

IX. A NEW AËTOSAURIAN REPTILE FROM THE
MORRISON FORMATION OF UTAH.¹

BY CHARLES W. GILMORE,

*Curator of Vertebrate Paleontology,
U. S. National Museum.*

(PLATES XXVII-XXIX.)

Although for fifty years the fresh-water beds of the Morrison formation have been repeatedly searched for remains of fossil vertebrate life, they still yield specimens of rare scientific interest. In 1917, Mr. LeRoy Kay, a member of the Paleontological Staff of the Carnegie Museum, Pittsburgh, discovered within the boundaries of the Dinosaur National Monument, Utah, a nearly complete articulated skeleton of a small aëtosaurian reptile, which, through the courtesy of the Director of that Museum, Dr. Douglas Stewart, has been submitted to me for study. The specimen was uncovered during the construction of a new trail which passes upward along the north and east sides of the upturned "hogback" in which the dinosaur quarry is located, and was found in a sandstone layer about one hundred feet below the level of the heavy cross-bedded sandstone, in which dinosaur remains have been found in much abundance.

The presence of a carapace of overlapping bony scutes extending from the skull to the end of the tail, and features observed in the structure of the skull and other skeletal parts, seem to show the affinities of this animal to be with the *Aëtosauria*, thus marking the first occurrence of this suborder in the Morrison formation of North America. In size it closely approaches the Triassic *Stegomachus* (*Stegomus*) *longipes* (Emerson and Loomis), but differences in osteological structure and its much later geological occurrence show it to be an undescribed form, for which the new genus and species *Hoplosuchus kayi* are proposed, the specific name being in honor of Mr. LeRoy Kay, the discoverer of the specimen.

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Class REPTILIA.

Order THECODONTIA R. Owen, 1859.

SUBORDER AËTOSAURIA Nicholson and Lydekker, 1890.

Family STEGOMOSUCHIDÆ von Huene, 1922.

Hoplosuchus kayi, gen. et sp. nov.

Type: No. 11,361, Carn. Mus. Cat. Vert. Foss. It consists of a nearly complete articulated skeleton. Collected by LeRoy Kay, July, 1917.

Type locality: Dinosaur National Monument, near Jensen, Uinta County, Utah.

Geological occurrence: Morrison (Jurassic), one hundred feet below the level of the Dinosaur Quarry.

Generic and specific characters: Skeleton small, lizard-like; skull triangular; supratemporal fossæ apparently roofed over; pineal foramen doubtfully present; quadrate fixed, steeply inclined forward; external nares placed far forward; internal nares forward of middle of palate; orbits large, centrally placed, directed outward and slightly forward; small pre-orbital fossæ; infratemporal fossæ relatively small, triangular in shape; pterygoids meeting strongly on the median line in front of basisphenoid and with descending processes; teeth thecodont; lower jaws apparently without external mandibular foramen. Limbs slender, fore limb slightly shorter than the hind; fifth digit of pes apparently wanting; metatarsals elongate, slender. Dorsal armor consisting of a paired series of oblong plates. Tail completely enclosed by bony armor.

The nearly complete articulated skeleton lay on its belly with the limbs folded up beneath the bony dermal carapace, which roofs over the vertebral column and other underlying bones. The skull and lower jaws were articulated, the mouth widely distended, which, with the sinuous bend in the tail, appears to register a silent protest against the agony endured during the animal's dying moments (See Pl. XXVIII). Few of the bones are displaced and most of those which are missing protruded from the rock in which the main portion of the skeleton was enclosed.

Many of the detailed features of both skull and skeleton are rendered obscure because of the delicate nature of the bone and the obliteration

tion of all sutures, and also from the fact that grains of sand have been forced into the surface of the bone in such a manner that they cannot be removed. Furthermore, most of the vertebral column, ribs, and much of the pectoral and pelvic arches remain hidden in the matrix beneath the bony carapace and are not available for detailed study.

DESCRIPTION.

The total length of the specimen, as preserved, with the beak of the skull and tip of the tail missing, is one hundred and eighty millimeters measured between perpendiculars. It is estimated that in life it may have had a total length of over two hundred millimeters. The body from the back of the skull to the center of the pelvis has a greatest length of seventy-two millimeters.

Skull. The skull is uncrushed and completely preserved, except for the loss of the premaxillary portion of the nose. Certain palatal and internal parts are obscured by adhering matrix, which it was deemed unwise to remove for fear of permanently injuring the delicate fossil. The complete coalescence of all the cranial sutures adds still further difficulties to a proper interpretation of the structure of the skull, but there is no doubt as to the general position of most of the bones, although their exact extent remains uncertain.

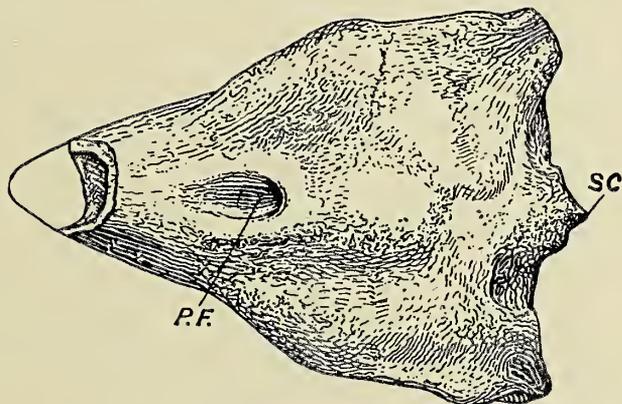


FIG. 1. Skull of *Hoplosuchus kayi* Gilmore. Type, No. 11,361, C. M. Cat. Vert. Foss., dorsal view. *P.F.* supposed pineal foramen; *sc*, portions of dorsal scutes. One and one-half natural size.

Viewed from above (See fig. 1) the skull is broadly triangular in outline. That the muzzle is missing is shown by comparison with the jaws which, when placed in an articulated position, project beyond the end of the skull as now preserved. The fact of the external nares opening forward without bony division also lends weight to the

belief that the snout must have been longer. A tentative restoration of this missing part is shown in Figure 2. The preservation of the bone around the narial opening is of such a nature that it is quite impossible to surely determine whether the edges are broken or not.

The upper surface of the cranium seems to be completely roofed over by bone, but again one is in doubt because of the peculiar nature of the preservation. Since supratemporal fossæ are present in all known aëtosaurians, it appears reasonable to expect to find them in the skull under discussion, especially since most of the important structural features of the specimen are typically aëtosaurian in character. Supratemporal fossæ are found in *Stegomosuchus longipes* as was first definitely pointed out by Lull,¹ and the affinities of the present specimen seem to be nearest to that genus.

On the median line between the orbits is a small, foramen-like depression surrounded, except in front, by a rounded, raised border of bone. (Fig. 1, P.F.) This strongly suggests a parietal foramen. A reason for doubting the authenticity of this determination is the extremely anterior position of the depression forward of a transverse line drawn across the back of the orbits, which, from analogy, one concludes would lie wholly within the frontal bone, a location unknown in any other reptile either living or extinct. True, the pineal foramen is occasionally found at the junction of the frontal and parietal bones, as in *Sphenodon* and in some ichthyosaurian and mosasaurian reptiles, but in none, except some members of the last group, does it ever occur so far forward in relation to the orbits. Its absence in nearly all other members of the *Aëtosauria* is further reason for questioning its authenticity, and, until the production of additional evidence, I am inclined to regard this foramen as of accidental origin. Should it eventually be shown to be a true parietal foramen, it would be an important character in distinguishing *Hoplosuchus* from other members of the suborder.

The orbits are entirely roofed over by bone which renders them invisible from a superior view, resembling in this respect the dinosaurian genus *Stegosaurus*. There is no indication of a supraorbital fossa such as was thought to be present in *Stegomosuchus*.² (See fig. 4.) Beginning at a transverse line drawn at the back of the

¹Bull. No. 24, State of Connecticut Geol. and Nat. Hist. Survey, 1915, p. 107, fig. 11.

²Emerson and Loomis, *Amér. Journ. Sci.*, (4) Vol. XVII, 1904, p. 378.

orbits, the top of the skull is strongly inclined downward toward the nose; transversely this surface is shallowly concave. Viewed from above, the posterior outline of the skull is broadly concave from side to side. Viewed from the side, the skull is low, the depth being about one-third the total length. The orbit is of large size, subcircular in outline, and centrally placed in relation to the longitudinal diameter of the skull; it looks outward and slightly forward. Its position in the skull is intermediate between that of *Aëtosaurus* and *Stegomosuchus*, resembling the former in shape and size, and the latter in its anterior placement.

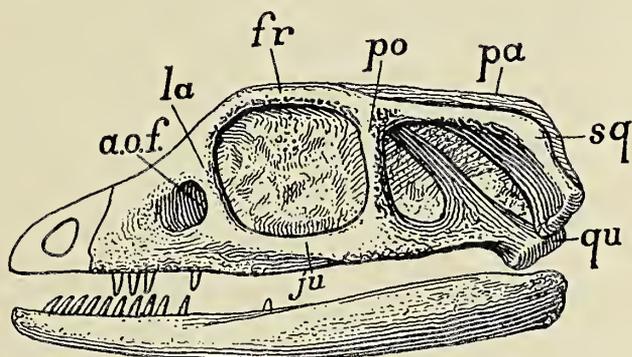


FIG. 2. Skull of *Hoplosuchus kayi* Gilmore. Type, No. 11,361, C. M. Cat., Vert. Foss., viewed from the left side. *a.o.f.*, anteorbital fossa; *fr*, frontal; *ju*, jugal; *la*, lachrymal; *pa*, parietal; *po*, postorbital; *qu*, quadrate; *sq*, squamosal. One and one-half natural size.

In front of the orbits and separated from them by the lachrymal are small, triangular shaped preorbital fossæ (See fig. 2), their small size furnishing a striking contrast when compared with such aëtosaurian forms as *Aëtosaurus*, *Scleromochlus*, or *Ornithosuchus*. Its size is even more reduced than in the American *Stegomosuchus* or the South African *Chasmatosaurus*.

In the temporal region, many features approximating the structure of the crocodylian skull are found, namely the strongly inclined and fixed quadrate and quadratojugal, which are rigidly joined to the roof of the skull internal to the upper end of the postorbital bar, as in the eusuchian *Crocodylia*. These bones thus enclose a small triangle-shaped infratemporal fossa immediately behind the orbit, and distinctly separate it from an upper elongated auditory channel, which posteriorly appears to be without osseous border. This channel is strongly overhung laterally and posteriorly by the squamosal, which bends downward at its posterior extremity. The hinder end of the

squamosal is pointed and free and is not in close relation with the paroccipital process, as is general in the *Crocodylia*.

Among described Aëtosauria, *Erpetosuchus granti* Newton³ most nearly approaches the above condition. Although this portion of the *Stegomosuchus* skull is rather imperfectly preserved, a somewhat similar division of the area below the supratemporal bar is suggested in the diagrammatic figure given by Emerson and Loomis (See fig. 4). The differences between that specimen and the one here considered may, however, be more apparent than real, since much uncertainty existed in the minds of the authors regarding the precise structure of this region in the Triassic genus. The postorbital bar is slender and stands perpendicularly, and is not inclined inward at the top, as in the crocodiles; neither does it lean backward as in many of the aëtosaurians.

Viewed from the back the skull is subrectangular in outline. The small, subcircular occipital condyle is placed high up toward the roof of the skull. On each side a large process passes off from the exoccipital region, the outer expanded end of which seems to come into close relation with the overlying squamosal bone. The posterior surface of these ends appears to be continuous ventrally with a constricted descending bone, the lower extremity of which is expanded and reaches nearly to the level of the posterior branch of the pterygoid. It seems hardly possible that all of this bone could belong to the paroccipital process, but, in the absence of all sutures, its identification remains in doubt. It may represent a process from the basiptyergoid, or, more probably, an inner wing-like development from the quadrate. The other parts of the occiput are hidden by matrix, which it was deemed inexpedient to remove.

The palate is in an almost perfect state of preservation (See fig. 3) and all uncovered, except the foremost part, but none of the sutural contacts can be determined. The pterygoids meet strongly on the median line in front of the basisphenoid and there is no evidence of pterygoid teeth, such as are found in *Proterosuchus fergusi* Broom. The pterygoid sends down a large pointed process, against the outer edge of which the inner surface of the mandible plays as in *Erpetosuchus granti* and especially in the *Crocodylia*. Posterior to these descending processes, lateral divergent processes are continued backward from

³Philos. Trans., Vol. CLXXXVB, 1894, pl. 53, fig. 1.

the main body of the pterygoid to meet the quadrates, with which they seem to be firmly joined on their inner sides.

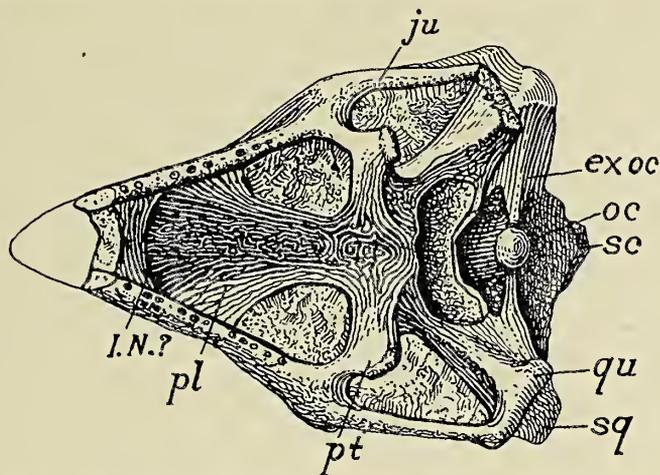


FIG. 3. Skull of *Hoplosuchus kayi* Gilmore. Type, No. 11,361, C. M. Cat. Vert. Foss., palatal view. *ex oc*, exoccipital; *in?*, internal nares; *ju*, jugal; *oc*, occipital condyle; *qu*, quadrate; *pl*, palatine; *pt*, pterygoid; *sc*, portions of dorsal scutes. One and one-half natural size.

The pterygoids are much constricted between the post-palatine vacuities which are of good size. It is quite probable that both the palatines and pterygoids help to form the inner boundaries of the post-palatine vacuities. Passing forward from the constricted area between these vacuities, the palatines rapidly widen to meet the maxillaries. Whether the maxillaries develop a palatal plate cannot be determined from this specimen. The roof of the mouth is highly arched, especially that portion lying between the teeth. There is a suggestion of a median trough slightly approaching the condition found in the palate of *Erpetosuchus granti* Newton, but not so clearly defined as in that species. The posterior nares seem to be outlined by a thin filament of bone running through the matrix in the anterior portion of the palate, but this has resisted all attempts at further development. If correct in this supposition, the posterior nares open backward from beneath a thin shelf of bone bridging across the forward portion of the mouth. Their outline cannot certainly be determined, though they are tentatively represented as shown in figure 3, I.N.?

Lower jaw.—Both rami are preserved, but only their external surfaces are freed from the investing matrix. The lower jaw, corresponding with the skull, is narrow in front, but the rami diverge regularly, as they proceed backward. They are relatively slender, fully coalesced on the median line, and give no evidence of sutural

union. The symphysis is comparatively short. There may have been a mandibular foramen, although the evidence on that point is not conclusive. Teeth appear to occupy the rami for one-half their total length. None of the sutures of the jaw can be detected so that nothing is to be learned regarding the extent of the individual elements.

Teeth.—The teeth are thecodont with long, subcylindrical roots, which are deeply inserted in the jaws. None of the upper teeth have their crowns sufficiently well preserved to determine their characters, nor can their total number be ascertained. In the right ramus there is evidence of not less than fourteen teeth, which probably closely approximates the number in the complete series. The forward teeth of the dentary have a decided backward rake. There is a suggestion of a carina on both front and back edges of the crowns of a few dentary teeth, but this evidence is very obscure. Haughton⁴ points out that in *Chasmatosaurus*, "a feature of the teeth is the manner in which the bone of the alveolar border grows on to the older teeth, *e. g.*, the Mosasaurs."

MEASUREMENTS OF SKULL.

Greatest length as preserved.....	31.0 mm.
Greatest width.....	23.0 mm.
Greatest width between orbits at center.....	16.0 mm.
Greatest width across external nares.....	7.0 mm.
Depth in front of orbits.....	7.5 mm.
Depth at orbits.....	11.3 mm.
Longitudinal diameter of orbit.....	10.0 mm.
Vertical diameter of orbit.....	6.8 mm.
Distance from posterior end of squamosal to back of orbit.....	12.0 mm.
Distance from end of snout, as preserved, to front of orbit.....	9.5 mm.
Width between center of distal ends of quadrates, about.....	18.5 mm.

MEASUREMENTS OF LOWER JAWS.

Length.....	32.0 mm.
Width across posterior ends of rami.....	22.0 mm.
Width at symphysis.....	7.0 mm.
Greatest depth of ramus.....	5.0 mm.
Greatest depth anterior end.....	2.0 mm.
Length of symphysis, about.....	5.0 mm.

Vertebrae.—The ventral portion of the centra of three anterior cervicals, a posterior sacral, and four anterior caudals are all that is

⁴Ann. Transvaal Museum, Vol. XI, 1924, p. 95.

visible of the vertebral column in the present state of preparation of the specimen (See Pl. XXVIII). It is quite probable that the entire backbone is present, for the few vertebræ exposed are in articulated series. Whether the vertebræ are amphicœlous or pleurocœlous cannot be ascertained. The cervical centra are moderately concave with a suggestion of a keel. The posterior sacral is broadly flattened below, with wide, heavy, transverse processes, extending outward to support the ilia. The caudal centra are strongly concave from end to end, and those posterior to the first have long transverse processes, which reach to the outer border of the carapace. These processes are given off from the posterior half of the centrum. The centrum of the second caudal has a length of 4 mm. The third caudal seems to have borne the first chevron. The tail is broad and flat as in *Aëtosaurus*.

Ribs.—A few slender ribs of each side project downward from the matrix beneath the carapace but they are too imperfect to supply satisfactory information. None gives evidence of the presence of uncinæ processes.

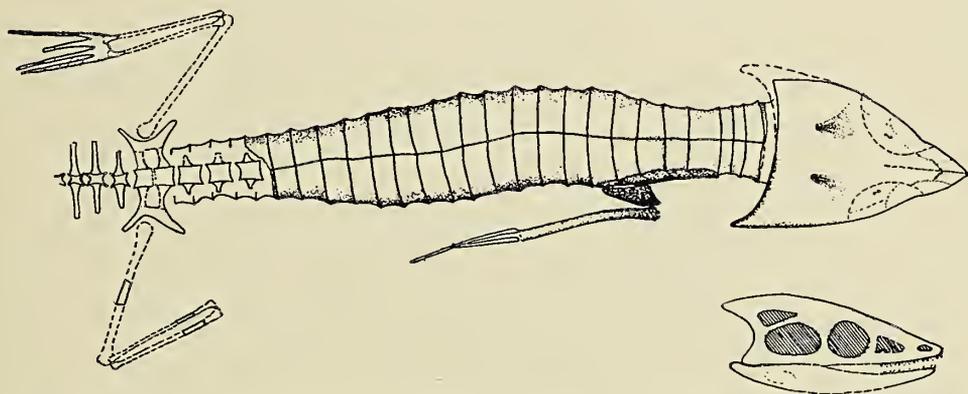


FIG. 4. Skeleton and Skull of *Stegomosuchus longipes* (Emerson and Loomis). Type. About one-half natural size. (After Emerson and Loomis.)

Dermal armor.—The dorsal side of the body was protected by a bony covering consisting of a double row of rectangular plates, which join by their shorter diameters on the median line (See Pl. XXVII, fig. 1). The rear margin of each scute overlaps the front of the succeeding. The outer margins of the dorsal scutes are oblique to the inner margin as in *Stegomus arcuatus* Marsh, while in *Stegomosuchus longipes* (Emerson and Loomis) the two margins are parallel or with only a slight tendency to diverge at the rear edge of each plate (See fig. 4). Posterior to the sacrum their outer edges are

flanked by small subtriangular scutes similar to those found in the presacral region in *Stegomosuchus longipes*. The posterior half of the tail, however, shows evidence of having been entirely enveloped by bony armor. It has been impossible to determine the total number of bony segments forming one of these tail rings, but that there were not less than six distinct elements is certain.

Between the head and the pelvis there are certainly twenty-two sets of plates, possibly one or two more, the uncertainty of the precise number being occasioned by a fracture across the carapace immediately posterior to the skull, which destroyed a transverse area. It is presumed that the number of sets of dermal plates equals the number of presacral vertebræ, *i. e.*, there being one set for each vertebra as in *Aëtosaurus*. If this be true, the presacral series would closely approach the extant *Crocodylia* which have twenty-four vertebræ in front of the sacrum.

This feature is in itself an important distinction between this reptile and the armored Triassic *Stegomosuchus* which is said to have twenty-eight sets of dermal plates, although von Huene⁵ was of the opinion that there are not more than twenty-five presacral vertebræ.

In the neck and anterior dorsal region the plates are so firmly coalesced on the median line that their union can no longer be seen. More posteriorly, however, and continuing well backward above the tail their median junction is clearly defined.

The fourth segment posterior to the sacrum bears the first small triangular scute, which is smaller than any of those immediately following. On the left side of the fifth caudal segment and in juxtaposition to the small triangular scute of this segment is found the first evidence of ventral plates. This is a rectangular scute about subequal in size to the dorsal scutes and articulated with the small triangular scute previously mentioned. That the under side of the remaining portion of the tail was armored is clearly indicated in this specimen, although the details of its structure are more or less obscure. It is also quite evident that the tail was flattened dorso-ventrally. The dorsal scutes of the tail become narrower transversely and longer antero-posteriorly from the sacrum backward.

The arrangement and relationships of the dorsal scutes are clearly shown in Plate XXVII, fig. 1. Scutes in the mid-dorsal region have

⁵Geol. und Pal. Abhl., Jena, Vol. XIII, pt. 1, 1914, p. 19.

a fore-and-aft width of 4.5 mm. and a transverse diameter of about 10 mm. The narrowness fore-and-aft of many of the cervical segments is probably due to the bending upward of the neck thus causing the scutes to slide over one another. There is no evidence of a wide segment in the middle of the cervical region, such as was found in *Stegomosuchus longipes* (See fig. 4).

Taken as a whole the carapace is slightly constricted in the region of the neck, gradually widening to the middle of the dorsal region, and again becoming progressively narrower proceeding toward the extremity of the tail.

On the dorsal surface of the scutes there are indications of pitting but the character of the preservation is such that one cannot be certain. This apparently is also the condition in *Stegomosuchus*, as contrasted with the radially arranged striæ ornamenting the scutes in *Aëtosaurus*.

Allowing two segments for the sacrum there are twenty-three sets of caudal segments to the point where the tip of the tail protruded from the rock and was lost.

Pectoral girdle.—The scapula and coracoid of both sides are present, but all of these bones are so situated that it is impossible to obtain either a full conception of their shape or to determine their individual characteristics. The scapulæ are partially hidden beneath the overlying carapace, and the coracoids project downward between the fore limbs in such a manner that they cannot be fully developed. The left scapula, which is most fully exposed, shows the expanded articular end bending strongly inward, as in *Erpetosuchus*. Over all it has a greatest length of 12.8 mm. The upper or free end is rather squarely truncated and without especial backward expansion, in this respect resembling the crocodilian scapula more nearly than that of the armored *Aëtosaurus*.

The scapula of *Aëtosaurus*, as illustrated by von Huene,⁶ shows a decided backward extension of the upper end. The outer surface of the blade is gently convex transversely, becoming flattened toward the upper extremity and concave toward the lower or articular end.

Both scapulæ, as found in this articulated specimen, lie with their longest diameters practically parallel with the vertebral column, but whether this represents the natural angulation of these bones, or that

⁶Acta Zoologica, 1920, p. 477, figs. 26 and 27.

they have been flattened down from a more vertical position by postmortem causes, is impossible of determination.

The coracoids are slightly separated from their respective scapulæ. The surface of the coracoid which articulates with the scapula corresponds in thickness and outline with the corresponding surface of the latter bone. The external border of this surface makes an oblique angle with the longitudinal axis of the bone. The glenoid surface faces outward and is situated on a process, which is sharply set off from the main mass of the bone, as in the *Crocodylia*. The portion below this expanded end cannot be seen sufficiently well to determine its other characteristics. A coracoid foramen has not been recognized, though it may be present.

In the present stage of preparation of this specimen none of the other elements of the girdle have been disclosed.

Fore leg and foot.—Both articulated fore limbs are present, but the left fore foot is entirely missing and a single metacarpal and one phalangeal bone is all that remains of the right.

The humerus is relatively slender in proportion to its length. It is expanded at both ends, more especially the proximal, the planes of the proximal and distal expansions cutting one another at a considerable angle, as in the *Sauria*, instead of being nearly parallel, as in the *Crocodylia*. The humerus viewed from the side is sinuously curved from end to end, so that the proximal end curves slightly backward and the distal end slightly downward. On the posterior side of the distal end the bone is decidedly grooved. The deltoid crest is prominently developed and located near the proximal end of the bone. There is no indication of either entepicondylar or ectoepicondylar foramina. The humerus is somewhat shorter than the femur, having a total length of 19.3 mm. whereas the latter is 26 mm. long.

MEASUREMENTS OF HUMERUS.

Length.....	19.30 mm.
Breadth of proximal end.....	5.50 mm.
Breadth of distal end.....	3.00 mm.
Least diameter of shaft.....	1.75 mm.

The radius and ulna of both fore limbs are closely applied to one another, the radius having a tendency to cross the front of the ulna, a condition noted by Emerson and Loomis in *Stegomosuchus (Stegomus) longipes*,⁷ a condition closely simulating the mammalian forearm.

⁷Amer. Journ. Sci., Vol. XVII, 1904, p. 378.

The radius is a slender, straight-shafted bone, slightly shorter than the ulna, and slightly expanded at the proximal and distal ends. It has a greatest length of 17.5 mm.

The ulna is characteristic in form, being heavy at the proximal end and small at its distal end. It slightly exceeds the humerus in length, a condition found also in *Crocodylus americanus*. The left humerus, which is most perfect, has a greatest length over all of 19.4 mm.

A single poorly preserved articulated metacarpal appears to have a length of about 7 mm. The preservation of this bone is such that it shows no other details of value. A small fragment of bone attached to its distal end may represent a phalangeal, but it shows no features by which its identification can be fully established. There is no positive evidence of the presence of an ossified carpus.

Pelvic arch.—There is reason for believing that the complete pelvic arch is present, but the articulated hind limbs are folded up in such a manner along both sides that it has been quite impossible to expose the forward part of the arch to view. By removing the matrix from the rear the uncrushed and articulated ischia are partially disclosed. Their distally expanded ends meet broadly on the median line and at the center send backward an obtusely pointed projection. The pelvic orifice has a greatest vertical depth of 7 mm. The line of articulation with the ilium cannot be surely determined, so that it is impossible to say anything about this important feature. Neither can it be determined whether the ischium excludes the pubis from contact with the ilium, as in the *Crocodylia*, a most important structural feature and one that would be of the greatest importance in the positive determination of the true relationships of the present specimen. The outlines of the ilium cannot be delimited and the pubes are entirely hidden in the matrix.

Hind leg and foot.—Except for the loss of a few phalanges both hind limbs and feet are completely preserved. The fact that both hind legs are folded up parallel to one another appears indicative of an upright mammalian posture of the limbs in life, rather than the sprawling pose of a crawling reptile.

The femur is expanded at both ends, with the planes of these ends oblique to one another as in the humerus. The shaft of the bone has a forward arcuation and the proximal end bends decidedly upward much as in the lacertilian reptiles. The anterior surface toward the distal end is shallowly grooved longitudinally. The other features of

the femur are hidden from view, either by adjacent bones or the enveloping matrix. Over all the femur has a length of 25 mm., being the longest bone of the appendicular skeleton.

The right tibia is exposed for its full length on the posterior side, but it is folded up beneath the femur in such a manner that none of its other characteristics are disclosed at this time. It has a greatest length of about 21 mm.

The fibula is long and slender. Its detailed features are obscure like those of the tibia. The tarsi are apparently complete in both limbs, but the bones are so merged into one another that it is quite impossible to differentiate the separate elements. The calcaneum can be recognized from its position below the fibula and also from its prominent backward projection, which is especially well shown in the right tarsus. In this respect it resembles other *Aëtosauria*, such as *Aëtosaurus* and *Scleromochlus*.

The hind foot consists of four digits, there being no trace of a fifth in either pes. The metatarsus is much longer than the metacarpus. The metatarsals are long and slender, and closely articulated at their proximal ends. The inner one is the shortest, the second and third about subequal in length, and the fourth slightly shorter than the median pair. In the number of digits and relative length of metatarsals they bear a close resemblance to the crocodilian pes. The complete digital formula is unknown. The complete proximal row of phalanges is present on the right foot and the inner two on the left. The third is the longest and stoutest. The third metatarsal is about one-half the length of the tibia. A second phalanx is preserved on the fourth toe of the right hind foot, but all other distal phalanges are missing.

AFFINITIES.

The anterior position of the external nares; the forward location of the internal nares; the large orbital, opening laterally; the small, but distinct, preorbital vacuity; the triangular infratemporal fossa; the fixed quadrate; the deeply socketed thecodont teeth; the fore limb shorter than the hind; the fifth digit of the pes, either absent, or very much reduced; and a dorsal armor of a series of oblong paired plates are a combination of structural features in *Hoplosuchus* characteristic of the suborder *Aëtosauria* (*Pseudosuchia*).

On the other hand the failure to recognize the existence in this

genus of supratemporal fossæ, and the presence of what appears to be a distinct pineal foramen are structural features unknown in the other members of this suborder. Some doubt exists as to whether the so-called pineal is a true foramen in this skull, or whether it only represents an accidental opening. Under the glass it appears to be authentic, although its position so far forward between the orbits is without parallel among other Reptilia, with the possible exception of the *Ichthyosauria*. The matter of the absence of supratemporal fossæ I do not consider so important, as they might have been roofed over secondarily. However, on account of these uncertainties of skull-structure, the present reference of this specimen to the *Aëtosauria* (*Pseudosuchia*) is made with reservations.

In size, general contour of the skull, and in the placing and relative proportions of the lateral openings of the cranium, *Hoplosuchus kayi* finds its nearest counterpart in the skull of *Stegomosuchus*. Still closer resemblances between these two genera are found when the skeletal parts and the dermal armor are compared. Unfortunately the skull of *Stegomosuchus* is not fully known, so that it cannot be contrasted throughout with the specimen under consideration. This observation applies particularly to the important postero-lateral portion, which, in the rather sketchy outline published by Emerson and Loomis (See fig. 4), leaves one in doubt as to how much dependence can be placed on it, as illustrating the actual structure. The perpendicular position of the quadrate, having in front of it two lateral fossæ, separated by a slender and nearly horizontal bar, in the light of the skull of *Hoplosuchus* at once suggests that the above mentioned bar may after all represent an inclined quadrate and quadratojugal, and, if this supposition be true, the small triangular fossa above the bar would represent the auditory channel and the one below the true infratemporal fossa. Whether this is the correct interpretation or not must, however, await the discovery of better preserved specimens. Furthermore, doubt of the existence of an external mandibular foramen in *Stegomosuchus* is also expressed by the broken line used in indicating its probable position.

In the large size of the orbit *Hoplosuchus* approaches *Aëtosaurus*, although its submedian position in relation to the longitudinal diameter of the skull finds its nearest resemblance in *Stegomosuchus*. A further similarity between these two genera is the greatly reduced anteorbital fossa, as contrasted with the large preorbital vacuities in

such genera as *Erpetosuchus*, *Ornithosuchus*, *Aëtosaurus*, and *Scleromochlus*.

The inclined quadrate-quadratojugal with strongly overhanging squamosal of *Hoplosuchus* finds its closest resemblance in the Elgin *Erpetosuchus granti*. This is a crocodile-like feature of the *Aëtosauria*, which reaches its extreme development in *Hoplosuchus*. The skull resemblances of certain members of this suborder to the *Dinosauria*, *Crocodylia*, and *Pterosauria* have been noticed by several writers, but in *Hoplosuchus* the trend of development appears to be toward the *Crocodylia*, as shown by the presence of a fixed quadrate, which is strongly inclined forward and articulating dorsally internal to the upper end of the postorbital bar, the presence of a reduced infratemporal fossa with a large auditory channel lying above and behind this fossa, pterygoids completely united on the median line in front of the basisphenoid and with descending plates, thecodont dentition, elongated coracoids, four elongated digits in the pes, and a produced calcaneum. The articulated ischia also have a crocodylian aspect, although they are not greatly unlike those of *Aëtosaurus*.

The forward position of the posterior nares gives the palate a lizard-like character and quite unlike any *Mesosuchia* or *Eusuchia*, but resembles the condition found in *Erpetosuchus* and *Ornithosuchus*. The preorbital vacuity finds no counterpart in the *Crocodylia*, but is present in many of the *Dinosauria*.

The appendicular skeleton, so far as it can be compared, shows a remarkably close resemblance to the long, slender limbs of *Stegomosuchus longipes*, the closest similarity existing in the relative proportions between fore and hind limbs, and between the several segments composing them. In view of this, I refer the new genus *Hoplosuchus* provisionally to the family *Stegomosuchidæ*.

RESTORATION.

On Plate XXIX is shown a skeletal restoration of *Hoplosuchus kayi* somewhat less than natural size. While there are many critical points regarding the skeletal anatomy of this animal yet to be determined, the tentative restoration serves to graphically display some of its more striking characteristics, such as the upright, cursorial type of limbs, the flatness of the tail, and the general slenderness of the whole animal.

The missing parts and the obscure form of many of the bones in the original skeleton have been restored after other aëtosaurians, and apart from the skull and dermal exoskeleton, the detailed form of most of the remaining elements is subject to revision with the discovery of better preserved specimens. However, the proportions of the animal may be relied on as being approximately correct.

Practically nothing is known of the structure of the fore foot and little of the pectoral and pelvic girdles, the scapulæ and poorly preserved coracoid of the former and the ischia of the latter only being present; these parts, therefore, have been almost entirely restored.

It is presumed that the dermal armature was more extensive than is here represented, but its complete development can be depicted only after discovery of better specimens.

Hoplosuchus seems to have been a cursorial terrestrial animal, as is evidenced by the slender body and long, light limbs, formed of nearly straight-shafted bones. A further reason for the adoption of the upright, mammalian-like pose of the limbs is furnished by the parallel position of the legs in relation to the body, as preserved in the matrix, a position not likely to be assumed in the preservation of a skeleton of a low, sprawling reptile.

REFERENCES TO LITERATURE.

- BOULENGER, G. A. *On Reptilian Remains from the Trias of Elgin.* Philos. Trans. Roy. Soc. London, Vol. CXCVI, 1903, p. 175-189, fig. 9, Pls. V-X.
- BROOM, R. *On the South African Pseudosuchian Euparkeria and Allied Genera.* Proc. Zoöl. Soc. London, 1913, pp. 619-633, Pls. LXXV-LXXIX.
- EMERSON, B. K., and LOOMIS, F. B. *Stegomus longipes, a New Reptile from the Triassic Sandstones of the Connecticut Valley.* Amer. Journ. Sci., (4) XVII, 1904, pp. 377-380, Pl. XXII.
- FRASS, O. *Dyoplax arenaceus, ein neuer Keupersaurier.* Jahresb. d. Ver. f. vaterl. Naturk. in Württemberg, Vol. XXIII, 1867, p. 108.
- *Aëtosaurus ferratus, Fr., die gepanzerte Vogelechse aus dem Stubensandstein bei Stuttgart.* Jahresb. d. Ver. f. vaterl. Naturk. in Württemberg, Vol. XXXIII, 1877, pp. 1-21.

- HAUGHTON, S. H. *A New Thecodont from the Stormberg Beds. (Sphenosuchus acutus, g. et sp. nov.)*. Ann. South African Museum, Vol. XII, 1915, p. 98.
- *On a New Type of Thecodont from the Middle Beaufort Beds*. Ann. Transvaal Mus., Vol. XI, pt. 1, 1924, pp. 93-97, Pls. VII and VIII.
- HOEPEN, E. C. *A New Pseudosuchian from the Orange Free State*. Ann. Transvaal Mus., Vol. V, 1915, pp. 83-87.
- HUENE, F. VON. *Beiträge zur Kenntnis und Beurteilung der Parasuchier*. Geol. u. Paläont., Abh. Jena, 10 pt. 1, 1911, pp. 61-122.
- *Beiträge zur Geschichte der Archosaurier*. Geol. u. Paläont. Abh. Jena, Vol. 17, pt. 1, 1914, pp. 1-53, 7 Taf.
- *Osteologie von Aëtosaurus ferratus O. Frass*. Acta Zoologica, 1920, p. 465.
- *The Triassic Reptilian Order Thecodontia*. Amer. Journ. Sci., (5) Vol. 4, 1922, pp. 22-26, 1 fig.
- *Kurzer Überblick über die triassische Reptilordnung Thecodontia*. Centralbl. f. Min., Stuttgart, 1922, pp. 408-415, 1 fig.
- LULL, R. S. *Triassic Life of the Connecticut Valley*. State Geol. Nat. Hist. Survey of Connecticut, Bull. No. 24, 1915, p. 98.
- MARSH, O. C. *A New Belodont Reptile (Stegomus) from the Connecticut River Sandstone*. Amer. Journ. Sci., (4) II, 1896, pp. 59-62, Pl. I.
- NEWTON, E. T. *Reptiles from the Elgin Sandstone: Description of Two New Genera*. Philos. Trans. Royal Soc. London, CLXXXV, 1894, pp. 573-607, Pls. LIII-LVI.
- WOODWARD, A. S. *On a New Dinosaurian Reptile (Scleromochlus taylori) gen. et sp. nov. from the Trias of Lossiemouth, Elgin*. Quart. Journ. Geol. Soc. London, Vol. 63, 1907, pp. 140-144, Pl. IX.

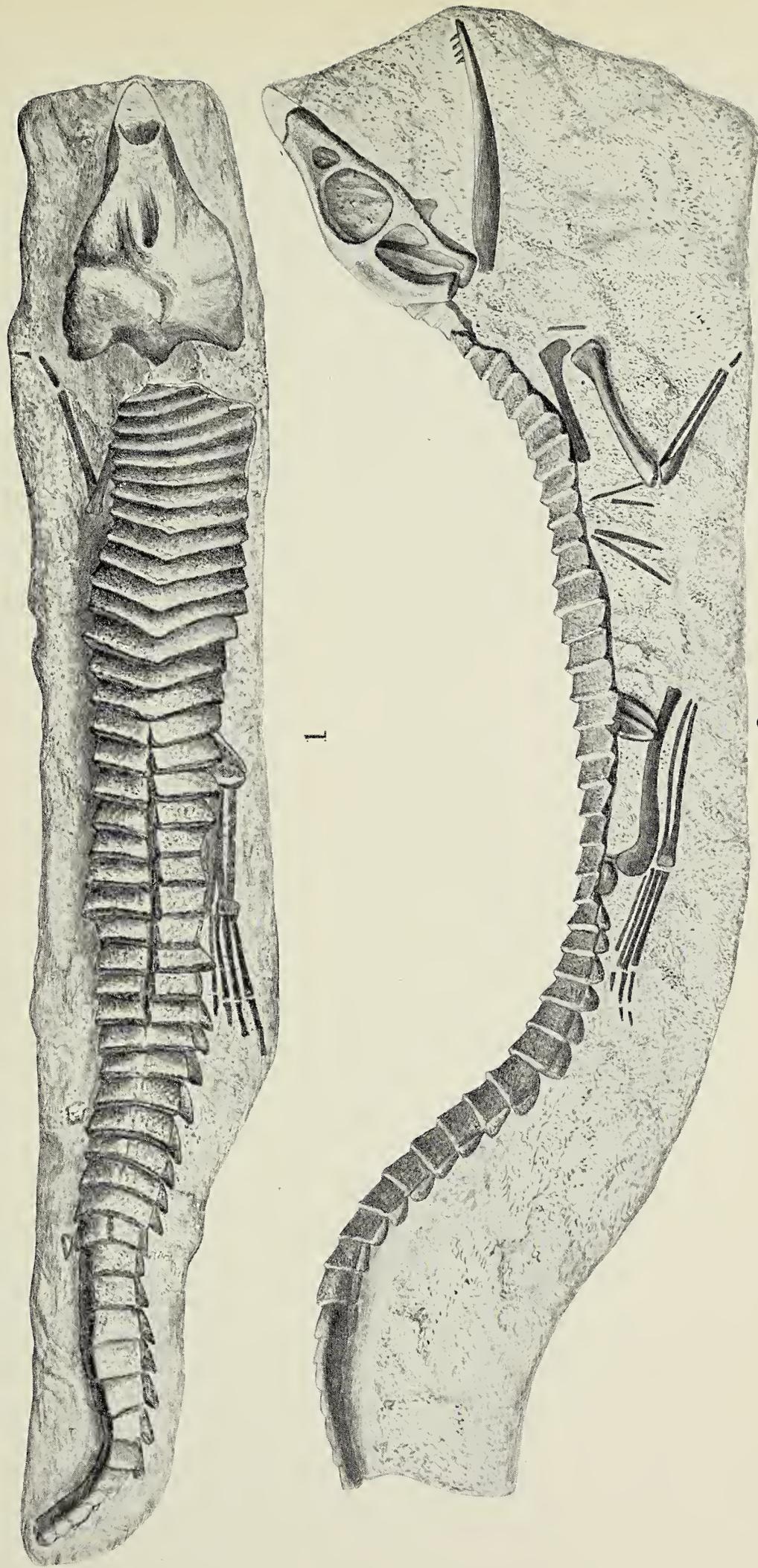
EXPLANATION OF PLATE XXVII.

Skeleton of *Hoplosuchus kayi* Gilmore. Type, No. 11,361, Carn. Mus. Cat.
Vert. Fossils.

FIG. 1. Dorsal View.

FIG. 2. Lateral View, Right Side.

(Both figures natural size.)



1

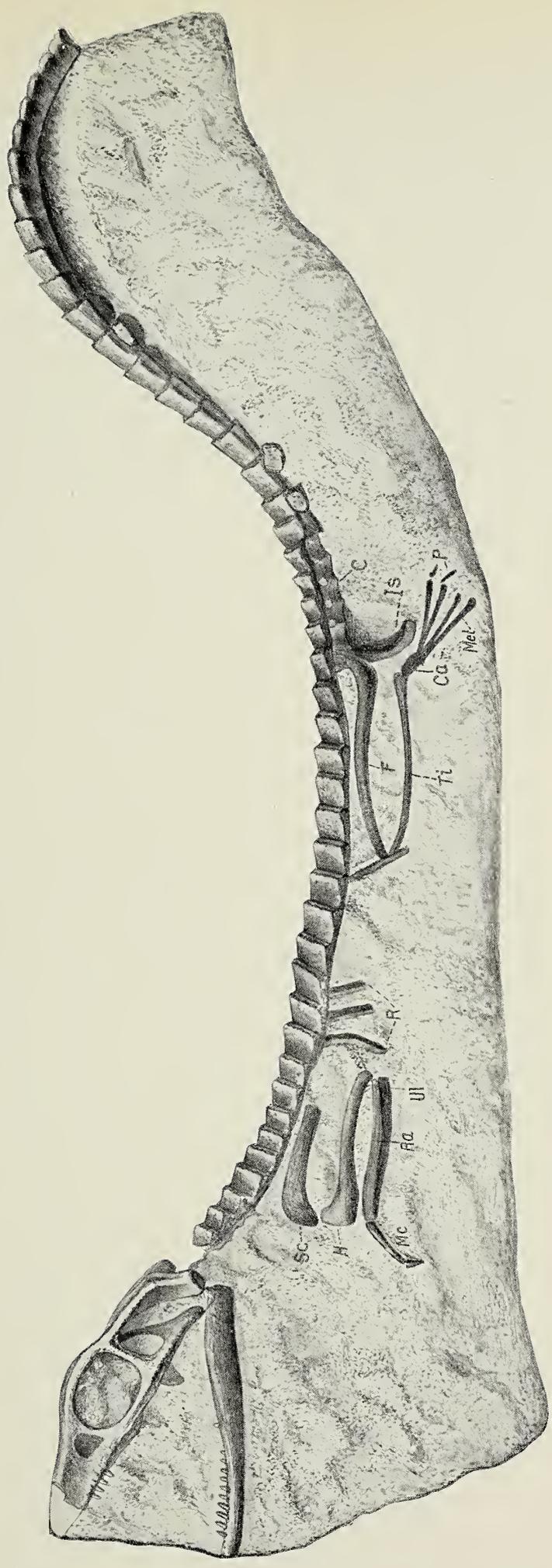
2

Hoplosuchus kayi Gilmore.

EXPLANATION OF PLATE XXVIII.

Skeleton of *Hoplosuchus kayi* Gilmore. Type, No. 11,361, Carn. Mus. Cat. Vert. Fossils. Lateral View, Left Side. (Natural size.)

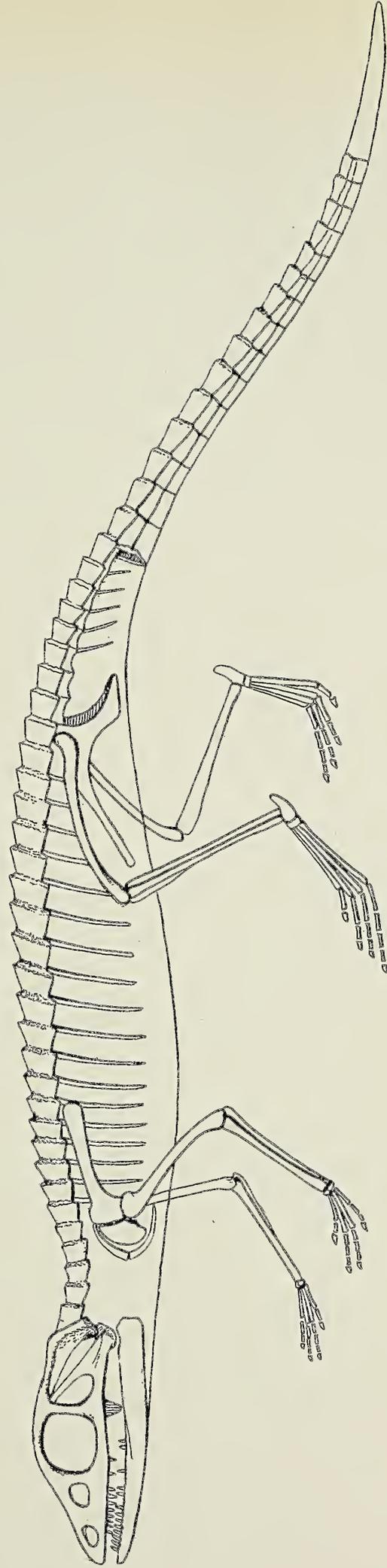
C, caudal centra; *Ca*, tarsus; *F*, femur; *H*, humerus; *Is*, ischium; *Mc*, metacarpals; *Met*, metatarsals; *P*, phalanges; *R*, ribs; *Ra*, radius; *Sc*, scapula; *Ti*, tibia; *Ul*, ulna.



Hoplosuchus kayi Gilmore.

EXPLANATION OF PLATE XXIX.

Restored Skeleton of *Hoplosuchus kayi* Gilmore, viewed from the left side.
(About natural size.) Some missing parts restored from other Aëtosaurians.



Hoplosuchus kayi Gilmore.