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Article X.— A COMPLETE SKELETON OF THE HORNED DINOSAUR MONOCLONIUS, AND DESCRIPTION OF A SECOND SKELETON SHOWING SKIN IMPRESSIONS.

By Barnum Brown.

Plates XI–XIX.

Introduction.

Systematic search in the Upper Cretaceous formations of the western United States and Canada rarely fails to reveal some fossils referable to the Ceratopsia. Their remains are abundant in the Lance, the Judith River, the upper part of the Belly River, and are fairly numerous in the Edmonton.

At the present writing no genus of the Ceratopsia is known to be common to any two distinct formations, hence they are excellent horizon markers where determinations are possible.

In the Lance formation *Triceratops* is by far the most common vertebrate fossil known. During seven years' work, 1902–1909, in the Hell Creek Beds (Lance) of Montana I identified no less than five hundred fragmentary

CORRELATION OF PRINCIPAL FORMATIONS IN WHICH HORNED DINOSAURS ARE FOUND

WYOMING	MONTANA	ALBERTA	*Characteristic Genera*
LANCE	LANCE (HELL CREEK BEDS)		*Triceratops* *Torosaurus*
	ST. MARY	EDMONTON	*Anchiceratops* *Leptoceratops*
	JUDITH RIVER (ON MISSOURI RIVER) TWO MEDICINE	BELLY RIVER (ON RED DEER) (ON BELLY RIVER)	*Monoclonius* *Ceratops* *Styracosaurus* *Brachyceratops*

Fig. 1. Correlation Diagram.

skulls and innumerable bones referable to this genus. *Torosaurus*, the only other described Ceratopsian, is rare.

In the Edmonton, the next preceding formation, which contains a vertebrate fauna distinctly older than that of the Lance, Ceratopsian remains are less common. But it must be remembered that exposures of the Edmonton, for the most part confined to river banks, are less extensive than the Lance. *Triceratops* and *Torosaurus* are not present but the family is represented by two known genera, *Anchiceratops* a large animal of primitive skull characters, fairly common, and a small aberrant Ceratopsian *Leptoceratops* known from the type specimens and from a fragmentary skeleton soon to be described, from the St. Mary, a formation of synchronous age in Montana.

The Judith River formation of Montana and the Belly River formation of Canada are now generally considered to be equivalent in age. This I am convinced is only in part true, for the Belly River formation is certainly not a unit but is composed of two or more subdivisions that differ lithologically and faunally and which may eventually be given the rank of distinct formations. The upper part of the Belly River strata exposed on the Red Deer and the Saskatchewan Rivers and on Milk River where it again enters Montana, roughly the area north and east of the Sweet Grass Hills, is rich in vertebrate fossils. These strata are synchronous with the Judith River formation on Milk River and on the Missouri River at the mouth of Judith River and the vertebrate fauna is apparently the same. Ceratopsian remains are abundant and the genera and species are varied. *Monoclonius* and *Ceratops* are common to the designated Montana and Canadian areas. *Styracosaurus*, a rare form, is known only from the Belly River exposures on the Red Deer.

The Two Medicine formation of Montana differs materially in lithologic characters from the strata before mentioned and contains a varied fauna that appears to be older. These strata check perfectly with the typical Belly River exposed on Belly River between the mouth of the St. Mary and the Little Bow and are doubtless synchronous in age. In the Two Medicine, where the vertebrate fauna is best known, Ceratopsians are not abundant and so far only one form has been described, *Brachyceratops*, a small primitive genus not known from any later horizon.

Physical conditions that existed during deposition of the Belly River and the Edmonton strata appear to have been similar and these formations both show a gradual change from purely marine beds at the base up through brackish-water to fresh-water beds at the top. The Lance formation is more uniformly a fresh-water land deposit.

Frequently remains of many Trachodonts are found massed together in

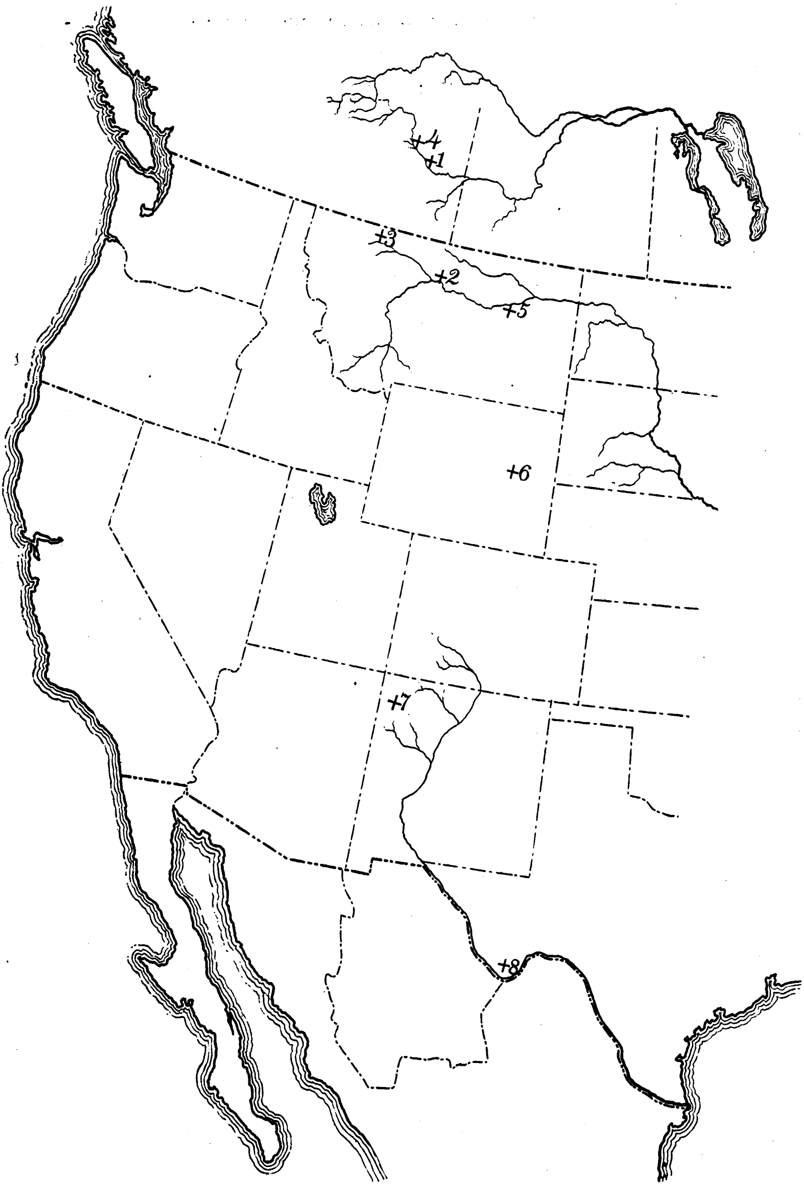


Fig. 2. Sketch map showing principal areas in which horned dinosaurs are found.

1 = Belly River formation on Red Deer River, Alberta.
2 = Judith River " " Missouri River, Montana.
3 = Two Medicine " " Blackfeet Indian Reservation.
4 = Edmonton " " Red Deer River, Alberta.
5 = Lance (Hell Creek Beds) formation on Missouri River, Montana.
6 = Lance formation, Converse Co., Wyoming.
7 = Ojo Alamo Beds, New Mexico.
8 = Rattlesnake Beds, Big Bend of Rio Grande, Texas.

quarries, probably as a result of water action, in the Belly River and in the Edmonton strata, and there are two records of such occurrence in the Lance. In such quarries it is not exceptional to find Trachodonts, carnivorous dinosaurs, Ceratopsia and other remains commingled, although Trachodonts usually predominate. Ceratopsian remains are rarely found massed without admixture of other forms. There is no record of an occurrence of two or more specimens of *Triceratops* having been found together in one place, but three *Monoclonius* quarries were observed by the writer in the Belly River strata of the Red Deer River and in one quarry no less than eleven individuals were determined from fragmentary skulls. In this particular quarry every bone exposed was that of *Monoclonius* or *Ceratops* and no other vertebrate fossils were represented. This purely circumstantial evidence of occurrence may or may not have value in considering their habits, but it would seem to indicate that the Belly River genera were gregarious.

The first discovery of any fossil referable to the Ceratopsia must be credited to Dr. F. V. Hayden who in 1855 collected in the Judith River badlands of Montana a single tooth which was figured in 1856 by Dr. Leidy.

In 1907 Hatcher, Marsh and Lull published a Monograph on the Ceratopsia in which most of the anatomy of the group is described, but in all of the vast amount of material preserved in different museums there was at that time no complete skeleton of a single individual, and the structure of the feet and length of tail have up to the present time remained problematical.

Occurrence and Preparation of Skeleton.

The American Museum Expedition to the Red Deer River in 1914 was fortunate in finding a perfect skeleton of *Monoclonius*, No. 5351, complete in all details from the tip of the tail to the end of the nose with most of the bones articulated in position. It was lying on its left side with the phalanges exposed and some of the bones were damaged but parts of all were present. Part of the skeleton was surrounded by sandstone and ironstone matrix of such nature that much of the scientific value of the skeleton would have been sacrificed by extracting it for a free mount. Consequently the skeleton has been worked out in relief and mounted as a panel. The credit for the difficult preparation and mounting is due to the skilful work of Mr. P. C. Kaisen and Mr. Charles Lang.

The vertebral column, femora, right hind leg and left scapula and coracoid were left in the original matrix and mounted exactly as found. During fossilization the tibia, fibula and foot of the right hind leg have been rotated 45 degrees from normal so that the fibula appears back of the tibia instead of on the outside as it would appear in life. This foot was in position. Other front and hind foot bones are assembled after another perfectly articulated specimen, No. 5372, found in 1915, and are presented so as to show the front view of the right front foot and the palmar view of the left front foot. The right ilium was disarticulated and crushed vertically so that it does not exactly fit the other pelvic bones or the sacrum except along the transverse processes.

Most of the other bones of the skeleton are more or less compressed laterally, especially the limb bones and the transverse processes of the dorsal vertebræ which have been elevated considerably. The ribs have been flattened excepting the last five dorsals which retain their normal curvature.

In the description of a complete skull of *Monoclonius flexus,* Bull. Amer. Mus. Nat. Hist., Vol. XXXIII, Art. xxxiv, pp. 449–558, 1914, I expressed the opinion that *M. sphenoceros* was a synonym of *M. crassus,* a view that I continue to hold, but in the light of material recently collected it seems advisable to await more complete material from the type locality of the Judith River species before referring doubtful Belly River Ceratopsians to Judith River species. I shall therefore describe this complete skeleton as a new species.

Monoclonius *Cope.*

Characters assigned to the skeleton include those of family value.

Generic characters: Skull small to medium sized with three horns; nasal horn large, curved or straight, rising from middle of nasals immediately above the posterior border of the nares; supraorbital horns small or incipient. Nasals large; nares nearly separated by osseous septum formed by premaxillaries and nasals. Premaxilaries deep with vertical plate forming septum non-fenestrated. Crest composed of short, broad squamosals and extension of elongate coössified postfrontals or derm-supraoccipitals (parietals) perforated by large fenestræ; each fenestra wholly within the boundary of the derm-supraoccipitals. Margin of crest crenulated, each prominence bearing a separate ossification. A pair of long curved hook-like processes on posterior border of derm-supraoccipitals, orbit round, eye with sclerotic bony plates.

Vertebral column composed of 77 vertebræ comprising 21 presacrals, 10 sacrals and 46 caudals. The three anterior cervicals coössified.

Pelvis: Ilium, long and narrow. Ischium long and moderately curved. Pubis with long thin postpubis.

Scapula long, narrow and straight.

Coracoid with pronounced curved distal point.

Humerus long and only moderately robust with deltoid crest terminating above the middle of the shaft.

Carpus with 2 ossified carpals.

Manus with five digits, the inner three bearing hoofs; phalangeal formula, I = 2, II = 3, III = 4, IV = 3, V = 2.

Femur with vestigial fourth trochanter, in middle of shaft.

Tibia and *fibula* more than half the length of femur.

Tarsus with 4 ossified tarsals in two rows.

Pes with four functional digits bearing hoofs and the fifth vestigial, represented by reduced metatarsal. Phalangeal formula, I = 2, II = 3, III = 4, IV = 5.

Monoclonius nasicornus sp. nov.

Type of species: A complete skeleton, No. 5351.

Horizon and locality: Belly River formation, 100 feet below top of beds, north fork of Sand Creek, 12 miles below Steveville, Red Deer River, Alberta, Canada.

Specific characters: Skull with short face; supraorbital horns incipient, nasal horn long, straight and laterally compressed; epoccipitals large. Two inwardly directed processes on posterior end of frill; a forwardly directed process over each fontanelle. Teeth with low median carina and not more than 31 vertical rows.

For advantage of comparison the different parts of the skeleton will be treated in the order described in the Monograph of the Ceratopsia by Hatcher, Marsh and Lull.

Skull.

Most writers in describing species of the Ceratopsia have attached greater importance to the development of the horns and accessory frill growths than to me seems warranted. These parts are subject to great individual variation and too much stress should not be laid on such characters when they are not corroborated by differences of the fundamental skull elements.

Compared with the type skull of *Monoclonius flexus* this new species shows a striking difference in the development of the facial region as may be seen from the measurements given below.

The skulls are of equal width and height and *M. nasicornus* is 17^c shorter than *M. flexus*, but the shortness is accentuated by the contraction of the facial portion in front of the orbits; minor differences are observed in the frill.

The nasal horn is long, straight, massive and laterally compressed but less compressed than in *M. crassus* (*sphenoceros*) which it resembles. In *M. flexus* the nasal horn curves forward and is ovate in cross-section. Rugosities appear above the eyes but the orbital horns are incipient and less developed than in *M. flexus*. The skull character of greatest importance in distinguishing this species is the short face in which nasals and premaxillaries are both much shorter than in *M. flexus*. The superior border of the premaxillaries where they unite with the nasals are angular, swollen and rugose.

The frill or crest is in areal dimension nearly equal to that of *M. flexus* with the central derm-supraoccipital portion somewhat modified. This central element consists of a median thin, roof-like, posteriorly directed bar which at the end divides forming a T, and the cross-bar continues outward and forward in a broad curve to unite with the squamosal and the central portion at its origin, thus enclosing on each side a large fontanelle as in all monoclonid Ceratopsia. At the extreme posterior end the cross-bar of the T is broadly incised and flanked on each side by a large hook-like process. These hooked processes approach each other one-half nearer than in *M. flexus*.

Opposite the hooked process on the anterior face there is a large free spur that extends forward over each fontanelle. On the free borders of the frill there are large epoccipital bones that increase in size from below upward, all considerably larger than in *M. flexus;* five are present on the squamosal and four on each side of the derm-supraoccipital.

The squamosal is exactly like that of *M. flexus* and the laterotemporal vacuities are relatively smaller than in *M. flexus.*

In this specimen five plates of the sclerotic ring are preserved in the right orbit, the first recorded occurrence in this family. The plates differ from those of Trachodonts, and I believe the sclerotic ring was not capable of as much expansion and contraction as in forms where the eye occupied relatively less of the orbital space. The outer surface of each plate is finely rugose and one-half was overlapped by the succeeding plate; the upper and lower borders are both thin and irregular.

In the maxillary there are 29 rows of teeth having the same method of succession and implantation as in *Triceratops.* The teeth differ from those of *Triceratops* in the position of the median carina which instead of being central is invariably located on the posterior third of the enamel face.

The lower jaws are less massive than in *Triceratops* with a reduced number of teeth. The elements that compose the mandible are of the same form as in *Triceratops* but the surangular is relatively much larger.

In the right dentary there are 29 alveoli and in the left dentary 31. Not more than five teeth are determinable in any vertical row although there may be incipient teeth at the base not detected. In the middle rows the central carina of the enameled crown is relatively higher than in *Triceratops* and the outward curvature of the rows is consequently greater.

Skull measurements.

	M. nasicornus	*M. flexus*
Total length of skull measured over face	1420 mm.	1570 mm.
" " " " between posterior central border of derm-supraoccipital and rostral	1330 "	1410 "
Length between center of orbits and posterior border of nasal horn	177 "	230 "
Length between anterior border of nasal horn and rostral	250 "	355 "

Vertebral Column.

The complete vertebral column comprises 77 vertebræ distinguished as follows: 21 presacrals in which there are 9 cervicals and 12 dorsals; 10 sacrals; and 46 caudals. The form of the vertebræ is the same as in *Triceratops* which has been adequately and accurately described in the Ceratopsia Monograph. It is only necessary here to point out features that define this species and settle doubtful points in previous descriptions of the family. There are no true lumbars and I have considered as sacrals all of those vertebræ that are coössified by their centra. All of these support the ilia, including the anterior sacral which carries an independent short rib underlying the ilium. In the description of the vertebral column in the Monograph Hatcher and Lull (p. 47) have considered the division between cervicals and dorsals to be governed chiefly by the length and curvature of the ribs. This I take exception to, not only from the form of the ribs but also the position of the capitular facets and the entire form of the ninth vertebra. In the cervical series throughout the Dinosauria the capitular facets are invariably located on the centra of the vertebræ, the change from the cervical to the dorsal series being marked by the rise of this facet from the centrum to the neural arch. In *Monoclonius* the last vertebra having a capitular facet on the centrum is the ninth. The spine of this vertebra is narrow anteroposteriorly like that of the preceding cervicals, with the transverse processes small. The head of the rib for this vertebra is distinctly divided into a tubercular and capitular portion with exactly the same form as the two preceding cervical ribs. In this skeleton the rib of the ninth vertebra is as long as the next succeeding rib but it is much straighter in the shaft and narrower like the two preceding definitely determined cervicals.

Cervical Series.

The three anterior cervicals are coössified as in all known genera of the Ceratopsia. Besides this specimen there are in the American Museum collection three other *Monoclonius* coössified cervicals which show distinctly that there are only three vertebræ represented in this coössified section. Moreover there is one coössified section of a *Triceratops* in the collection. All of these specimens show only three vertebral divisions clearly marked by the point of union of the vertebræ, the neural arches and spines. Lull was evidently mistaken in determining four vertebræ in this section as described and figured in the Monograph (p. 47).

The atlas is deeply cupped anteriorly, the same length as the succeeding vertebra and the spine is separated from the succeeding spine at its base by a round foramen. The top of the spine is coössified with the next succeeding spine. The second or axis vertebra carries the first rib of the cervical series. The centra of the second and third vertebræ are coössified but the spines and zygapophyses are distinct. Succeeding vertebræ in the cervical series are as described in the Monograph. There is apparently a gradual decrease in the length of the centra up to the eighth which is shortest. The ninth vertebra is as long as the first dorsal but the centrum is not so high nor is it excavated on the sides as much as in the dorsal series.

Dorsal Series.

According to the above determination there are 12 dorsal vertebræ in the series. The sides of the centre are quite deeply excavated, spines broad anteroposteriorly and high, and transverse processes oblique to the spines. In this specimen the transverse processes are unquestionably elevated considerably more than normal so that the obliquity to the spines is increased.

Sacral Series.

As in all known genera of the Ceratopsia there are 10 sacrals, all coössified by their centra and united with the ilia by the transverse processes. So far as can be determined from this specimen and *Monoclonius cutleri*, No. 5427, described at the end of this paper, the sacrum follows the same general form and development as that described in *Triceratops*. The spines of the sacral vertebræ are short, broad anteroposteriorly and apparently those from the second to the seventh are coössified.

Caudal Series.

The caudal series is complete and is composed of 46 vertebræ including the minute terminal centrum. 23 of the anterior caudals bear transverse processes. The centra and spines of the caudal series decrease in size uniformly from the last sacral vertebra down to the 45th. The 46th apparently does not have a spine. The centra of the last 12 caudals are proportionately longer than high, slightly cupped on the anterior end with a corresponding ball on the posterior end and the spines of these last 12 vertebræ are likewise elongated anteroposteriorly. The spines in the caudal series are in height equal to the length of the corresponding chevrons and they are not as high as in the genus *Leptoceratops*.

From the development of the caudal series as a whole, the absence of a well developed 4th trochanter on the femur, and a forwardly curved ischium, it seems probable that the tail did not function as a balancing organ nor could it have been used to any extent in swimming. That portion of it back of the 34th caudal dragged on the ground.

Chevrons.

There are 32 chevrons, which is apparently the complete series, the first being between the 3rd and 4th vertebra. They increase in length from the 1st to the 4th and then gradually decrease from the 7th back to the 32nd. From the 21st back to the 32nd the lower end is expanded anteroposteriorly. Beyond the 32nd there are apparently no facets for chevrons.

Ossified Tendons.

In this specimen there is a mass of ossified tendons grouped upon the sacrum. Over the center of the sacrum they are fused apparently without any regular order or placement and the free ends extend posteriorly to the spine of the 9th sacral vertebra and anteriorly to the 6th dorsal. The tendon rods, where separated, are round and the distal ends are expanded and fimbricated. They do not appear to have been in regular rows as found in different genera of the Trachodontidæ.

Pelvis.

All three elements of the pelvis enter into the construction of the acetabulum as in *Triceratops*. In this specimen the ilium on the right side was detached, fossilized independently and so crushed in the vertical plane that it could not be accurately articulated with the sacrum or other pelvic bones. It is here placed in articulation with the transverse processes of the sacrum. Owing to vertical crushing, the anterior blade of the ilium, which should be straight, as will be seen by a comparison with the accompanying illustration of the pelvis in *Monoclonius cutleri*, No. 5427, is decurved.

Ilium.

The ilium is markedly different from *Triceratops* in that it is elongated to a greater extent and is not so wide. That part of it posterior to the ischiadic peduncle is like that of *Triceratops*.

Pubis.

The pubis is like that of *Triceratops* in form with, however, a longer post-pubis and the entire bone is less massive.

Ischium.

The ischium is proportionately longer than in *Triceratops* and the distal end is curved forward less, whereas in *Monoclonius crassus* the blade is very long, straight throughout most of its length and sharply decurved at the distal end.

SHOULDER-GIRDLE.

The pectoral arch includes the scapulæ, coracoids and two flat sternal plates. In this specimen the left coracoid and scapula have been retained in the position in which they were found. It is possible that the scapulæ and coracoids have dropped slightly lower than their normal position, but they have retained their proper relative horizontal position thus defining the chest.

Scapula.

The scapula apparently has the same general form as in *Triceratops* but with a deeper glenoid cavity. The blade is long, thin and moderately expanded at the distal end but less than in *Monoclonius crassus.* On the outer face a high ridge extends from the border of the glenoid cavity diagonally across the blade to the distal end.

Coracoid.

The coracoid is united by suture with the scapula and shares equally with it in the formation of the glenoid cavity. The outer face is distinctly convex and it terminates in a long pointed process for articulation with the sternum. The coracoid foramen is large and passes diagonally through the coracoid as in *Triceratops,* the internal opening situated close to the coraco-scapular union.

Sternum.

Previous to the publication of the Monograph on the Ceratopsia (1907) I described the sternum of *Triceratops* in an article entitled "New Notes on the Osteology of *Triceratops,*" Bull. Amer. Mus. Nat. Hist., Vol. XXII, Art.

xvii, pp. 297–300, 1906, a paper that evidently escaped the notice of the authors of the Ceratopsia Monograph. The sternum of *Monoclonius* differs from that of *Triceratops* only in size. It consists of two broad flat plates, each plate having a thick external border and a thin internal border for articulation with its mate. The anterior end is thickened on the external border for articulation with the process of the coracoid, while the distal end

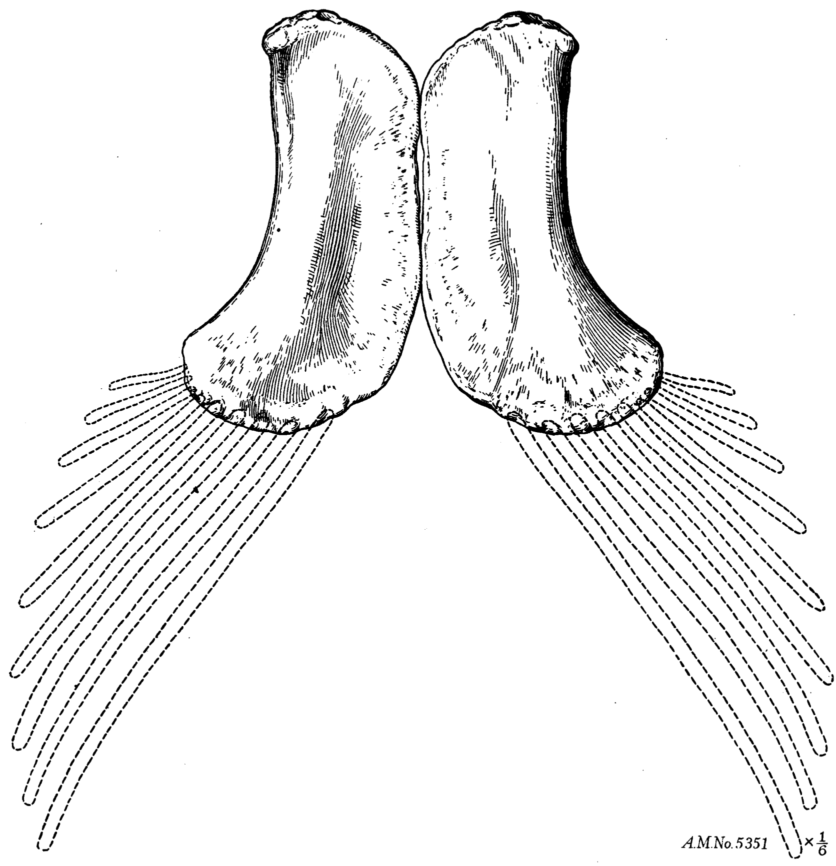


Fig. 3. Ventral view of sternal plates showing cartilaginous attachments.

is thick and shows on the ventral surface indentures for the attachment of the cartilaginous ribs. The dorsal surface of each plate is flat and the ventral surface is marked by a low ridge that extends from the proximal to the distal end near the outer border. There was probably no intermediate cartilaginous element.

Ribs.

In the cervical-dorsal-sacral series there are 21 ribs, beginning with the 2nd cervical and ending with the 1st sacral. The cervical ribs show a great variety in form. The 1st cervical is comparatively slender; the 2nd cervi-

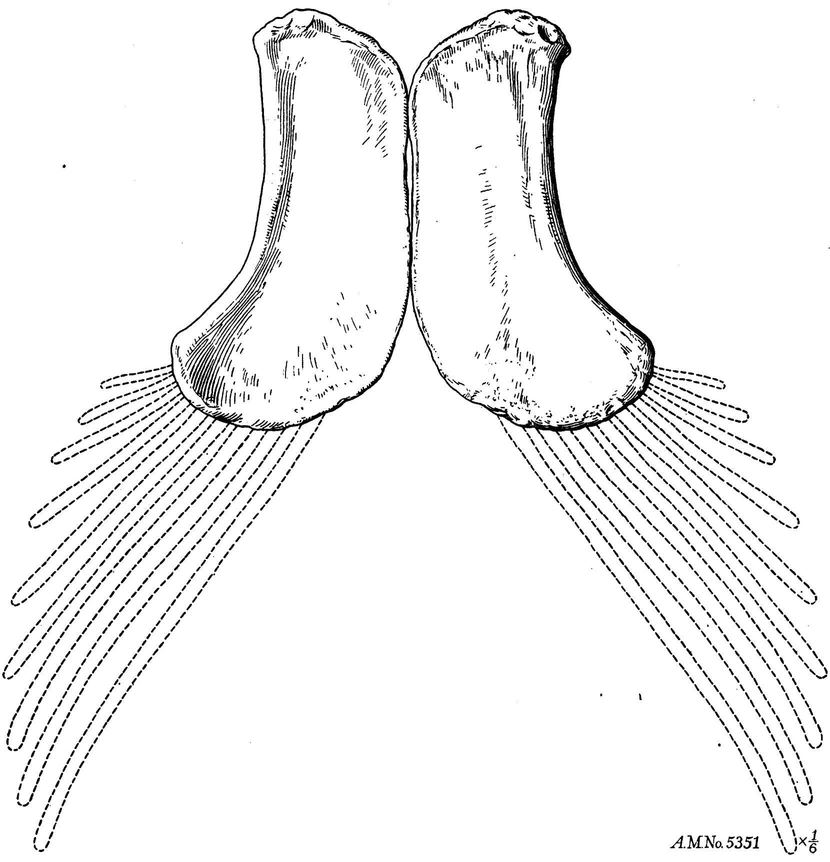


Fig. 4. Dorsal view of sternal plates showing cartilaginous attachments.

cal is quite broad at the union of the capitular and tubercular heads with the shaft, and there is a central anteriorly-directed sharp process. The center of the rib is broad and the distal third of its length is thin and pointed. This construction follows in the next succeeding or 3rd rib and the 4th is about the same length but its central part is the broadest in the cervical series. The 5th rib is not so broad as the 4th but distally it is round and lengthened, taking on the character of the succeeding long cervicals. The 6th, 7th and 8th cervical ribs lie within the confines of the pectoral arch and increase in length rapidly, the 8th rib being almost as long as the succeeding 1st dorsal. The 9th rib, the 1st dorsal, is expanded distally for connection with the 1st abdominal cartilaginous rib. The 3rd dorsal rib is apparently the longest in the series, although there is little difference in length among the 2nd, 3rd, 4th, 5th and 6th dorsals. All of the dorsal ribs in this specimen excepting the last four are considerably flattened and on account of lateral crushing have not been articulated with the transverse processes of the vertebræ. The last four are less robust than the preceding ribs and they have retained their normal curvature.

As may be seen by comparison with this skeleton and the restorations of *Triceratops* by Marsh, Hatcher and Lull, the last four dorsal ribs are much longer than are represented in *Triceratops*. Normally in position the last dorsal rib is curved forward, outward and inward at its distal end, just in front of the anterior end of the ilium. This gives a much greater girth to the body in this region than in previous restorations. The independent sacral rib is slender, comparatively short, extending forward and outward and underlies the normal ilium.

Fore Limb.

Compared with *Triceratops* the general form of the fore limb is the same but it is less massive throughout; the humerus is relatively longer and the ulna and radius are relatively shorter. When the limb is articulated in relation to the skeleton the elbow bends outward to a marked degree, the digits facing outward rather than forward, the axis of digit II being approximately parallel with the line of the vertebral column.

Humerus.

The humerus is broadly expanded transversely at the upper end with the radial crest terminating near the middle of the bone. The shaft is round and the distal end is not greatly expanded. Ulnar and radial condyles are about equal in size.

Ulna.

The ulna is distinguished from that of *Triceratops* chiefly by its size but in comparison with the humerus it is shorter. The same muscular rugosities are present.

Radius.

Except in size the radius does not differ from that of *Triceratops;* the shaft is long and slender and the ends are expanded, the distal end slightly oblique to the shaft.

Manus.

The entire manus denotes a foot of less digital movement than in carnivorous dinosaurs or the active Trachodonts. The rugose furrowed ends of the metacarpals and metatarsals indicate considerable cartilage in the joints of both manus and pes.

Five digits are present having the formula I^{-2}, II^{-3}, III^{-4}, IV^{-3}, V^{-2}. All known bones of the manus in *Triceratops* agree perfectly in form with this specimen and the construction was doubtless the same in both genera, probably throughout the family.

The manus was considerably arched and the metacarpals articulated with each other closer than they are placed in this specimen in which the proximal ends are crushed. The three inner digits terminating in hoofs contributed chiefly in support of the weight.

Carpals.

Two ossified carpals are present, both irregular, flattened and deeply pitted. One is twice the size of the other and they are here placed as in the perfectly articulated foot of another specimen, No. 5372, the larger carpal on the ulnar side. The rest of the series were doubtless cartilaginous.

Metacarpals.

In all the metacarpals the shafts are constricted and the ends are expanded and deeply furrowed. The proximal ends vary in form, the first three being roughly triangular and more closely associated. The distal ends of all are expanded transversely. Metacarpal I is the shortest and broadest of the series with the distal end slightly oblique and the proximal end excavated in the center. Metacarpal III is longest. Metacarpals IV and V show less intimate contact at the proximal ends and the distal ends are markedly reduced. Metacarpal V is slightly longer than metacarpal I and the distal end is rounded.

Phalanges.

Digits I, II, and III terminated in hoofs and IV and V in reduced rounded phalanges that were not ensheathed. There was little lateral movement possible between the phalanges.

The phalanges of the manus are distinguished from those of the pes by their less vertical depth, expanded, flattened distal ends, and rugose surfaces. The proximal phalanx of digit I is the largest and heaviest of the series. The terminal phalanx of this digit is also the largest ungual and it is considerably longer in the neck than the other unguals. In digit II the second phalanx is about two-thirds the size of the first and the ungual is broad and shorter than the ungual of digit I. In digit III the ungual is much smaller than in digit II. The phalanges of digit IV are flat and broad and the terminal phalanx is greatly reduced in size without indication of a hoof having been present. In digit V only two phalanges are present, the proximal one broad and flat with the distal end oblique and its articular face carried far up on the outer border. The terminal phalanx is a rounded nodular bone.

Hind Limb.

In general form the hind limb and foot are like those of *Triceratops*, showing the same development and muscular attachments. But in this species and in *Monoclonius crassus* the tibia is relatively longer. The size of the hind limb compared to the front limb is the same as in *Triceratops*.

Femur.

Taking into consideration the size and the amount of distortion due to crushing there is no marked difference from the femur of *Triceratops*.

The shaft is long and straight with a slight inward curvature at the distal end. The head is elevated only slightly above the great trochanter although on the right side in this specimen it is crushed considerably above the normal position.

The fourth trochanter is not extensive and terminates a little below the middle of the shaft. The condyles are crushed laterally but appear to be relatively the same as in *Triceratops*.

Tibia.

As pointed out above the tibia is relatively longer than in *Triceratops*. In this specimen the femur is only 140 mm. longer than the tibia, whereas in *Triceratops prorsus* the femur is a half again larger than the tibia. In *Monoclonius crassus* the relative size of femur and tibia is similar to the present species but in *Monoclonius cutleri* described and figured at the close of this article the comparative size of femur and tibia is the same as in *Triceratops prorsus*. I believe that the relative lengths of limb bones is at least of specific value in this family.

Both tibiæ are badly crushed in this specimen and I can see no marked departure in form from the typical *Triceratops*.

Fibula.

The fibula is long and slender with subcylindrical shaft and expanded ends. It is relatively as large as in *Triceratops*. With the calcaneum it equals the length of the tibia. At the distal end the surface applied to the tibia is flat and the outer face is convex with the terminal end swollen. The upper end is warped on the shaft so that the greatest diameter of the proximal end is at right angles to the distal end.

Pes.

In the pes there are two rows of ossified tarsals, four functional digits and a rudimentary fifth digit. This is probably the normal type of foot throughout the family. It is the exact structure of *Triceratops* and they differ only in size as determined from a complete foot in the American Museum collection found since the publication of the Ceratopsia Monograph.

The pes of *Triceratops* was supposed by Marsh to have but three complete digits. It is so considered in the "Ceratopsia" Monograph and so restored in the mounted skeleton in the U. S. National Museum. There is no doubt, however, that it was tetradactyl and proportioned like that of *Monoclonius*.

The foot displays considerable arch and there was but little lateral movement between the segments. The second and third digits faced forward and the axis of the foot appears to have been between them. The articular faces of the phalanges on the third digit are oblique, so that they curve forward with the terminal hoof only a little posterior to the terminal of the second digit. The first digit was short and powerful and directed well to the inside.

The articular faces of the phalanges are squarely on the ends and only slightly reflexed indicating a vertical position in life that recalls the heavy, fleshy foot of the Proboscidea.

Tarsals.

The astragalus, the largest element in the tarsus, was firmly united to the tibia with which it was to a high degree coössified. The coössification of tibia and astragalus was doubtless a family character for in every specimen known to the writer, representing several genera, the tibia and astragalus are inseparable. In the Trachodontidæ the tibia and astragalus were firmly united but not coössified.

The astragalus is a moderately thick, flattened plate covering about three-fourths of the end of the tibia, its posterior border thin and its anterior border thick but not extending far up on the face of the tibia. The borders are deeply pitted.

The calcaneum is about one-third as large as the astragalus and it was free. In the second row of tarsals two ossified elements are preserved, the largest articulated with the 4th metatarsal.

Metatarsals.

The functional metatarsals are much larger than the metacarpals and more closely applied throughout most of their length. Metatarsals II, III and IV are especially interesting as they are similar in form and development to these elements in the Trachodontidæ. Metatarsal I is short and heavy, its proximal end triangular and slightly cupped; the shaft is closely applied to the shaft of metatarsal II for four-fifths of its length where it abruptly bends away and the distal end is reflexed, permitting more lateral movement than was possible in the other digits. Metatarsal II is a little longer than metatarsal IV; the proximal end is quadrilateral in form, its greatest length antero-posterior; the shaft is straight and the distal end is expanded laterally. Metatarsal III is longest of the series; its proximal end is roughly triangular in form with the outer border thin and interlocking with the head of metatarsal IV; the shaft is straight on the inner face and curved on the outer face, the distal end broadly expanded laterally. Metatarsal IV is broadly expanded laterally at its proximal end, triangular in form and deeply cupped; on the inner face there is a deep incision receiving a part of the head of metatarsal III; the shaft is straight on the inner face and strongly curved on the outer face. Metatarsal V is a mere vestige without phalanges and but loosely applied to metatarsal IV; it is about two-thirds the length of metatarsal I; the proximal end is comparatively large and ovate and the shaft is laterally compressed, the anteroposterior diameter being three to four times greater than the lateral diameter in any given section; the distal end is small and rounded.

Phalanges.

The phalanges, excepting the unguals, are readily distinguished from those of Trachodonts by the abrupt vertical sides and deep lateral depression near the distal end for the insertion of digital muscles. A slight difference is noticeable in the two sides. The outer faces of the phalanges in digits I, II and III are slightly more vertical than the inner faces. In digit IV this distinction is reversed.

The proximal phalanx of digit I is the longest and largest of the phalanges and nearly as long as metatarsal I. Its proximal end is oblique and the shaft is comparatively flattened. The ungual of digit I is slightly longer than that of digit II, is narrower and tapers to a point.

In digit II the first phalanx is half as long again as the second and the third is largest of all the unguals.

In digit III the phalanges grade rather uniformly and the ungual is somewhat narrower than in digit II.

In digit IV the phalanges grade abruptly; the entire series is shorter than in digit III, and the terminal is smallest of the unguals. As remarked before the articular faces are oblique and the inner face of each phalanx is shorter than the outer face; thus the entire toe curves forward.

Exoskeleton and Epidermis.

There is no evidence of an exoskeleton in this specimen. It is now known that the epidermis over the belly and sides was a free tuberculated skin comparable to the epidermis of the Trachodontidæ but of different pattern with low, polygonal, non-imbricating tubercles. With another specimen, No. 5430, probably this genus, seven dermal plates were preserved, all similar in form, symmetrical and about equal in size. Each is characterized by a narrow, elongate base and a high, median center. They are about an inch wide, an inch and a half long and an inch and a half high. In that specimen the pelvis, a part of the tail, and the hind limbs are preserved and the plates were probably located above the spines in the caudal region similar to those of *Ceratosaurus*.

It may be stated definitely that none of the plates figured in the Ceratopsia Monograph, page 65, pertain to this family. Those figured 1–10 are from armored dinosaurs of ankylosaurid type. The specimen figured 11–12 is probably not dinosaurian, the bone being very dense whereas dermal bones are highly cancellous. It is probably fish.

Reconstruction.

This reconstruction (Plate XIII) differs in several important features from the Marsh reconstruction of *Triceratops* and from the composite *Triceratops* skeleton mounted in the National Museum.

The body is shorter and deeper in the posterior dorsal region, while the feet are more digitigrade with toes turning out, the axis of the manus through digit II and the axis of the pes between digits II and III.

A *Triceratops* skeleton in the American Museum determines the general construction to have been essentially the same in the two genera and the skeletal structure in *Monoclonius* may be considered as typical of the family Ceratopsia.

Measurements of Monoclonius Skeleton. No. 5351.

Skull	mm.
Total length between rostral and terminal end of epoccipitals	1420
Length between condyles and anterior end of rostral	760
Length of nasals	400
Width between orbits	260
Greatest width of crest between borders of squamosals	1100
Height of skull between posterior end of nasals and border of alveolus	360
Extreme height of nasal horn from top of nasals, anteriorly	460
Circumference of nasal horn at base	400
Length of alveolus	300
Vertebral column	
Total length of vertebral column and skull from end of tail to rostral	5160
" " " vertebral column from end of tail to condyle of skull	4460
Length of three anterior coössified cervicals	260
Total length of sacrum	800
" " " ilium	1060
" " " pubis excluding postpubis	450
" " " ischium, following curve iliac peduncle to end	740
" " " scapula	700
" " " " and coracoid	910
Width of distal end of scapula	220
Greatest width of proximal end of scapula	260
Length of sternum	330
Greatest width of sternum, posterior end	160
" " " " proximal "	110
Length of humerus	600
" " " from end of deltoid crest to end of inner condyle	380
" " ulna	450
" " radius	350
Manus	
Length of metacarpal I	83
" " " II	127

				mm.
Length of metacarpal			III	130
"	"	"	IV	99
"	"	"	V	80
"	"	phalanx	I^1	56
"	"	"	I^2	64
"	"	"	II^1	46
"	"	"	II^2	30
"	"	"	II^3	55
"	"	"	III^1	38
"	"	"	III^2	27
"	"	"	III^3	20
"	"	"	III^4	41
"	"	"	IV^1	34
"	"	"	IV^2	21
"	"	"	IV^3	18
"	"	"	V^1	43
"	"	"	V^2	13
Length of femur, outside measurement, from top of greater trochanter to bottom of condyle				740
Length of tibia including astragalus				600
"	"	fibula		560
Pes				
Length of metatarsal			I	123
"	"	"	II	180
"	"	"	III	215
"	"	"	IV	160
"	"	"	V	77
"	"	phalanx	I^1	101
"	"	"	I^2	97
"	"	"	II^1	69
"	"	"	II^2	46
"	"	"	II^3	93
"	"	"	III^1	60
"	"	"	III^2	37
"	"	"	III^3	35
"	"	"	III^4	80
"	"	"	IV^1	54
"	"	"	IV^2	35
"	"	"	IV^3	32
"	"	"	IV^4	23
"	"	"	IV^5	69

Monoclonius cutleri sp. nov.

This species is established on an incomplete skeleton (Plates XVI–XIX) found in the same region as the type of *Monoclonius nasicornus*, at about the same level but on another branch of North Sand Creek. It includes the posterior half of the skeleton, mostly connected, and a section of the epidermal impression overlying the right femur.

The entire skeleton had been present but the anterior half was too fragmentary to be preserved. The part of the skeleton preserved includes fragments of the skull, 8 posterior dorsal, 10 sacral and 31 caudal vertebræ, half of the ribs and chevrons, the sternal plates, half of the right scapula, 4 metacarpals and 3 phalanges of the right fore foot, and 3 phalanges of the left fore foot, the complete pelvis, femora, tibiæ, fibulæ, 4 metatarsals and 5 phalanges of the left hind foot, and 2 metatarsals and 1 phalanx of the right hind foot.

The reference to the genus *Monoclonius* is reasonably certain, the identification being based on fragments of the skull including the coössified anterior ends of nasals and premaxillaries which are diagnostic.

An element of doubt was the presence of the posterior end of a *Ceratops* derm-supraoccipital bone and a Trachodont tibia. But the skeleton was weathered out and the *Ceratops* bone was embedded in undisturbed strata one foot below bones of the skeleton, was water-worn and of different color, so that I feel safe in eliminating it from consideration.

Sufficient material is not yet available in this family to determine what species characters in the skeleton are constant nor are we able to correlate skull characters with those of the skeleton in many instances.

The relative length of limb bones appears to be constant in *Triceratops prorsus* and is definitely known to be constant in several genera of the Trachodontidæ.

In the specimen here described there are several characters, especially the length of the hind limb and the straight ischium, that distinguish it from *Monoclonius nasicornus*. These features are pronounced in different parts of the body and so obviously not a result of crushing that it seems advisable to refer it to a distinct species.

Type of species: An incomplete skeleton, No. 5427.

Horizon and locality: Belly River formation, 100 feet below top of beds, north fork of Sand Creek, 12 miles below Steveville, Red Deer River, Alberta, Canada.

Specific characters: Femur nearly half as long again as tibia; ischium very long and straight with distal end decurved; sternal plates elongate.

The animal was a little larger than the type specimen of *Monoclonius nasicornus* and the preserved bones, excepting those which distinguish this species, closely follow the form of similar parts in that species.

VERTEBRÆ.

The vertebræ are a little larger but of exactly the same form as in the type specimen of *Monoclonius nasicornus* and no distinctions are apparent in any part of the column. The sacrum is especially interesting as it shows a development exactly as in *Triceratops.* The third, fourth, fifth and sixth vertebræ bear diapophyses and parapophyses and may be considered the original true sacrals, additions having been made from the dorsal and caudal series. It is improbable that there were ever true lumbars in immediate ancestral forms for the first sacral vertebra carries a well developed, short, free rib underlying the point of the ilium.

STERNUM.

The sternal plates although displaced back of their normal position are still in approximately correct relation with each other and with the ribs on the right side.

They are markedly longer, narrower proximally and wider distally than in *Monoclonius nasicornus.*

RIBS.

Incomplete ribs are preserved on both sides, including thé two posterior cervicals, twelve dorsals and the first sacral on the right side and two posterior dorsals and the first sacral on the left side. The last dorsal rib on each side is complete and uncrushed; they curve outward and forward then downward, outlining the body which follows the outward curve of the ilium and was much deeper in the flank than has been indicated in previous restorations of the horned dinosaurs. The free sacral rib is single-headed and flat, extending to the point of the ilium which it underlies.

PELVIS.

The ilia retain their normal position and are uncrushed but somewhat lengthened. Allowing for all cracks the anterior blade is much longer than in *Monoclonius crassus* or *Monoclonius nasicornus.* The ilium has the same general form as in *Triceratops* but the blade in front of the pubic peduncle is comparatively longer and narrower, a generic character.

The pubis has the same general form as in *Triceratops* but in this genus the post-pubis is relatively longer.

The ischium shows the most striking departure from the *Triceratops* pelvic bones and differs markedly from *Monoclonius nasicornus.* It resembles *Monoclonius crassus* and is long and comparatively straight with the posterior end sharply decurved and expanded, meeting its mate along this curved section.

Hind Limb.

Compared with the type specimen of *M. nasicornus* and with *M. crassus;* the tibiæ and fibulæ are so much shorter that the difference in length cannot be attributed to individual variation. The femur is nearly once and a half as long again as the tibia, the same proportion as in *Triceratops prorsus.*

Femur.

The femora are flattened but the general form is well preserved, displaying a long, straight shaft with a large head that rises slightly above the level of the great trochanter. The lesser trochanter is separated from the great trochanter by a narrow cleft and terminates slightly below its summit. The fourth trochanter is a faint elevated ridge about six inches long that terminates a little below the middle of the shaft. The distal end of the femur curves inward from the line of the shaft and the inner condyle appears to be larger than the outer condyle, a condition which if true is the reverse of *Triceratops.* The crushed femora in the type specimen of *M. nasicornus* fails to settle this point.

Tibia.

The tibiæ are unequal in length, as is frequently the case in fossil bones, the left in this case being somewhat longer than the right. They are formed like *Triceratops* and are actually and relatively much shorter than in *M. nasicornus* or *M. crassus.*

Fibula.

The fibulæ are like those of *M. nasicornus* and of the same relative size.

Metapodials and Phalanges.

All of the preserved bones in both manus and pes appear to be the same as in *M. nasicornus,* the slight differences in form being attributable to crushing.

Epidermis.

A section of the epidermal impression is preserved with this specimen which may be considered typical of the genus *Monoclonius.* It differs markedly in pattern from the integument described by Lambe in *Ceratops* (*Chasmosaurus* or *Protosaurus*), a related genus having an entirely different skull.

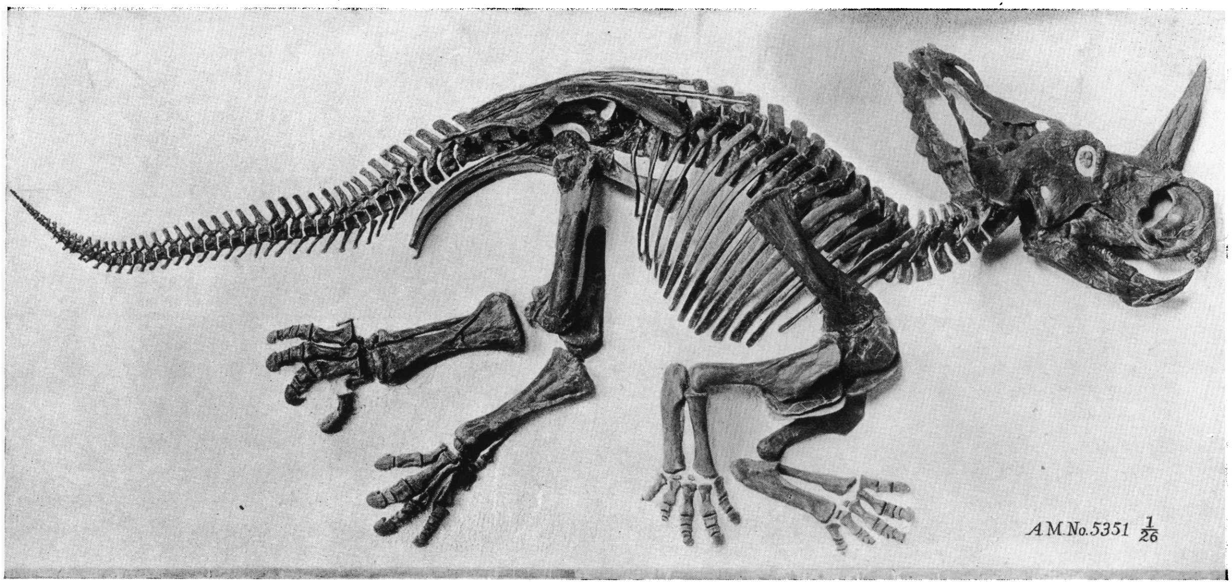
The epidermis overlies the lower end of the femur and in this section at least consists of small polygonal tubercles and large round tubercles, all low and of the same height.

The small tubercles are five or six-sided, close set together and do not grade in size up to the larger, round ones as they do in *Ceratops.* If attention is centered on any small tubercle five, six or seven adjacent ones are seen to touch its border. The large tubercles are defined by a circumscribing groove and are uniformly round; they were disposed in rows over a part, probably the ventral surface of the body.

Measurements.

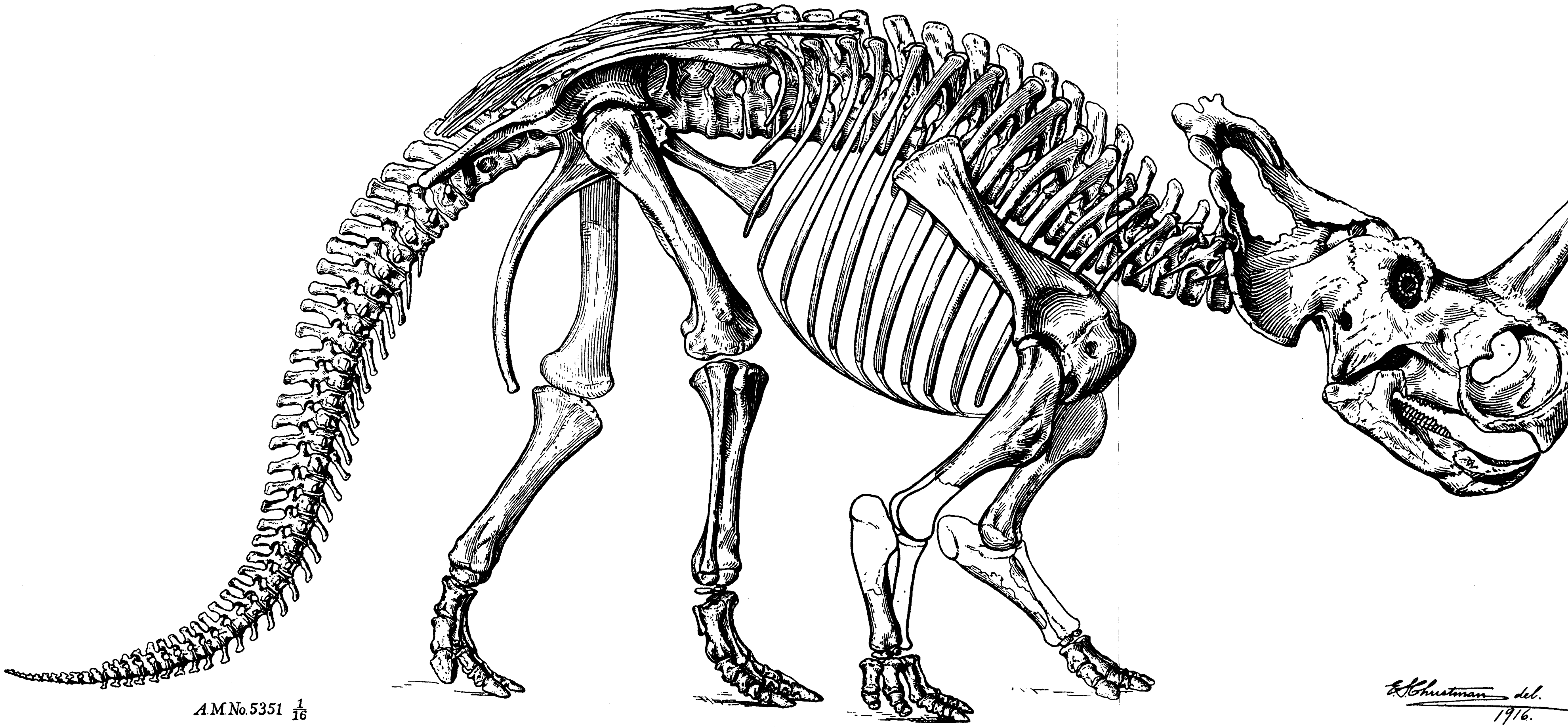
	mm.
Total length of sacrum, bottom	800
“ “ “ ilium	1120
“ “ “ publis, excluding postpubis	500
“ “ “ ischium; iliac peduncle to end	800
“ “ “ sternum, left side	450
Greatest width of “ posterior end, left side	180
“ “ “ “ anterior “ “	110
Length of metacarpal I	97
“ “ “ II	140
“ “ “ III	143
“ “ “ IV	105
“ “ phalanx I^{1}	50
“ “ “ I^{2}	73
“ “ “ II^{3}	61
“ “ “ III^{1}	42
“ “ “ IV^{1}	36
“ “ femur, outside top of great trochanter to bottom of condyle	800
“ “ tibia, including astragalus	500

	mm.
Length of fibula	460
" " metatarsal I	103
" " " II	200
" " " III	230
" " " IV	184
" " " V	69
" " phalanx I^1	92
" " " II^1	64
" " " II^3	77
" " " III^1	40
" " " IV^4	77



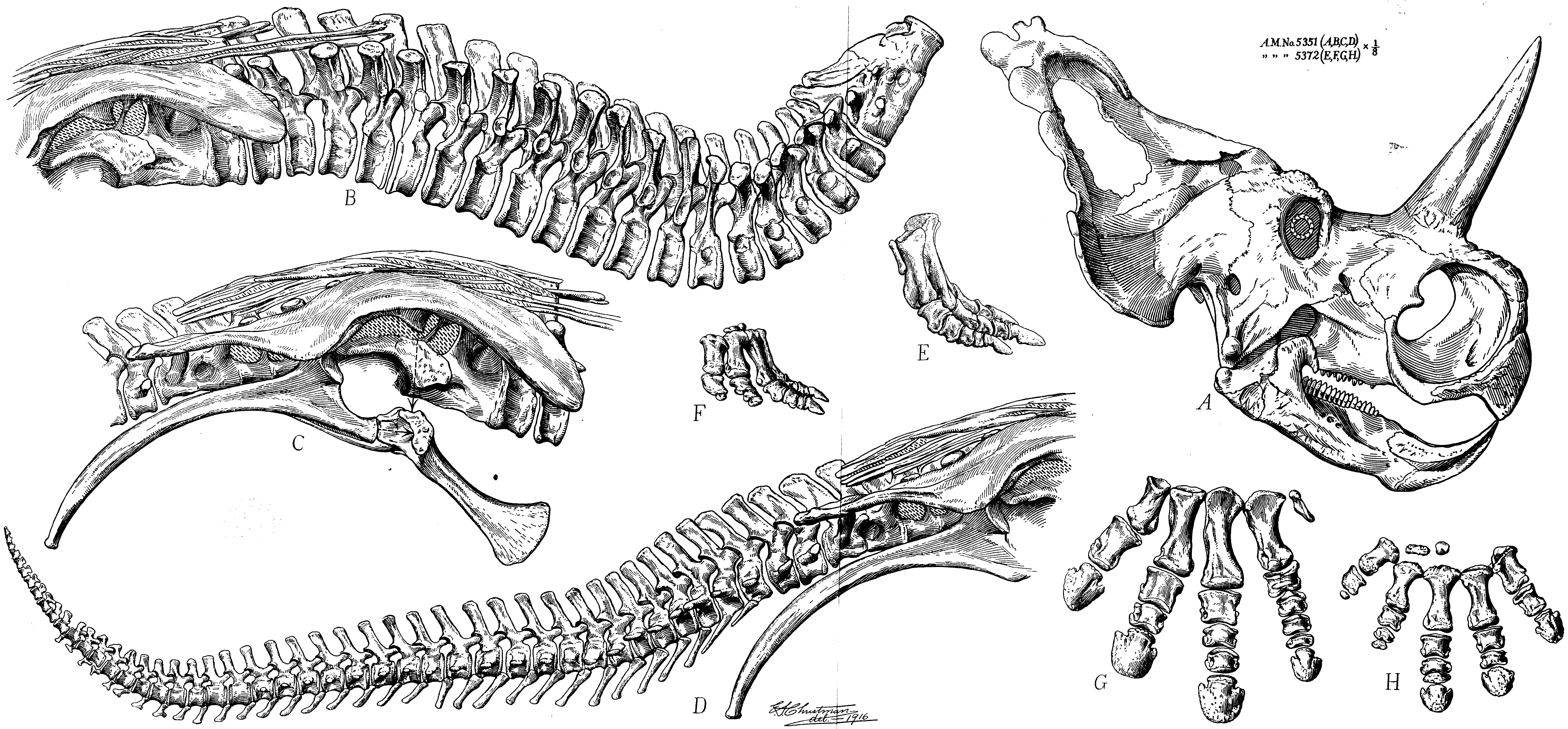
MONOCLONIUS NASICORNUS.

Side view of skeleton of type, No. 5351, mounted in the American Museum. Bones for the most part articulated as found. The right ilium thrown upward out of position, ribs flattened and tubercular heads separated from transverse processes on vertebræ which are laterally compressed.



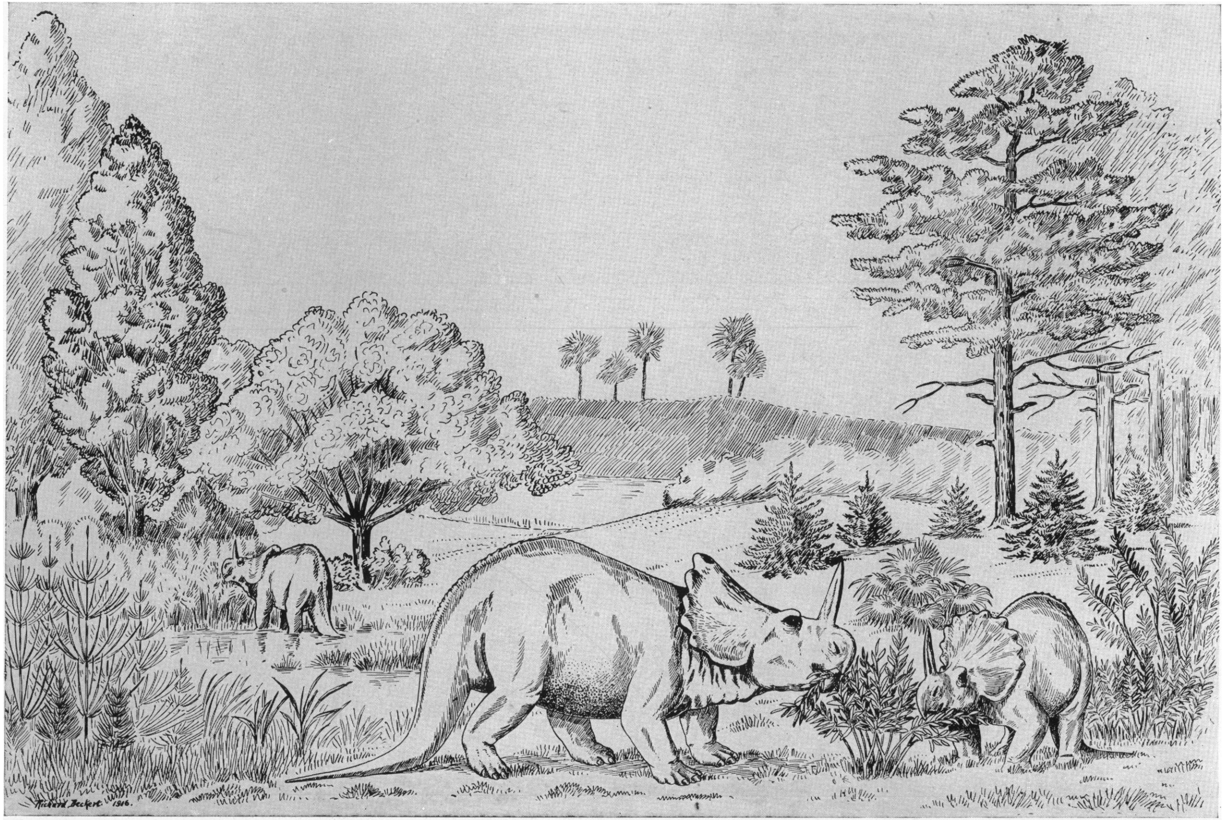
Monoclonius nasicornus.

Restoration of skeleton, No. 5351. Bones articulated as in life.

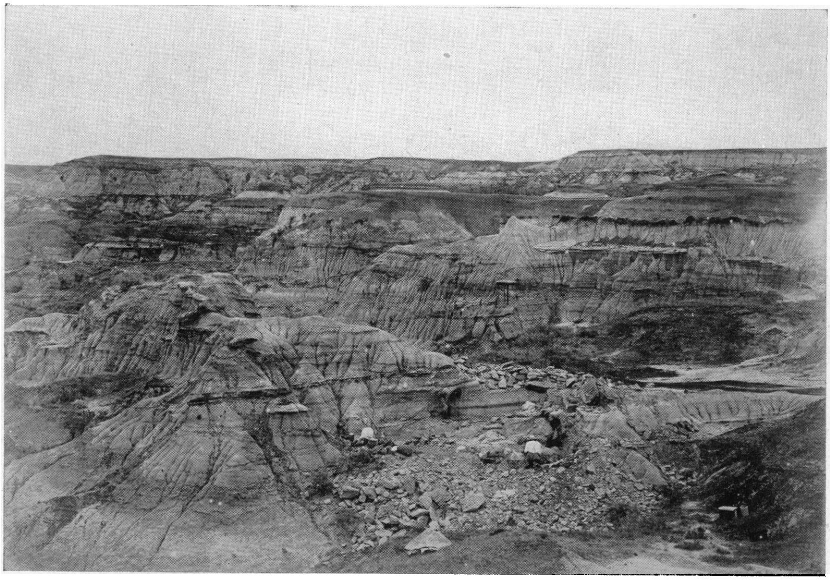


MONOCLONIUS NASICORNIS.

Detailed view of axial skeleton of type, No. 5351. A, skull; B, cervical-dorsal series; C, pelvis, ilium decurved by crushing; D, caudal series; E, side view of right hind foot of *Monoclonius* sp., No. 5372; F, side view of right front foot of *Monoclonius* sp., No. 5372; G, dorsal view of front foot in detail, *Monoclonius* sp., No. 5372; H, dorsal view of hind foot in detail, No. 5372.

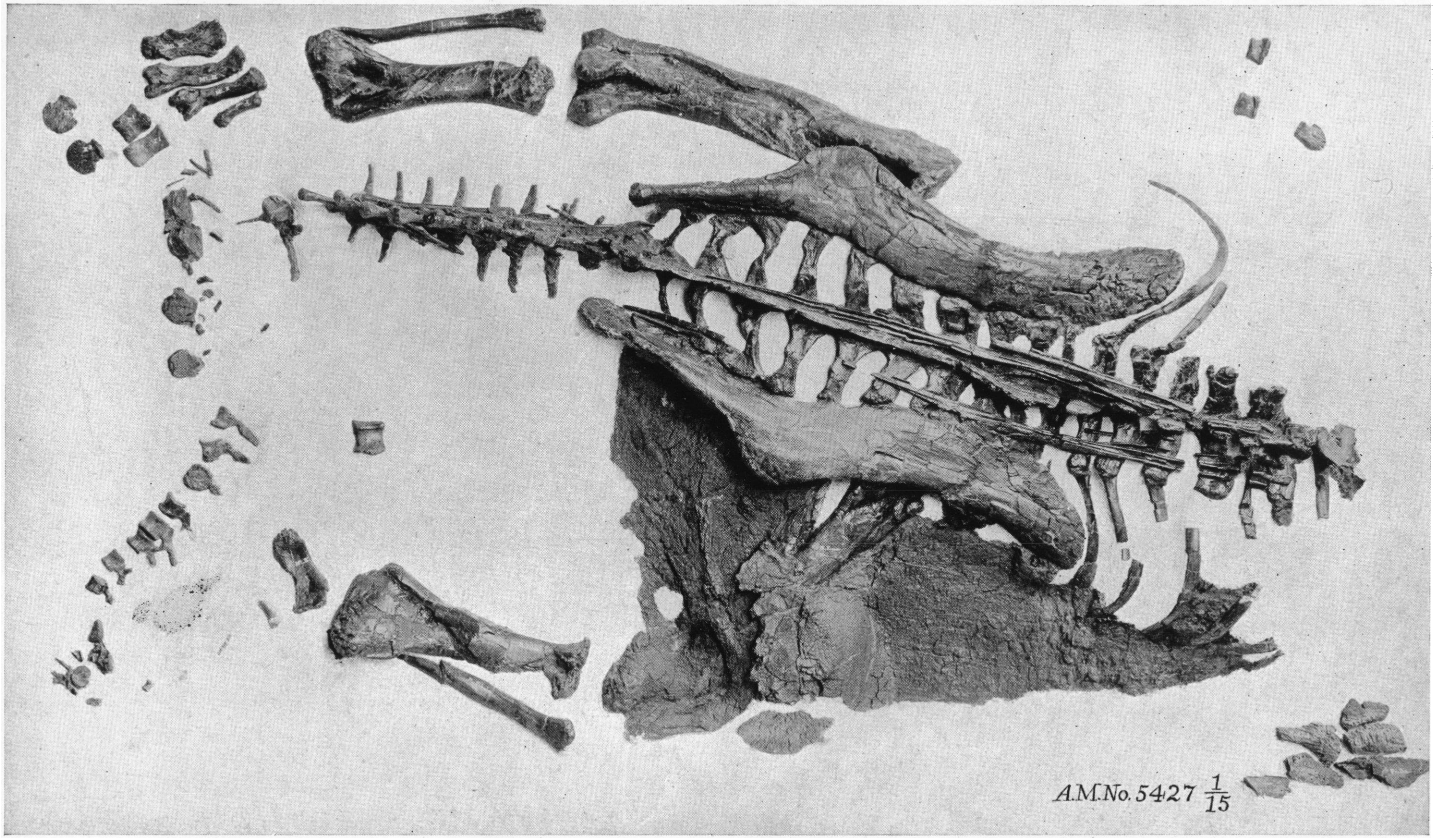


MONOCLONIUS.
Life restoration, in typical Belly River foliage. Restoration by Richard Deckert.



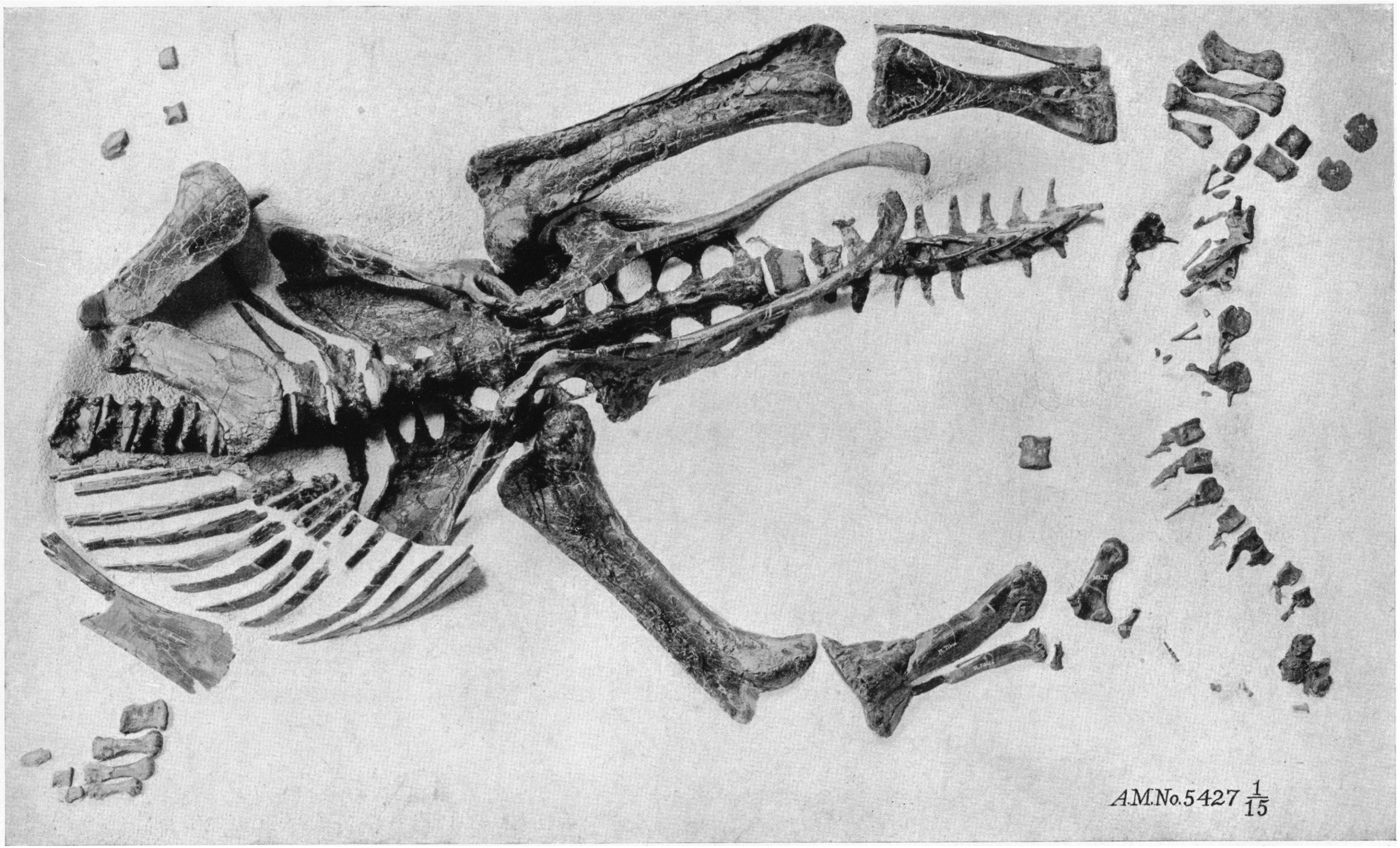
MONOCLONIUS NASICORNUS.

Excavation of skeleton, No. 5351, north fork of Sand Creek, 12 miles south of Steveville, Alberta.



Monoclonius cutleri.

Dorsal view of type, No. 5427, showing patch of skin, posterior ribs in normal position, pelvis and vertebræ uncrushed.



Monoclonius cutleri.
Ventral view of type, No. 5427.

Monoclonius cutleri.
Detail of epidermal markings overlying the right femur, type, No. 5427.

Monoclonius cutleri.

Excavation of skeleton, No. 5427, north fork of Sand Creek, 12 miles south of Steveville, Alberta.