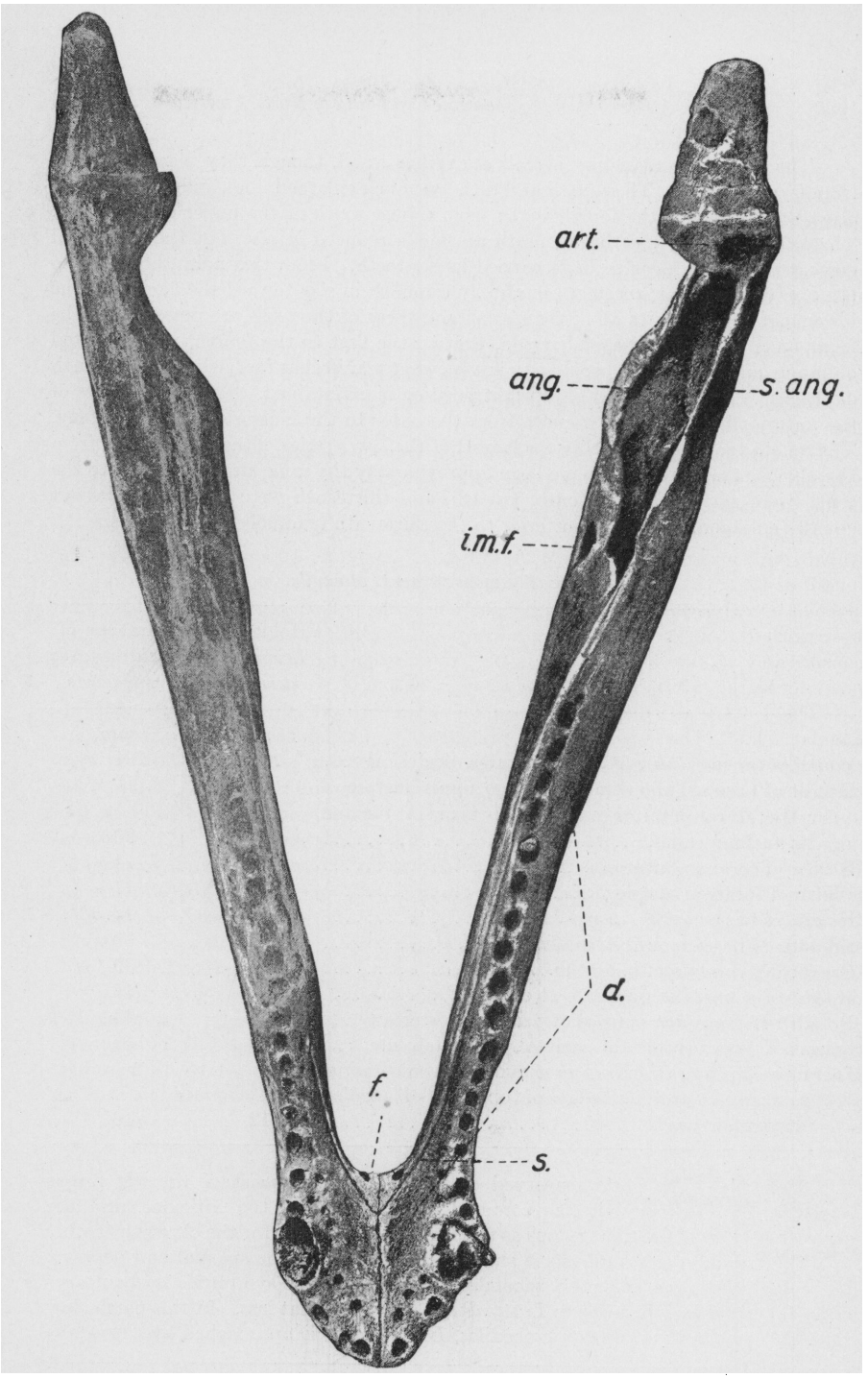

Fig. 52. *Leidyosuchus sternbergii* Gilmore. Type specimen, lower jaws (U. S. Nat. Mus. No. 6533).

One-half natural size. Superior view; *ang.*, angular; *art.*, articular; *d.*, dentary; *f.*, postsymphysial foramen; *i.m.f.*, intermandibular foramen; *s.*, splenial; *s.ang.*, surangular. Original type figure. (After Gilmore.)

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 symphysial 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 crocodilians. 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 the 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 symphysial union, the splenial is pierced by a small, longitudinally elongated foramen which leads into the meckelian groove. Lambe has shown .... 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 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 *Leidyosuchus sternbergii*	Holotype of *Leidyosuchus canadensis*
	mm.	mm.
Length of ramus	380	*a*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	*a*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

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

The neurapophysis, when compared with the homologous part in *Crocodilus 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 *Leidyosuchus 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 vertebræ 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.

"*a*. Estimated."

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 vertebræ from those of *L. canadensis*.

Measurements of dorsal vertebræ of Leidyosuchus sternbergii.

	I.	II.	III.	IV.
	mm.	*mm.*	*mm.*	*mm.*
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 vertebræ 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 vertebræ 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, . . . 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 *Crocodilus 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

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 cannot 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 Beds fauna, the following forms having been recognized. *Triceratops, Trachodon, Champsosaurus, Basilemys*, and *Lepidosteus*."

The species may be considered valid.

Deinosuchus Holland

Original Type Reference.—Holland, W. J., 1909, 'Deinosuchus hatcheri, a New Genus and Species of Crocodile from the Judith River Beds of Montana,' Ann. Carn. Mus., VI, No. 1, Art. 4, p. 282.

SUBSEQUENT REFERENCE.—GILMORE, C. W., 1910, 'Leidyosuchus sternbergii, a New Species of Crocodile from the Ceratops Beds of Wyoming,' Proc. U. S. Nat. Mus., XXXVIII, p. 501 (Pub. No. 1762).

TYPE.—*Deinosuchus hatcheri* Holland.

ORIGINAL TYPE DESCRIPTION.—"Great size, exceeding that of any other representative of the Crocodilia thus far described from North America. . . . Scutes massive and possessing great vertical height in comparison with their breadth, many of the smaller scutes being almost hemispherical, and some of the smallest subglobose. Pubis straighter and less deeply excavated posteriorly than in recent crocodilia. Extremities of spines of dorsal vertebræ broad transversely and thickened for attachments, much more so than in existing genera. The postzygapophyses of the vertebræ more nearly on the same plane as the transverse processes and not looking outwardly as much as in other crocodiles."

The genus may be considered valid.

Deinosuchus hatcheri Holland

ORIGINAL TYPE REFERENCE.—HOLLAND, W. J., 1909, 'Deinosuchus hatcheri, a New Genus and Species of Crocodile from the Judith River Beds of Montana,' Ann. Carn. Mus., VI, No. 1, Art. 4, pp. 281–294, 16 figs.

SUBSEQUENT REFERENCES.—No subsequent references are available at the present time.

ORIGINAL TYPE FIGURES.—HOLLAND, W. J., 1909, 'Deinosuchus hatcheri, a New Genus and Species of Crocodile from the Judith River Beds of Montana,' Ann. Carn. Mus., VI, No. 1, Art. 4, pp. 281–294, figs. 1–7, 9–16.

TYPE.—Two vertebræ, a cervical rib, one complete dorsal rib and fragments of others, a pubic bone and twenty-five scutes. Carn. Mus. No. 963.

TYPE LOCALITY AND LEVEL.—Willow Creek, three miles west of Nolan and Archer's ranch, Fergus County, Montana. Judith River Beds of Upper Cretaceous age.

ORIGINAL TYPE DESCRIPTION.—

"*Generic characters of Deinosuchus so far as known.* Great size, exceeding that of any other representative of the Crocodilia thus far described from North America.[4] Scutes massive and possessing great vertical height in comparison with their breadth, many of the smaller scutes being almost hemispherical, and some of the smallest subglobose. Pubis straighter and less deeply excavated posteriorly than in recent crocodilia. Extremities of dorsal spines of vertebræ broad transversely and thickened for attachments, much more so than in existing genera. The postzygapophyses of the vertebræ more nearly on the same plane as the transverse processes and not looking outwardly as much as in other crocodiles.

Seventh (?) Dorsal Vertebra.

(C. M. Cat. Vert. Foss., No. $\frac{963}{1}$.)

The specimen, which almost beyond a doubt is the seventh in the dorsal series, is the better preserved of the two vertebræ which were recovered. It is procœlous. At the extremities of the transverse processes it shows the articulating surfaces for

[4] "The writer has carefully examined and inquired in various museums at home and abroad and has been unable to find in any of them the fossil remains of any crocodile from North America equaling in size those here reported upon."

the ribs. It is a very massive bone and the dorsal spine is broad above, being greatly thickened transversely for attachment to adjacent structures. The postzygapophyses do not look as strongly outwardly as in the recent crocodilia, the under surfaces lying at their outer extremities nearly in the same plane as the upper surface of the transverse processes. Three views of the vertebra are given in Figures 1–3.

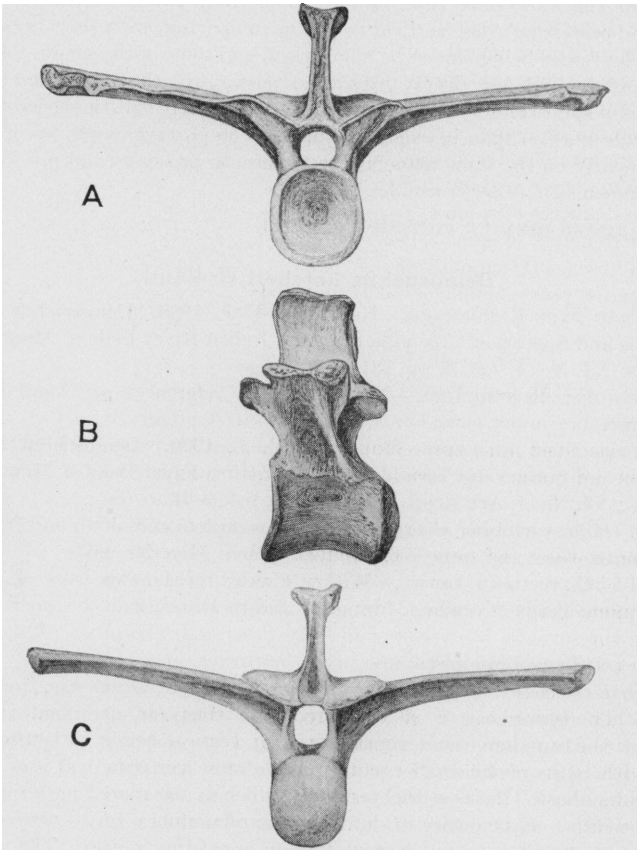

Fig. 53. *Deinosuchus hatcheri* Holland. Type specimen, seventh (?) dorsal vertebra (Carn. Mus. No. $\frac{2\,6\,3}{1}$).
One-ninth natural size. A, anterior view; B, lateral view, left side; C, posterior view. Original type figures. (After Holland.)

DIMENSIONS.

Extreme width from tip to tip of transverse processes	680 mm.
Height from bottom of centrum to tip of spine	310 "
Extreme length across zygapophyses	180 "
Length of centrum at middle	140 "
Length of centrum along floor of neural canal	125 "

DIMENSIONS (*Continued*)

Vertical diameter of centrum in front	122 "
Transverse diameter of centrum in front	122 "
Vertical diameter of centrum behind	110 "
Transverse diameter of centrum behind	95 "
Vertical diameter of neural canal	52 "
Transverse diameter of neural canal	35 "
Height of spine above neural canal	150 "
Height of spine above postzygapophyses	105 "
Height of spine above prezygapophyses	135 "
Antero-posterior diameter of spine at base	110 "
Antero-posterior diameter of spine at top	87 "
Transverse diameter of spine at base posteriorly	30 "
Transverse diameter of spine at base anteriorly	30 "
Transverse diameter of spine at top	65 "
Distance across postzygapophyses	173 "
Distance across prezygapophyses at their base	230 "

LAST LUMBAR VERTEBRA

(C. M. Cat. Vert. Foss., No. $\frac{9\,6\,3}{2}$.)

The vertebra under consideration is not so well preserved as the one described in the preceding paragraph, but the extremity of the left transverse process is sufficiently complete to show that it did not carry ribs. I assign it with doubt to the position of the last member of the lumbar series on account of the manner in which the spine and postzygapophyses overhang backwardly. If not that it must be one or the other of the two vertebræ immediately preceding. In general appearance it is not unlike the seventh (?) vertebra already described, except that the transverse processes are much narrower and the left, which is well preserved, shows no articular surfaces at the end. The spine has a much smaller antero-posterior diameter at the top than the seventh dorsal and its posterior margin is placed more decidedly caudad than in that vertebra. Fig. 4 shows the left side of the vertebra, which is the more complete, which may be compared with the corresponding view of the seventh dorsal.

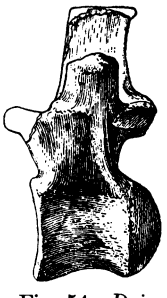

Fig. 54. *Deinosuchus hatcheri* Holland. Type specimen, last (?) lumbar vertebra (Carn. Mus. No. $\frac{9\,6\,3}{2}$).

One-ninth natural size. Lateral view, left side. Original type figure. (After Holland.)

DIMENSIONS

Extreme width from tip to tip of transverse processes*	670 (?) mm.
Height from bottom of centrum to tip of spine†	320± "
Extreme length across zygapophyses	160± "
Length of centrum at middle	150 "
Length of centrum along floor of neural canal	90 "

"*The right transverse process is broken; the measurement given represents twice the distance from the middle of the spine to the end of the left transverse process."

"†The top of the spine appears to be broken, and may not quite represent the true length in life."

DIMENSIONS (*Continued*)

Vertical diameter of centrum in front	130	"
Transverse diameter of centrum in front	105	"
Vertical diameter of centrum behind	110	"
Transverse diameter of centrum behind	85	"
Vertical diameter of neural canal	53	"
Transverse diameter of neural canal	35	"
Height of spine above neural canal	158±	"
Height of spine above postzygapophyses	105	"
Height of spine above prezygapophyses	155	"
Antero-posterior diameter of spine at base	110	"
Antero-posterior diameter of spine at top	67	"
Transverse diameter of spine at base posteriorly	28	"
Transverse diameter of spine at base anteriorly	10	"
Transverse diameter of spine at top	40±	"
Distance across postzygapophyses	200	"
Distance across prezygapophyses at their base	230±	"

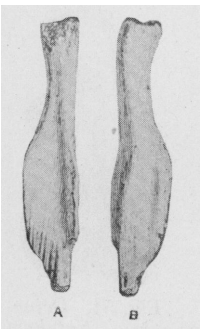

Fig. 55. *Deinosuchus hatcheri* Holland. Type specimen, left first cervical rib (Carn. Mus. No. $\frac{963}{3}$).

One-sixth natural size. A, internal view; B, external view. Original type figures. (After Holland.)

CERVICAL RIB

(C. M. Vert. Cat. Foss., No. $\frac{963}{3}$.)

A fairly well preserved specimen of the first cervical rib of the left side was found. At its proximal end it has been somewhat broken, but not enough to greatly diminish its length. Its proportions and general appearance are represented in Fig. 5, *a* representing the inner, and *b* the outer surface of the bone.

DIMENSIONS

Greatest length	235	mm.
Width at proximal end	37	"
Smallest width at proximal end	28	"
Greatest width in distal half	51	"
Width at distal extremity	17	"
Transverse diameter at proximal end	18	"
Transverse diameter at distal end	8	"

DORSAL RIBS

(C. M. Cat. Vert. Foss., No. $\frac{963}{4}$.)

A fairly well preserved specimen of the first dorsal or thoracic rib of the left side was recovered. Its shape is represented in Fig. 6, *A* showing the posterior, and *B* the anterior surface of the rib. It had been broken about the middle of the shaft and was repaired in the laboratory. The writer has been assured that the contacts within, which are not now visible, justified the proportions which are shown by the specimen, but nevertheless, is disposed to believe that the restored bone does not quite fully represent the entire length of the sternal part as it was in life. It is proportionately considerably shorter in its total length than the corresponding bone in other crocodilians. The relative length and shape of the capitulum and tuberculum is very like what is seen in the crocodiles of to-day. The tuberosity is well developed and directed forward and slightly more downward than in recent crocodilia.

In addition to the specimen which is here figured there were found a number of fragments of ribs, one of them apparently the proximal end with the capitulum of the third thoracic rib of the left side; another evidently a piece of the upper portion of the first rib of the right side carrying the tuberosity, but lacking the capitulum and tuberculum, and still another which is apparently the proximal end of the fifth dorsal. A few fragments of the distal end of the ribs also occur in the mass of bones picked up by Mr. Utterback.

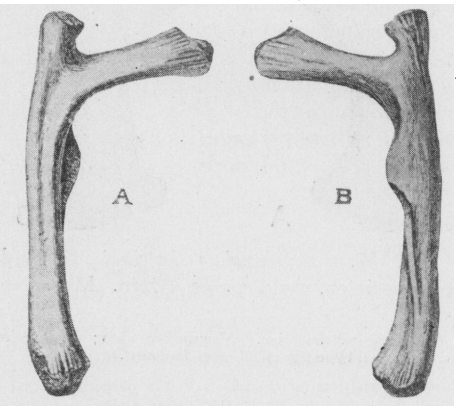

Fig. 56. *Deinosuchus hatcheri* Holland. Type specimen, left first dorsal rib (Carn. Mus. No. $\frac{963}{4}$).

One-eighth natural size. A, posterior view; B, anterior view. Original type figure. (After Holland.)

Dimensions

(First left dorsal rib. See Fig. 6.)

Greatest length from end of tuberculum to distal extremity	460	mm.
Distance from outer edge of tuberculum to extremity or capitulum	220	"
Greatest width of rib over tuberosity	80	"
Greatest width of capitulum at end	60	"
Antero-posterior diameter of capitulum at end	32	"
Greatest width of tuberculum at end	50	"
Antero-posterior diameter of tuberculum	30	"
Greatest width of distal end of rib	60	"
Antero-posterior diameter of rib at end	35	"

The Pubis

(C. M. Cat. Vert. Foss., No. $\frac{963}{11}$.)

A very well preserved specimen of the right pubic bone was recovered. It agrees very closely in its general outline and proportions with the corresponding bone in recent crocodiles, but is somewhat less rounded on its distal margin and decidedly less excavated on its posterior margin, at least when compared with the specimens of *Crocodilus* and *Alligator* before me. It is represented in Fig. 7, the illustration at the

left of the cut showing the superior, and that on the right of the cut the inferior surfaces of the bone, the strongly curved, or excavated, side being the anterior margin.

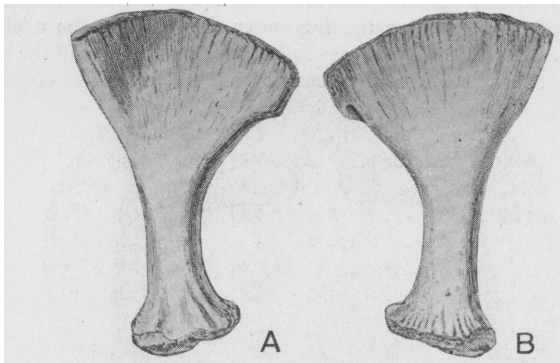

Fig. 57. *Deinosuchus hatcheri* Holland. Type specimen, right pubis (Carn. Mus. No. $\frac{9\,6\,3}{11}$).

One-sixth natural size. A, superior view; B, inferior view. Original type figure. (After Holland.)

Dimensions

Distance from proximal extremity to distal extremity of posterior margin	287	mm.
Distance from proximal extremity to distal extremity of anterior margin	223	"
Antero-posterior diameter of proximal end	100	"
Vertical diameter of proximal end	55	"
Smallest antero-posterior diameter of shaft	45	"
Vertical diameter of shaft	30	"
Greatest width of distal end	200	"
Vertical diameter at posterior angle of distal margin	23	"
Vertical diameter at anterior angle of distal margin	10	"

The Scutes.

Of the scutes representing the specimen there are twenty-five, which are in fairly good condition, and numerous fragments of others.

In a beautifully perfect skeleton of *Crocodilus acutus floridanus* before me as I write I find that there are ninety-two osseous scutes entering into the dermal covering of the neck and back. The anterior series forms a transverse row of four scutes located immediately over and covering the spine of the axis; the second series consists of two transverse rows, the first made up of four scutes, the second of two scutes, and these overlie and cover the spines of the third, fourth, and fifth cervicals. The third series is composed of two scutes, covering the spine of the sixth cervical. The spine of the seventh cervical is not shielded above by a row of scutes; and the spine of the eighth cervical is only partially covered by the first transverse row of the dorsal series of scutes. The dorsal series is made up of fifteen transverse rows of scutes, each row composed of four or six bony plates. Those containing six plates are the second,

the fifth, the eighth, the tenth, eleventh, and twelfth rows, reckoning backward. The fifteenth transverse row of scutes, overlies and covers the spines of the third and fourth lumbar vertebræ. Following the dorsal series of scutes terminating at the point just stated, there are on either side, extending backward over the region of the sacrum

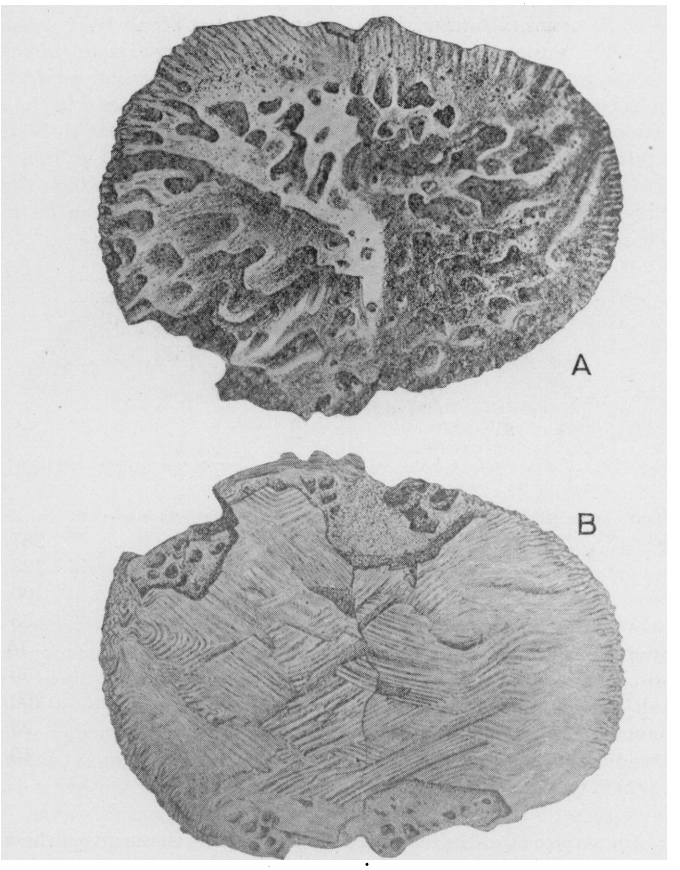

Fig. 58. *Deinosuchus hatcheri* Holland. Type specimen, cervical scute (Carn. Mus. No. $\frac{963}{12}$).

One-half natural size. A, superior view; B, inferior view. Original type figures. (After Holland.)

and the two anterior caudal vertebræ, six bony scutes diminishing in size backward and forming the backward prolongation of the second longitudinal row of scutes reckoning from the median line outwardly on either side. The arrangement of the scutes in *C. floridanus* is represented diagrammatically in Fig. 8.

All the scutes in *D. hatcheri* are characterized on the superior surface by an elevated longitudinal median ridge or carina, which does not, however, rise as sharply

from the surface as in recent genera, and as is shown in the figures herewith given, passes by almost insensible degrees into the surface of the adjoining parts of the scutes.

An attempt has been made by comparison with the scutes as they exist upon the back of recent crocodiles to ascertain the relative position of the scutes belonging to the specimen of *Deinosuchus hatcheri*, but the result has not been wholly satisfactory to the writer. The scute represented in Figs. 9 and 10 appears to undoubtedly correspond to the internal right scute of the first row in the second cervical series, and the scute represented in Figs. 11–13 to be its immediate successor in the second row of the same series. Fig. 14 represents what the writer believes to be the left scute of the third cervical series. The smaller scute represented in Fig. 16 no doubt belongs to the sacro-caudal series, and the large broad scutes, of which there are several well-preserved specimens, one of them shown in Fig. 15, can be referred approximately to their places about the middle of the dorsal series.

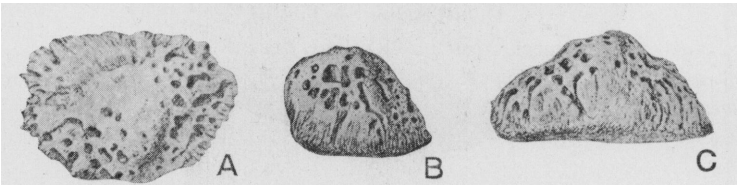

Fig. 59. *Deinosuchus hatcheri* Holland. Type specimen, cervical scute (Carn. Mus. No. $\frac{963}{13}$).

About one-fourth natural size. A, dorsal view; B, posterior view; C, lateral view, right side; *a*, anterior margin; *b*, posterior margin; *l*, left side; *r*, right side. Original type figures. (After Holland.)

The scutes differ from those of all other crocodilia by their great vertical thickness in comparison with their length and breadth. They are not proportionally nearly as thin as those of any recent species, and the writer cannot discover in the literature of the subject, nor has he found in any of the collections at home or abroad crocodilian scutes which are so heavy and massive as these. The smaller scutes are some of them almost hemispherical and a few of the smallest almost spherical in form, causing them thus to differ widely in appearance from those of other crocodilian scutes. This character is regarded by the writer as possessing generic value.

On the upper surface all of the scutes are deeply pitted on either side of the median longitudinal ridge, the pits being often confluent. The median ridge is also in almost all cases marked by a few narrow but deep circular pits. On the under side the scutes are slightly rounded at their edges in the case of the larger specimens, and quite rounded in the cases of the smaller specimens. They show on the under surface numerous fine straight lines decussating with each other at an angle of about forty-five degrees, indicating the structure of the dermal tissues in which they were imbedded and to which they adhered.* On the anterior margin many of the scutes show bevelled margins to adapt them to union with the scutes which preceded them and evidently somewhat overlapped them in front.

"*Sir Richard Owen (Report of the British Association for the Advancement of Science, 11th meeting, 1841, p. 71) calls attention to a similar feature in the scutes of *Goniopholus crassidens* Owen."

DIMENSIONS OF SCUTES

Cervical Scute. (See Figs. 9 and 10.)

(Carnegie Museum Cat. Vert. Foss., No. $\frac{863}{12}$.)

Antero-posterior diameter	111 mm.
Transverse diameter	143 "
Greatest vertical diameter	58 "

? Cervical Scute (See Figs. 11–13.)

(Carnegie Museum Cat. Vert. Foss., No $\frac{863}{13}$.) [963 ?]

Antero-posterior diameter	80 mm.
Transverse diameter	115 "
Greatest vertical diameter	60 "

Dorsal Scute (See Fig. 15.)

(Carnegie Museum Cat. Vert. Foss. No. $\frac{963}{14}$.)

Antero-posterior diameter	103 mm.
Transverse diameter	160 "
Greatest vertical diameter	42 "

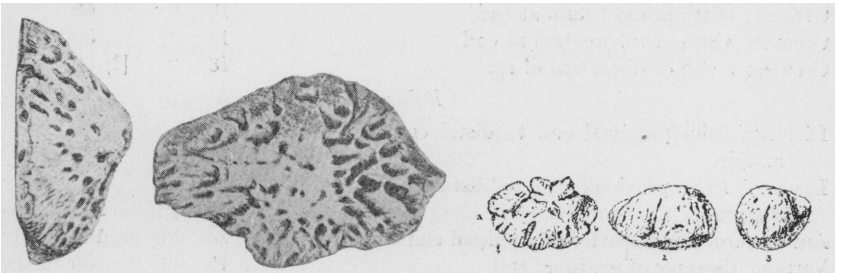

Fig. 60 Fig. 61 Fig. 62

Fig. 60. *Deinosuchus hatcheri* Holland. Type specimen, cervical scute (Carn. Mus. No. $\frac{963}{15}$).

About one-fourth natural size. Anterior view. Original type figure. (After Holland.)

Fig. 61. *Deinosuchus hatcheri* Holland. Type specimen, dorsal scute (Carn. Mus. No. $\frac{963}{14}$).

About one-fourth natural size. Superior view. Original type figure. (After Holland.)

Fig. 62. *Deinosuchus hatcheri* Holland. Type specimen, sacro-caudal scute (Carn. Mus. No. $\frac{963}{16}$).

About one-fourth natural size. 1, superior view; 2, lateral view, left side; 3, posterior view; *a*, anterior margin; *b*, posterior margin. Original type figure. (After Holland.)

Sacro-caudal Scute (See Fig. 16.)

(Carnegie Museum Cat. Vert. Foss. No. $\frac{963}{16}$.)

Antero-posterior diameter	60 mm.
Transverse diameter	37 "
Greatest vertical diameter	33 "

COMPARATIVE MEASUREMENTS OF THE CORRESPONDING BONES IN THE SKELETON OF CROCODILUS FLORIDANUS (Carnegie Museum Accession No. $\frac{1010}{2}$) AND THE TYPE OF DEINOSUCHUS HATCHERI (Carnegie Museum Cat. Vert. Foss., No. 963).

	C. floridanus.	*D. hatcheri.*
Cervical Rib.		
Length	105 mm.	235 mm.
Width at proximal end	12 "	37 "
Smallest width in proximal half	9 "	28 "
Greatest width in distal half	13 "	51 "
Width at distal end	5 "	17 "
Transverse diameter at proximal end	6 "	18 "
Transverse diameter at distal end	2.5 "	8 "
Dorsal Rib.		
Greatest length from end of tuberculum to distal extremity	125 mm.	460 mm.
Distance from outer edge of tuberculum to end of capitulum	50 "	220 "
Greatest width of rib over tuberosity	22 "	80 "
Greatest width of capitulum at end	10 "	60 "
Greatest width of tuberculum at end	15 "	50 "
Greatest width of distal end of rib	13 "	[?] 60 "
Pubis.		
Distance from proximal end to distal end of posterior margin	78 mm.	287 mm.
Distance from proximal end to distal end of anterior margin	80 "	223 "
Antero-posterior diameter of proximal end	23 "	100 "
Vertical diameter of proximal end	15 "	55 "
Smallest antero-posterior diameter of shaft	12 "	45 "
Vertical diameter of shaft	9 "	30 "
Greatest width at distal end	54 "	200 "
Vertical diameter at posterior angle of distal margin	5 "	23 "
Vertical diameter at anterior angle of distal margin	2.5 "	10 "
Seventh Dorsal Vertebra.		
Extreme width across transverse processes	158 mm.	680 mm.
Height from bottom of centrum to top of spine	60 "	310 "
Length across zygapophyses	60 "	180 "
Last(?) Lumbar Vertebra.		
Extreme width across transverse processes	135 mm.	670 mm.
Height from bottom of centrum to top of spine	83 "	320 "
Length across zygapophyses	58 "	160 "

The measurements given in the foregoing comparative table for *Crocodilus floridanus* yield a total of 1220, from which we obtain a general average of 43.5. The total of the measurements given for *Deinosuchus hatcheri* is 4617, yielding us a general

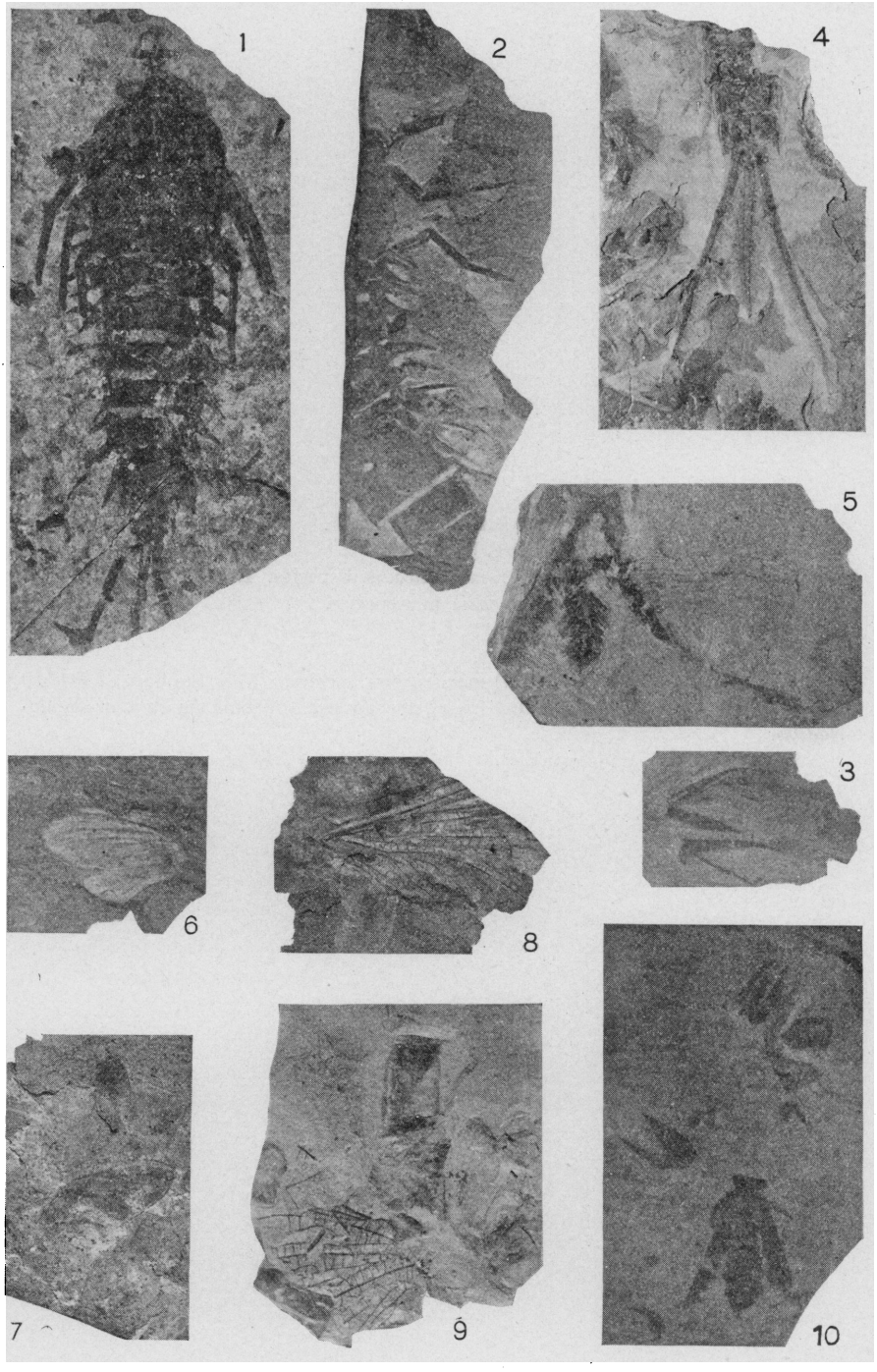
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PLATE II

Fig. 1. *Lycoptera middendorffi* Johannes Müller.

Fig. 2. *Estheria middendorffi* T. R. Jones.

Figs. 3, 4. 5. *Cymatophlebia* (?) *mongolica*, new species. Details of wing.

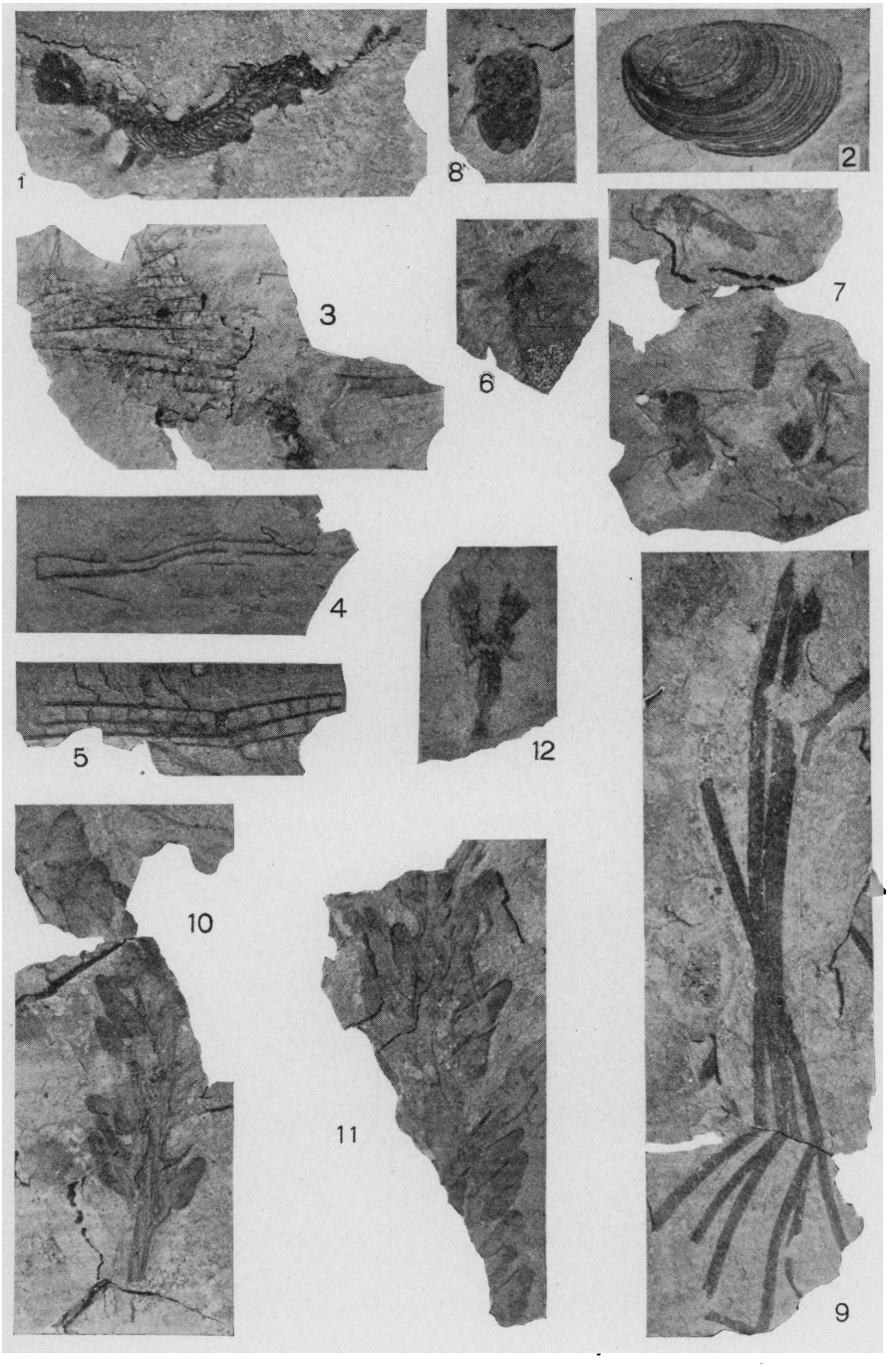
Figs. 6, 7. *Chironomopsis gobiensis*, new species.

Fig. 8. Beetle, undetermined.

Fig. 9. *Baiera*.

Figs. 10, 11. *Phyllocladites* (?) *morrisi*, new species. Near the base of Fig. 10 specimen is the caddis case of *Indusia reisi*, new species, touching the stem of *Phyllocladites*.

Fig. 12. Plant, undetermined.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average of 164.8. The length of the specimen of *Crocodilus floridanus* from the tip of the nose to the end of the tail, from which the measurements in the first column were derived, is 3050 mm. In the ratio of 43.5 to 164.8 we would find that the total length of *Deinosuchus hatcheri*, provided it was built on the same relative proportions as *Crocodilus floridanus*, would be 13,830 mm., or about 45 feet in length.

This method of calculating may be open to objection and the result may be somewhat excessive. We may approach the problem in another way. We may assume that the length of the seventh dorsal vertebra represents the average length of the vertebræ in the series. In fact the centra of the caudals about the middle of the tail in all crocodilian skeletons I have examined considerably exceed in length the centra of the anterior vertebræ, though the last eight or nine rapidly decrease. The centrum of the seventh dorsal in the specimen of *C. floridanus* before me certainly is rather under than over the average length of the members of the series. The length of the seventh dorsal in *D. hatcheri* is almost exactly six inches. The number of vertebræ in the total series is sixty (?). This would give us a length of thirty feet, without taking into account the length of the skull from its point of union with the atlas to the tip of the snout, which in *C. floridanus* is as 13 to 60. Applying this proportion to the case in hand we would have a length of from five to six feet for the skull. Adding this to the length of the vertebral column back of the head we have thirty-five as the total length of the bony framework of the animal. It is therefore no exaggeration to say that *D. hatcheri* must have been a crocodile which possessed a length of from thirty-five to forty feet, exceeding thus in length the largest specimen of *C. porosus* of which we have record, which is said to have been thirty-three feet in length, and therefore the longest crocodile belonging to a living species, which has ever been observed.

Deinosuchus hatcheri was undoubtedly one of the hugest representatives of the Crocodilia which has existed upon our globe."

The species may be considered valid.

BRACHYCHAMPSA Gilmore

ORIGINAL TYPE REFERENCE.—GILMORE, C. W., 1911, 'A New Fossil Alligator from the Hell Creek Beds of Montana,' Proc. U. S. Nat. Mus., XLI, pp. 297–302 (Pub. No. 1860).

SUBSEQUENT REFERENCE.—MEHL, M. G., 1916, 'Caimanoidea visheri, a New Crocodilian from the Oligocene of South Dakota,' Journ. Geol., XXIV, p. 50.

TYPE.—*Brachychampsa montana* Gilmore.

ORIGINAL TYPE DESCRIPTION.—The characters of the genus were not separated from those of the type species by Gilmore. See *Brachychampsa montana.*

The genus may be considered valid.

Brachychampsa montana Gilmore

ORIGINAL TYPE REFERENCE.—GILMORE, C. W., 1911, 'A New Fossil Alligator from the Hell Creek Beds of Montana,' Proc. U. S. Nat. Mus., XLI, pp. 297–302, 1 fig., Pls. XXVI, XXVII (Pub. No. 1860).

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ORIGINAL TYPE FIGURES.—GILMORE, C. W., 1911, 'A New Fossil Alligator from the Hell Creek Beds of Montana,' Proc. U. S. Nat. Mus., XLI, pp. 297–302, fig. 1, Pls. XXVI, XXVII (Pub. No. 1860).

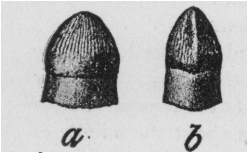


Fig. 63. *Brachychampsa montana* Gilmore. Type specimen, twelfth maxillary tooth (Amer. Mus. No. 5032).

Natural size. *a*, lateral view, *b*, posterior view. Original type figure. (After Gilmore.)

TYPE.—The anterior two-thirds of the skull, accompanied by detached fragments of the posterior portion. Amer. Mus. No. 5032.

TYPE LOCALITY AND LEVEL.—Twenty-five miles southeast of Lismas, Dawson County, Montana. Hell Creek Beds. Upper sandstone.

ORIGINAL TYPE DESCRIPTION.—"The type-specimen is a short, broad-snouted skull, the length from the level of the front border of the orbits being only 7 mm. greater than the width at the same point. Excepting a few detached fragments, the posterior portion of the skull behind the orbits is missing (Pl. 26). The remaining part is fairly complete and undistorted. The upper surface of the preorbital region is flat and without crests or ridges; the muzzle is evenly but broadly rounded; the nasal aperture is large and pear-shaped in outline. In the absence of a roof-like covering formed by the premaxillaries over the anterior part of the external nares, *Brachychampsa* differs from all known alligators, both recent and extinct. On account of the damaged condition of the anterior extremities of the nasal bones it can not be determined whether they extended forward into the narial opening. The facial processes of the premaxillaries extend posteriorly to the level of the alveolus for the fifth maxillary tooth. The nasal bones are comparatively slender and extend posteriorly to the level of the anterior borders of the orbits. In recent alligators these bones terminate well in front of the orbital line. The maxillaries are broad, flattened above, and much compressed vertically. The jugals are heavy, with roughly sculptured surfaces. The interorbital surface is flat and not concave as in many crocodiles and alligators. The orbital openings are everted as in the alligators and some crocodiles and are confluent with the lateral vacuities. The sculpturing of the facial surface of the bones is more strongly marked in the neighborhood of the orbits than it is anteriorly.

In the palatal view (Pl. 27), where the bones have not suffered mutilation, all of the sutures are plainly indicated. Latero-inferiorly the maxillo-premaxillary suture passes obliquely backward and inward on the palate. The damaged condition of the palate just back of the anterior palatine vacuity renders uncertain the posterior extent of the premaxillaries. In the recent alligators this suture extends nearly straight across on a level with the second maxillary tooth, while in this form it extends posteriorly at least as far as the level of the fourth maxillary tooth.

Each of the broad maxillaries has alveoli for 14 teeth, and each of the premaxillaries for 5. The palatines, of which only the anterior portions are present, unite with the maxillæ by an almost straight transverse suture on a level with the eleventh maxillary tooth. The lateral borders of the anterior ends of the palatines are divergent, as in all alligators, instead of parallel or convergent as in all true crocodiles. On the left side of the palate enough of the boundary of the posterior palatine vacuity remains to indicate that it was subround instead of elongate as in most members of this group. The preserved borders of the anterior palatine vacuity show it to have been of large size and probably pear-shaped in outline.

The pits on the palatal surface of the premaxillary for the reception of the anterior teeth of the lower jaw are broad and exceedingly shallow.

A detailed fragment of the pterygoid shows the processes to have been blunt and stout.

Measurements of skull of Brachychampsa montana. Type specimen.

	mm.
Distance from anterior angle of orbits to tip of snout	164
Width of skull at anterior angle of the orbits	157
Width of skull at maxillo-premaxillary suture	105
Greatest width of nasal opening	44
Greatest longitudinal length of premaxillary	80
Least width of interorbital bar	26
Greatest width of nasals	32
Greatest width of anterior palatine processes	45
Greatest width of anterior palatine vacuity	33
Distance from anterior end of palatine vacuity to tip of snout	24
Length of alveolar border of maxillary	135
Length of alveolar border of premaxillary	65

Teeth —The dental formula of the upper jaw consists of 5 premaxillary and 14 maxillary teeth, the total number (38) being the same as found in the upper mandible of many modern alligators. Judging from the size of the alveoli, all of the premaxillary teeth appear to have been of approximately the same size. The teeth still present in the skull are: the bases of three premaxillary teeth, and the third, fourth, fifth, sixth, seventh, ninth, eleventh, and twelfth maxillary teeth on the right side; the roots of the third, fifth, sixth, and seventh, with the tenth and eleventh teeth intact, in the left maxillary. The first three maxillary teeth were relatively small and evidently of about equal size. The fourth is slightly larger than the third; the fifth is larger than the fourth and is the most robust tooth of the anterior dental series; the sixth tooth is slightly smaller than the fifth; the seventh, eighth, ninth, and tenth were quite small, being the weakest of those in the upper mandible; the eleventh and twelfth were robust, and, judging from the size of the alveoli for the thirteenth and fourteenth, all of these teeth were of approximately the same size.

The anterior teeth of the maxillary series although somewhat compressed transversely are acutely pointed, and while the fifth is as long as the eleventh and twelfth the anterior posterior extent of the tooth is only a little over half that of the latter. The relative dimensions are well shown in the table of measurements of the teeth given below.

The posterior teeth of *Brachychampsa montana* resemble most nearly those figured by Leidy. . . as *Bottosaurus harlani* from the Cretaceous of New Jersey. . . . .

The crowns of the posterior teeth are somewhat compressed laterally, mammiliform, with outer and inner surfaces separated by a somewhat obscure carinæ which extends from the subacute apex to the base of the corrugated surface as shown in figure 1. The upper surface is corrugated with depressions radiating from the apex but the base of the enameled surface is smooth. The upper part of the tooth is separated from the gibbous root by a slight constriction at the base of the enamel.

In the collection of the U. S. National Museum there is a large number of detached teeth from the 'Ceratops beds' of Converse County, Wyoming, which can

not be distinguished from those in the specimen under discussion. With them are other teeth, which from their minute size and other differences appear to indicate the presence in those beds of one or more undescribed species, but the material is too meager upon which to base a determination. Many of these scattered teeth showed wear on their internal surfaces, thus substantiating the evidence of the *Alligatoroid* nature of the bite as shown by the worn posterior teeth of the type-specimen.

Principal measurements of maxillary teeth of Brachychampsa montana. Type-specimen.

Number of tooth.	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*	*mm.*
Length.....	9	10	12	9	7	5	6.5	12	11
Extent antero-posteriorly	6.5	7	8	7	6	5	6	12	12"

The species is valid beyond all question of doubt.

PLATES IV AND V

PLATE IV

Brachychampsa montana Gilmore
Type specimen, anterior portion of skull
Amer. Mus. No. 5032
Natural size
Superior view

e. na., external nares; *fr.*, frontal; *ju.*, jugal; *mx.*, maxillary; *n*, nasal; *o.*, orbit; *p. mx.*, premaxillary.

Original type figure. (After Gilmore.)

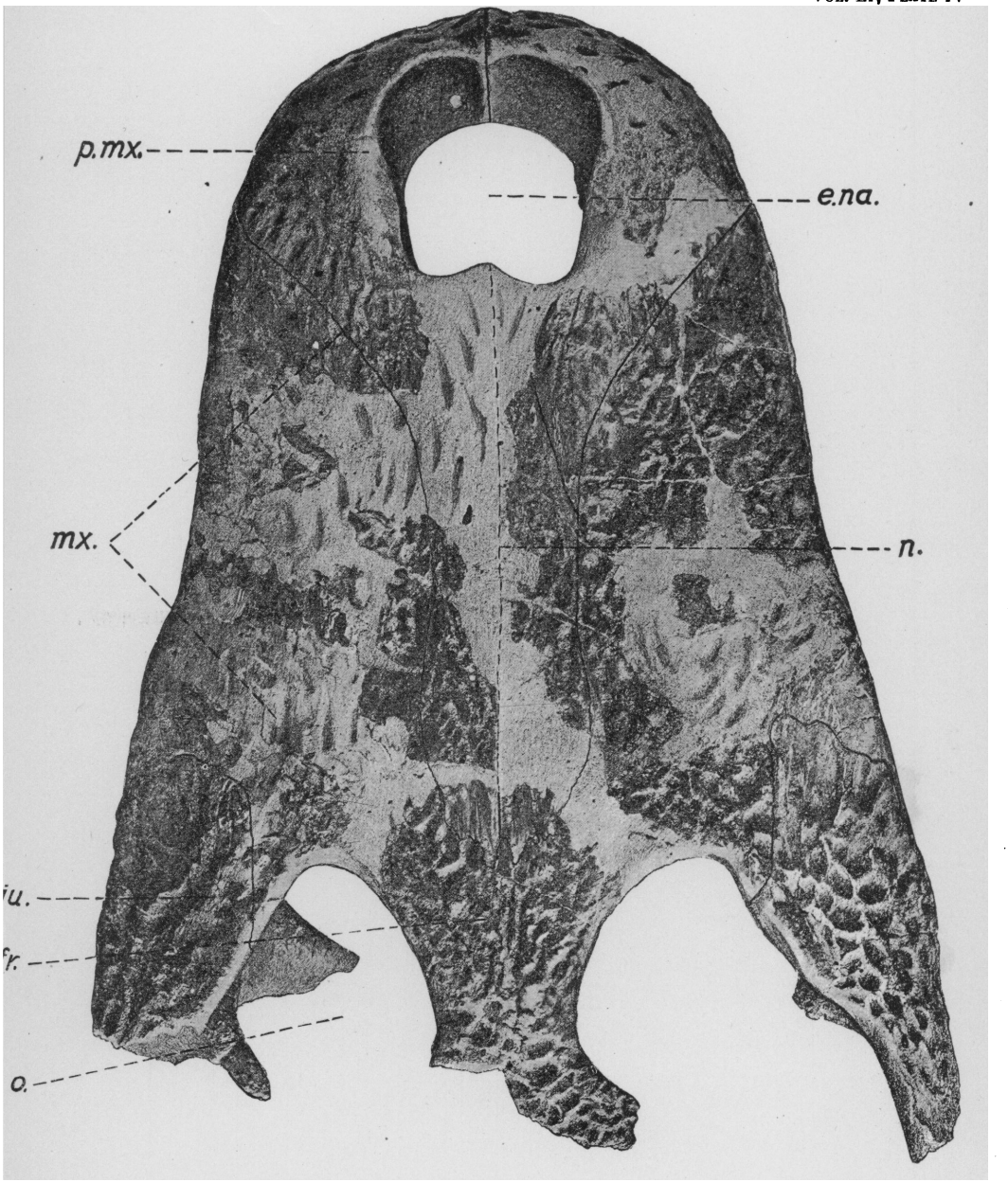

p.mx.
e.na.
mx.
n.
u.
r.
o.

PLATE V

Brachychampsa montana Gilmore

Type specimen, anterior portion of skull

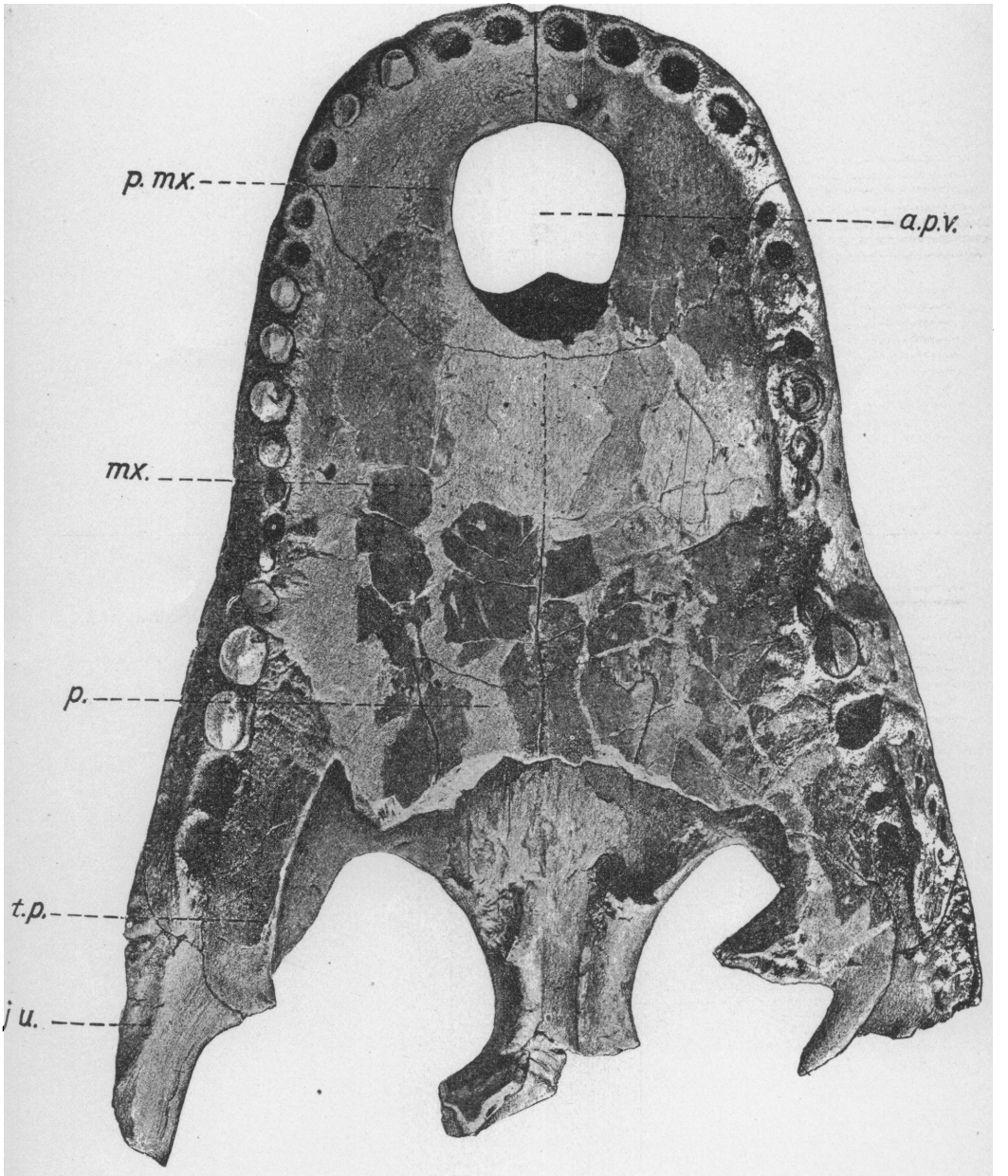
Amer. Mus. No. 5032

Natural size

Inferior view

a.p.v., premaxillary foramen; *ju.*, jugal; *mx.*, maxillary; *p.*, palatines; *p.mx.*, premaxillary; *t.p.*, ectopterygoid (transpalatine)

Original type figure. (After Gilmore.)


p. mx.
a.p.v.
mx.
p.
t.p.
j u.

INDEX TO VOLUME LI

New taxonomic names are printed in **heavy-faced type**, also the main reference in a series of references.

PLATES I AND II

Plate I

Figs. 1–9. *Ephemeropsis trisetalis* Eichwald.

Fig. 1. Nearly complete nymph about 40 mm. long.

Fig. 2. Part of a nymph, showing legs and abdominal gills.

Fig. 3. Abdominal gills, detached from the nymph.

Figs. 4, 5. Caudal appendages of nymph.

Figs. 6, 7. Nymphal wing pads.

Figs. 8, 9. Adult wing, basal portion.

Fig. 10. *Ephemeropsis melanurus*, new species. Detached gills and caudal appendages.

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