DEPARTMENT OF THE INTERIOR
FRANKLIN K. LANE, Secretary

UNITED STATES GEOLOGICAL SURVEY
GEORGE OTIS SMITH, Director

**Professional Paper 103**

# BRACHYCERATOPS

## A CERATOPSIAN DINOSAUR FROM THE TWO MEDICINE FORMATION OF MONTANA

### WITH NOTES ON ASSOCIATED FOSSIL REPTILES

BY

CHARLES W. GILMORE

WASHINGTON
GOVERNMENT PRINTING OFFICE
1917

ADDITIONAL COPIES
OF THIS PUBLICATION MAY BE PROCURED FROM
THE SUPERINTENDENT OF DOCUMENTS
GOVERNMENT PRINTING OFFICE
WASHINGTON, D. C.
AT
10 CENTS PER COPY
△

# CONTENTS.

# ILLUSTRATIONS.

# BRACHYCERATOPS, A CERATOPSIAN DINOSAUR FROM THE TWO MEDICINE FORMATION OF MONTANA, WITH NOTES ON ASSOCIATED FOSSIL REPTILES.

By Charles W. Gilmore.[1]

## INTRODUCTION.

The fossils on which this paper is based were collected by me and my assistant, Mr. J. F. Strayrer, during the summer of 1913, while working under the auspices of the United States Geological Survey on the Blackfeet Indian Reservation, in northwestern Montana. The specimens were obtained from exposures of the Two Medicine formation along Milk River near the Canadian boundary, in T. 37 N., R. 8 W., about 30 miles northwest of the town of Cut Bank, Mont., and along Two Medicine River in T. 31 N., R. 7 W., about 15 miles southwest of Cut Bank. Vertebrate remains were found at these places in 1911 and 1912 by Eugene Stebinger, while he was engaged in Geological Survey work, and he was the first to note that the localities are good fields for finding specimens of fossil vertebrates.[2] Although the present collection is small, it is of considerable scientific interest because it supplements the collections made in neighboring areas by other investigators, and because it contains a new genus of Ceratopsia in addition to other recognizable specimens which afford evidence that considerably extends the geologic and geographic ranges of forms heretofore described.

The beds from which the collection was made constitute the upper part of the Two Medicine formation, which includes the equivalent of the Judith River formation and some older beds. The fossiliferous beds are also the equivalent of the upper part of the Belly River formation as found in neighboring areas of Canada.

The fauna of the American Judith River formation, although diversified, is very inadequately known. Many of the genera and species have been founded on specimens so scant and fragmentary that it is almost impossible to refer to them subsequently discovered and more perfect materials. Recent collections made by L. M. Lambe, of the Canada Geological Survey, and by Barnum Brown, of the American Museum of Natural History, from the Belly River formation along Red Deer River in Canada, however, have placed this fauna on a more solid basis.

The purpose of this paper is to give as complete and detailed a description of the skeletal anatomy of *Brachyceratops montanensis* as the material at hand will permit and to discuss briefly, in systematic order, other forms represented by specimens in the collection made in 1913.

I take this opportunity to express my thanks for assistance rendered and for courtesies extended at many times, both in the field and during the preparation of this report, by Messrs. M. R. Campbell, T. W. Stanton, and F. H. Knowlton, and especially by Mr. Eugene Stebinger, all of the United States Geological Survey.

## STRATIGRAPHY OF THE TWO MEDICINE FORMATION.

By Eugene Stebinger.

All the vertebrate fossils described in this report were collected from a single formation of Montana (Upper Cretaceous) age, to which the name Two Medicine formation has been applied recently by the United States Geological Survey. It occurs throughout the part of the plains

[1] Assistant curator of fossil reptiles, United States National Museum.
[2] Stebinger, Eugene, Washington Acad. Sci. Jour., vol. 4, p. 383, 1914.

region in Montana that lies at the east base of the Lewis Range and the mountains immediately to the south. The formation is well exposed in all the larger stream valleys, and at many places along those streams it is carved into intricate badlands. (See Pl. II, *A*.) The rocks are soft and light colored, white to gray and greenish gray being the prevailing tints, and are chiefly clay, clay shale, and soft sandstone. The sandstones are very irregular in thickness, thinning rapidly in short distances, and in places are strongly cross-bedded, being in part at least of eolian origin. Thin beds of red clay and thin nodular limestones are occasionally found. The formation averages 2,000 feet in thickness and is very uniform in appearance throughout, except that its lowest 250 feet is more sandy than its upper part.

Besides a remarkable abundance of vertebrate remains, the fossils in the Two Medicine formation include both invertebrates and plants. The invertebrates, according to T. W. Stanton, are principally fresh-water types, and *Unio*, *Viviparus*, and *Campeloma* are the most abundant genera. Brackish-water forms are also frequently found, especially in the lower sandy portion. Fossil wood, some of it in complete sections of tree trunks as much as 18 inches in diameter, is abundant. The flora so far collected is reported by F. H. Knowlton to be of Belly River age. The evidence of rapid and irregular deposition afforded by the lithology of the formation, together with the presence of a dinosaur fauna, of land plants, and of fresh-water shells, leaves little doubt that the rocks as a whole are continental in origin.

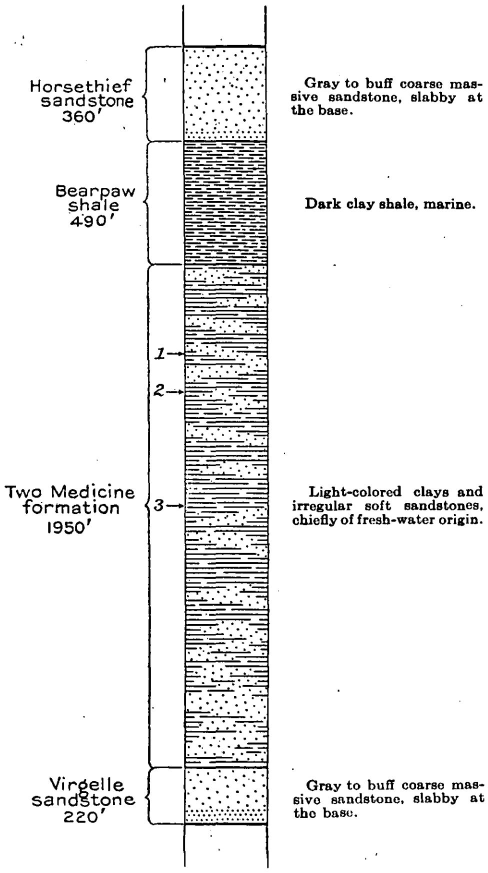
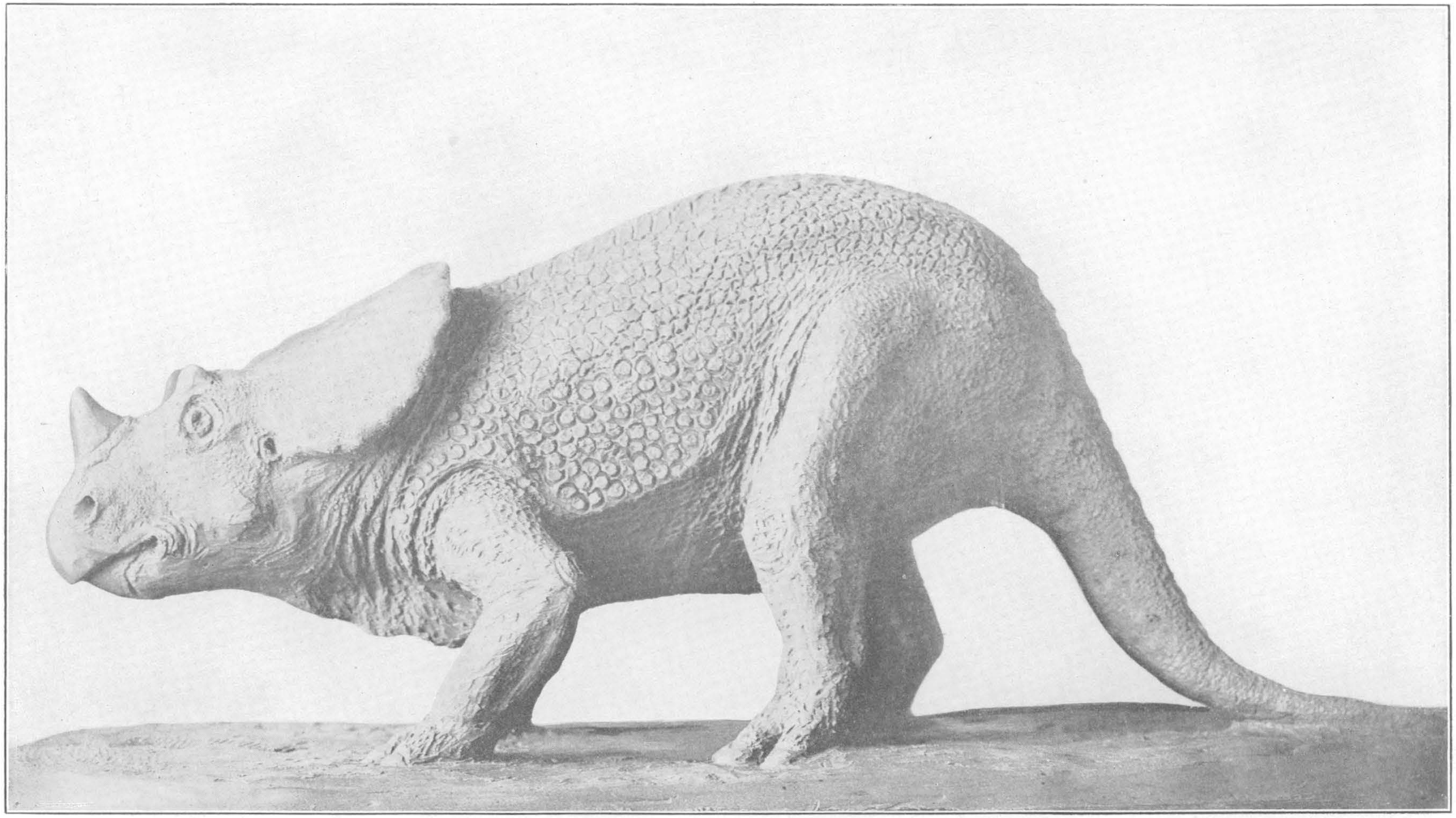



FIGURE 1.—Generalized section of the formations of the Montana group (Upper Cretaceous) in northwestern Montana. Arrows indicate position of horizons in Two Medicine formation from which most of the vertebrates described in this report were collected.

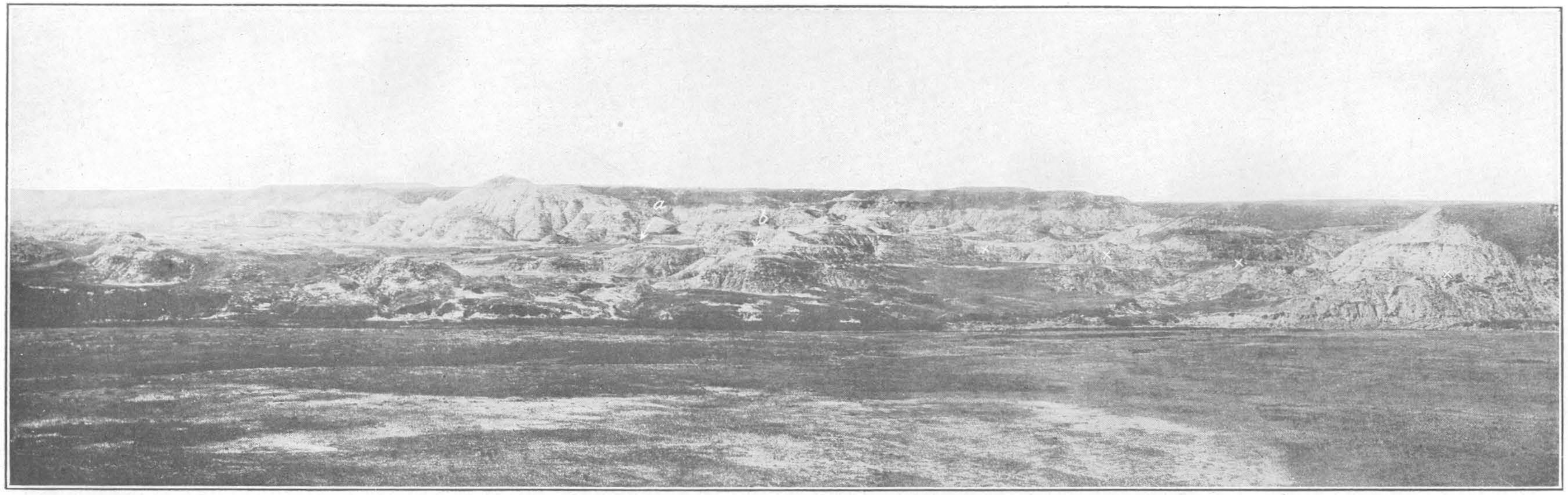
Fortunately, the stratigraphy of the Two Medicine formation and the formations associated with it can be very easily deciphered, because of the simplicity of the nearly horizontal structure and the general excellence of the exposures throughout large areas of the Montana group in northwestern Montana. The fact that the Two Medicine formation lies below one marine clay shale carrying a Pierre fauna and above another marine shale carrying an upper Colorado fauna is well established. According to recent work[1] the section of the Montana group, including the Two Medicine formation, as exposed on Two Medicine River between its mouth and Family post office, contains four lithologic units, which have been designated Virgelle sandstone, Two Medicine formation, Bearpaw shale and Horsethief sandstone. (See fig. 1.) The Colorado shale, carrying a characteristic marine fauna, underlies this group of formations and appears in the section at the mouth of Two Medicine River under bold cliffs of Virgelle sandstone. Traced northward the Virgelle sandstone and Two Medicine formation prove to be exactly equivalent to the Belly River beds as mapped by Dawson[2] in southern Alberta. Dawson recognized the prominent sandstone at the base of the Belly River formation and described it in detail but not as a separate formation. In Montana this basal sandstone has been traced over a large area in the western part of the State and has everywhere been recognized as a distinct mappable unit. This made it impossible to use Dawson's designation Belly River for any of the rocks in Montana, and the name Two Medicine was therefore adopted for the upper part of Dawson's original formation. On the other hand, the relations of the Judith River formation to the Two

[1] Stebinger, Eugene, Washington Acad. Sci. Jour., vol. 4, p. 383, 1914.
[2] Dawson, G. M., Canada Geol. Survey Progress Rept. for 1882–1884, p. 112c, 1885.



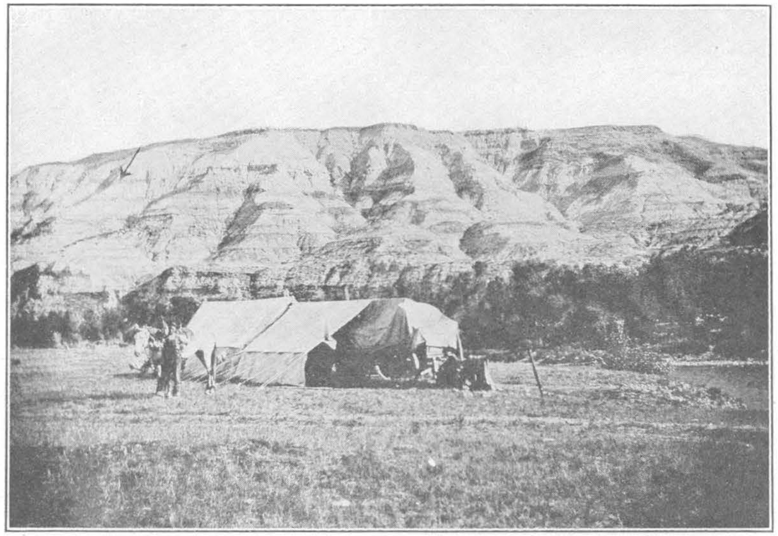
LIFE RESTORATION OF BRACHYCERATOPS MONTANENSIS.

Modeled by Charles W. Gilmore. About one-eighth natural size.



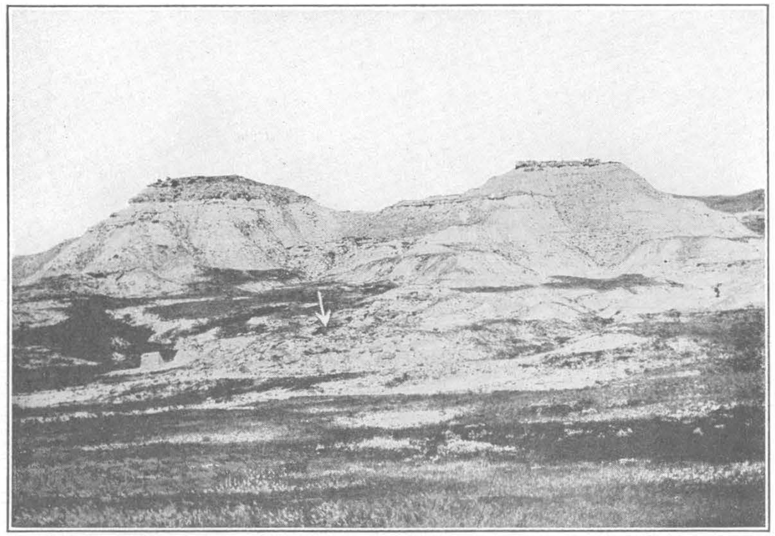

*A.* BADLANDS ON MILK RIVER ABOUT 30 MILES NORTHWEST OF CUT BANK, MONT.

Looking south across secs. 27 and 28. T. 37 N., R. 8 W. *a*, Place where large trachodont femur was found; *b*, place where Hypacrosaurus skeleton was found; x–x, clay zone, filled with minute shell fragments. Photograph by Eugene Stebinger.



*B.* TWO MEDICINE FORMATION AS EXPOSED ON TWO MEDICINE RIVER, MONT.

Arrow indicates place where large trachodont specimen was found



*C.* TWO MEDICINE FORMATION AS EXPOSED ON MILK RIVER, MONT.

Arrow indicates place where skeletons of Brachyceratops montanensis were found.

Medicine formation became apparent on tracing the formations eastward toward the type area of the Judith River formations in central Montana. The Judith River formation proves to be equivalent to only the upper part of the Two Medicine formation, which in its entirety is equivalent to the upper part of the Eagle, the Claggett, and the Judith River formations combined.

The stratigraphic positions of the three principal horizons in the Two Medicine formation at which the fossils here described were obtained are indicated by arrows on the columnar section. (See fig. 1.) All the vertebrate remains collected in 1913 were obtained from the upper half of the formation, so that the base of the overlying marine shale, the Bearpaw, was the most convenient datum for fixing the stratigraphic position of the fossil localities. This upper part of the Two Medicine formation is very fossiliferous, bone fragments being abundant throughout the strata and no well-marked zonal distribution being apparent. For the sake of stratigraphic accuracy three horizons at which most of the specimens were collected are described below, without implying that the distribution of these fossils is at all limited to these horizons. Horizon No. 1, at which *Brachyceratops montanensis* and *Hypacrosaurus altispinus*? were collected on Milk River in T. 37 N., R. 8 W., lies 340 feet below the base of the Bearpaw shale as exposed on the slopes of Landslide Butte on the south edge of this township. In the N. ½ sec. 27 the beds at this horizon lie immediately above a zone of clays about 10 feet thick filled with minute shell fragments (see X–X, Pl. II, *A*), apparently mainly Unios, which serves as an excellent marker for the bone bed above it, from which *Brachyceratops* and *Hypacrosaurus* were collected. This shell zone can be traced for about half a mile northwestward, to a point where the river valley turns abruptly northward, and is marked throughout by abundant fossil bones. All the specimens of *Brachyceratops montanensis* were found 1½ miles north of this locality (see Pl. II, *C*), on the strike of the gently westward-dipping beds, at nearly the same elevation and therefore at approximately the same stratigraphic position. Horizons 2 and 3, at which material was collected on Two Medicine River in T. 31 N., R. 7 W., were fixed stratigraphically by measuring downward from the base of the Bearpaw shale as exposed 6 miles to the west. Horizon 2, at which an unidentified trachodont (No. 7955, U. S. N. M.) was collected on the south side of Two Medicine River in the NE. ¼ sec. 15 (see Pl. II, *B*), is about 490 feet below the Bearpaw shale. Horizon 3, which yielded a trachodont on the south side of the river, but in the NE. ¼ sec. 12 (No. 8058, U. S. N. M.), is 445 feet lower, being approximately 935 feet below the same shale and therefore very near the center of the Two Medicine formation.

## FAUNA OF THE TWO MEDICINE AND RELATED FORMATIONS.

Vertebrate fossils are found throughout the upper part of the Two Medicine formation, and nearly all of them belong to the class Reptilia. The great number of trachodonts found appears to indicate that these were the most abundant dinosaurs of the epoch. Their remains are distributed from the base to the very top of the beds representing the upper half of the Two Medicine formation, as exposed in the localities visited in 1913 along Milk and Two Medicine rivers. On each of the 15 days spent in prospecting 8 to 14 specimens sufficiently complete to be recognized as pertaining to the Trachodontidae were discovered. Only a few of these, however, were perfect enough to warrant collecting, and none were intact, though many found in the Edmonton and Belly River areas in Canada and in the Lance formation of Wyoming and Montana were still articulated.

Next to the Trachodontidae the Ceratopsidae were most abundant, but of the half a dozen specimens found only one (the type specimen of *Brachyceratops montanensis*) is of scientific interest, the others consisting either of single bones or of fragments so badly weathered as to be of little value. They show, however, the existence here of large members of the group.

Armored dinosaurs were present in these localities, as indicated by the finding of the dermal plates of a member of the Ankylosauridae, provisionally referred to the genus *Europlocephalus*.

Teeth of carnivorous dinosaurs are common, but skeletal remains appear to be rare, except as single bones. It would appear from the scant evidence that several small dinosaurs of which little is known lived at this time.

Fragments of turtles are plentiful, but no complete shells were observed. The soft-shelled kinds appear to predominate. A few teeth and single bones of extinct crocodiles were found, but only two vertebral centra of the long-snouted rhyncocephalian reptile *Champsosaurus*, which is abundant in some areas of the Belly River formation.

Isolated scales and plates of ganoid fishes, probably referable to the genus *Lepisosteus*, were found here and there throughout the beds.

The genera and species identified from this small collection from the Two Medicine formation are as follows:

Ceratopsidae:
- Brachyceratops montanensis Gilmore.
- Ceratopsian, gen. and sp. undet.

Trachodontidae:
- Hypacrosaurus altispinus? Brown.
- Stephanosaurus marginatus? (Lambe).
- Trachodont, gen. and sp. undet.
- Trachodont, gen. and sp. undet.

Ankylosauridae:
- Europlocephalus sp.

Rhyncocephalia:
- Champsosaurus sp.

Chelonia:
- Basilemys sp.
- Aspideretes foveatus (Leidy).
- Aspideretes sp.

Crocodylidae:
- Leidyosuchus sp.

Pisces:
- Lepisosteus sp.

The vertebrate fauna of the Two Medicine formation, as represented by this small collection, although too meager to serve as a basis for close comparisons with related faunas, accords with the stratigraphic evidence for the correlation of the upper part of the Two Medicine formation with the dinosaur-bearing beds of the Judith River and Belly River formations. This is shown not so much perhaps by identity of forms as by the primitive facies of the fauna as a whole, and also by the similarity in degree of development of some of the principal representatives of the Dinosauria. The latter statement is especially applicable to members of the family Ceratopsidae. In order to make this assertion a little clearer, it may be well to review briefly the development of the Ceratopsia.

The earliest ceratopsians known were found in the Judith River and Belly River formations. The group occurs also in the Edmonton and in the upper part of the Lance.

In contrasting the ceratopsians from these formations the chief differences are found in the structure of the skull, especially in the comparative sizes of the postorbital and nasal horn cores and in the open or closed structure of the nuchal frill. In the Judith River, Belly River, and Two Medicine ceratopsians the nasal horn is usually the larger, whereas the postorbital horns are small, rudimentary, and sometimes wanting. In the Lance ceratopsians the opposite condition is universal. The fenestrated frill is a feature of all the earlier ceratopsians, but is retained in the Lance forms only by *Torosaurus* and in lesser degree by *Diceratops*, all others having a complete bony frill without fenestration.

The earliest known Ceratopsia may be contrasted with those from the Lance formation as follows: (1) The individuals are smaller, (2) the nasal horn core is usually larger than the postorbital horn cores, (3) the nuchal frill is imperfectly developed, (4) the postfrontal and dermosupraoccipital bones are less perfectly united, (5) the squamosals are shorter, and (6) the dentition is reduced.

With all these primitive characteristics the single known Two Medicine genus *Brachyceratops* is in exact accord. In addition it may be said that *Brachyceratops montanensis* appears to have its closest affinity with *Monoclonius*[1] *dawsoni* Lambe from the Belly River of Canada.

Previous to 1913 only three recognizable genera of the Ceratopsidae (*Monoclonius, Ceratops,* and *Centrosaurus*) were known from the Judith River and Belly River formations. Since 1913, however, the discovery of new material has more than doubled the number of described genera, Lambe having established the genera *Styracosaurus*,[2] *Chasmosaurus*,[3] *Eoceratops*,[4] and *Protoro-*

[1] Since this observation was made (1914) Lambe has referred his species to *Brachyceratops* (Lambe, L. M., On *Eoceratops canadensis*, gen. nov., with remarks on other genera of Cretaceous horned dinosaurs: Canada Geol. Survey Mus. Bull. 12, Geol. ser., No. 24, p. 18, May 7, 1915).

[2] Lambe, L. M., A new genus and species of Ceratopsia from the Belly River formation of Alberta: Ottawa Naturalist, vol. 27, pp. 109–116, pls. 10–12, 1913.

[3] Lambe, L. M., On *Gryposaurus notabilis*, a new genus and species of trachodont dinosaur from the Belly River formation of Alberta, with a description of the skull of *Chasmosaurus belli:* Idem, p. 155, pls. 19, 20, February, 1914.

[4] Lambe, L. M., op. cit. (On *Eoceratops canadensis*, etc.), pp. 1–25.

*saurus*,[1] from the Belly River of Canada, and *Brachyceratops* [2] having been added from the Two Medicine formation of Montana. Sufficient material of *Brachyceratops* was obtained to permit a skeletal restoration. (See Pl. IV.)

Recent explorations in the Edmonton formation show that these beds have a characteristic ceratopsian fauna, regarded by Brown [3] as being intermediate between that of the Judith River and Belly River formations on the one hand and that of the Lance formation on the other hand, with affinities nearer those of the former. The fact that a number of specimens from the Edmonton of Canada are as yet undescribed renders it impracticable at this time to make a close comparison of this fauna with those of the formations named. It should be mentioned, however, that none of the ceratopsian genera of the Judith River, Belly River, or Two Medicine formations are known to have continued into either the Edmonton or the Lance.

As stated previously, the trachodont reptiles were the most abundant dinosaurs of the Judith River, Belly River, and Two Medicine formations, and recent discoveries have shown them to be almost as diversified in their structure as the contemporary ceratopsians.

If the genera *Saurolophus*, *Hypacrosaurus*, *Stephanosaurus*, and *Kritosaurus* and the five species described since 1910 are included, no less than 15 genera and 25 species of North American Trachodontidae have been described. The list as known in 1902, however, consisting of 10 genera and 20 species, should be greatly reduced. Hatcher [4] favored the retention of only two genera, *Claosaurus* and *Trachodon*, considering that the remaining eight were synonyms of *Trachodon*. *Claosaurus* he would restrict to the single species from the Niobrara formation of Kansas. The finding of more perfect material, however, has shown that several of the species formerly referred to *Trachodon* represent distinct genera and that Hatcher's proposed reduction was too radical. Of the several genera established on good specimens it appears very likely that some will yet prove to be synonyms of earlier-described genera founded on fragmentary material, but this can be determined only by careful comparison of all the type specimens. Until such a revision is made few of the earlier described forms will be of use in correlation or in working out the phyletic or other relations of the group. Hatcher was probably correct in restricting *Claosaurus* to the single species from the Niobrara formation. It is unfortunate, however, that his opinion that the genus *Trachodon* should include species from the Judith River to the close of the Lance has become so widely accepted by vertebrate paleontologists. In the first place, the type species of the genus (*Trachodon mirabilis* Leidy) came from the Judith River formation and was founded on inadequate material, consisting of "specimens of teeth generally very much worn and in a fragmentary condition," with which it is wholly impossible positively to identify better specimens discovered subsequently. That Hatcher later realized this fact is clearly shown by his statement that "Although the trachodonts are easily distinguished by their teeth from the other Dinosauria of these beds (Judith River), it is scarcely possible to identify the various species of this genus or the genera of the family from the teeth alone."[5]

Even though it may eventually be found that *Trachodon* can be placed on a sound footing, there is reason for believing that the genus is not present in the Lance,[6] as shown by the less number of teeth in all the known specimens from the Judith River, Belly River, and Two Medicine formations.

In the Lance trachodonts, several complete dentaries of which are included in the United States National Museum collections, the rows of teeth vary from 52 to 57. All the Judith River, Belly River, and Two Medicine trachodont dentaries in the collections have fewer rows, varying in number from 39 to 46. The same difference exists in the few maxillae available. It thus

[1] Lambe, L. M., On the fore limb of a carnivorous dinosaur from the Belly River formation of Alberta, and a new genus of Ceratopsia from the same horizon, with remarks on the integument of some Cretaceous herbivorous dinosaurs: Ottawa Naturalist, vol. 27, pp. 131-135, pl. 14, January, 1914.

[2] Gilmore, C. W., A new ceratopsian dinosaur from the Upper Cretaceous of Montana, with note on *Hypacrosaurus*: Smithsonian Misc. Coll., vol. 63, No. 3, pp. 1-10, pls. 1-2, 1914.

[3] Brown, Barnum, Cretaceous correlation in New Mexico, Wyoming, Montana, and Alberta: Geol. Soc. America Bull., vol. 25, p. 374, 1914.

[4] Hatcher, J. B., The genera and species of the Trachodontidae (Hadrosauridae, Claosauridae) Marsh: Carnegie Mus. Annals, vol. 1, p. 385, 1902.

[5] Stanton, T. W., and Hatcher, J. B., Geology and paleontology of the Judith River beds: U. S. Geol. Survey Bull. 257, pp. 96-97, 1905.

[6] Gilmore, C. W., On the genus *Trachodon*: Science, new ser., vol. 41, pp. 658-660, 1915.

seems that the earliest known trachodonts, like the more primitive ceratopsians, have fewer teeth, so that now it may be safely asserted that one of the marked phases in the specialization of the members of this group in successive geologic periods is the progressive increase in the number of teeth in the dental magazines.

The genus *Trachodon* is based on specimens from the Judith River formation, and its smaller number of teeth would indicate that it did not persist into the later formations. It appears to me, therefore, that *Trachodon* should either be treated as an indeterminate genus or at the most should be restricted to Judith River species. Such restriction would leave the Lance specimens now referred to *Trachodon* without generic designation, unless by a study of the type specimens one of the older generic terms can be revived.

The geologic range of the Trachodontidae is considerably greater than that of the Ceratopsidae, commencing in the Niobrara and continuing through the Judith River, Belly River, Two Medicine, Edmonton, and Lance formations. They disappear, like the Ceratopsidae, at the close of the Lance.

Four genera, *Hypacrosaurus*, *Kritosaurus*, *Stephanosaurus*, and *Trachodon*, are now recognized as occurring in the Judith River and Belly River formations, and two of them, *Hypacrosaurus* and *Stephanosaurus*, have been identified in the collection from the Two Medicine formation. *Hypacrosaurus*[1] was described originally from the Edmonton of Alberta, Canada, and *Kritosaurus*[2] from beds in New Mexico described by Brown as the Ojo Alamo formation. Brown[3] has recently shown the generic identity of the *Gryposaurus* of Lambe, from the Belly River, with the *Kritosaurus* of Brown, and the suggestion is made that as "other reptilian remains are of the primative facies the Ojo Alamo beds may well be of Judith River age."

In a recent paper[4] Brown has shown that the family Trachodontidae may be divided naturally into two groups, those of one having a crested skull and a footed ischium; and those of the other lacking the crest and having a slender ischium without distal expansion. Members of the first group are so far known only from the Belly River, Two Medicine, and Edmonton formations, whereas representatives of the second group are present in all formations as well as in the Judith River and the Lance.

Little can be said at this time of the progressive changes that have taken place in the structure of the Trachodontidae, though it appears that the dental magazine of the Lance trachodonts contains a greater number of teeth than that of the trachodonts from the Judith River, Belly River, and Two Medicine formations. The presence of four digits in the pes of the Judith River genus *Pteryopelyx* would appear to indicate a foot more primitive than that of the three-toed Lance trachodonts.

Both the theropodous or flesh-eating dinosaurs and the armored dinosaurs are so little known that at present it is impossible to make adequate comparison between the species of different horizons. Representatives of the theropodous group, however, are present in all the formations discussed in this paper, and the study of specimens now at hand will doubtless show the progressive changes that have taken place in their skeletal structure and thus will be an aid in the future correlation of the separated formations.

The rhyncocephalian reptile *Champsosaurus* has a wider geologic range than any other of the extinct reptilian forms, except of course some of the chelonian genera. Remains of *Champsosaurus* have been found in the Judith River, Belly River, Two Medicine, Edmonton, Lance, Puerco, and Fort Union formations. It is likely that when better material is known the species will be found to vary in successive formations, but this fact can not now be determined.

The crocodiles are represented in the Belly River formation by the single identifiable genus *Leidyosuchus*, a genus that continues into the Lance, as shown by the type specimen of *Leidyosuchus sternbergii* from the Niobara County area in Wyoming. Isolated teeth and bones from the Two Medicine formation are provisionally identified as pertaining to this genus.

---

[1] Brown, Barnum, A new trachodont dinosaur, *Hypacrosaurus*, from the Edmonton Cretaceous of Alberta: Am. Mus. Nat. Hist. Bull., vol. 32, pp. 395–406, 1913.

[2] Brown, Barnum, The Cretaceous Ojo Alamo beds of New Mexico, with description of the new dinosaur *Kritosaurus*: Am. Mus. Nat. Hist. Bull., vol. 28, pp. 267–274, 1910.

[3] Sinclair, W. J., and Granger, Walter, Paleocene deposits of the San Juan Basin, N. Mex.: Am. Mus. Nat. Hist. Bull., vol. 33, p. 303, 1914.

[4] Brown, Barnum, Cretaceous-Eocene correlation in New Mexico, Wyoming, Montana, Alberta: Geol. Soc. Am. Bull., vol. 25, pp. 355–380, 1914.

The turtles are represented in the collection made in 1913 from the Two Medicine formation by only two identifiable specimens. One of these, *Basilemys* sp., is of interest as having its nearest affinity with *B. nobilis* Hay, from the beds in New Mexico to which Brown has applied the name Ojo Alamo, thus apparently corroborating the dinosaurian evidence on which the Belly River formation was correlated with the beds at Ojo Alamo.

The fish *Lepisosteus* has a wide geologic range and is valueless as a horizon indicator.

In conclusion it may be briefly stated that the fauna of the Two Medicine formations, as represented by this one small collection, is on account of its primitive facies in accord with the stratigraphic evidence for the correlation of these beds with the dinosaur-bearing beds of the Judith River and Belly River formations. Taken as a whole the faunas of the equivalent formations are undoubtedly ancestrally related to those of the Lance, for, with one exception, all the families represented in these older formations are present also in the Lance.

Notwithstanding the fact that certain of the earlier faunal lists seem to indicate that several genera and species of reptiles persisted from Belly River to Lance time, the evidence that has been gradually accumulating in recent years indicates beyond question that the fauna of the Judith River and Belly River formations is distinctly more primitive than the related forms in the Lance, although a few of the more persistent types, such as *Champsosaurus*, *Leidyosuchus*, and some turtle genera, pass from one formation to the other.

## DESCRIPTIONS.

### Family CERATOPSIDAE Marsh.

### Brachyceratops montanensis Gilmore.

Plates I, III, IV; text figures 2–9, 11–26, 28–39, 41–47.

*Brachyceratops montanensis* Gilmore, Smithsonian Misc. Coll., vol. 63, No. 3, pp. 1–10, pls. 1–2, 1914.

*Type of genus and species.*—A considerable portion of a disarticulated skull (No. 7951, U. S. N. M.), showing nasals, prefrontals, postfrontals, postorbitals, premaxillaries, maxillaries, lachrymal, alisphenoid, and exoccipital. With this is provisionally associated a fragmentary part of the frill, a right dentary, and a predentary.

*Type locality.*—NE. ¼ sec. 16, T. 37 N., R. 8 W., Milk River, Blackfeet Indian Reservation, Teton County, Mont.

*Paratypes.*—Rostral and portions of the premaxillaries (No. 7952, U. S. N. M.); sacrum, pelvis, articulated caudal series of 50 vertebrae continuous to the tip of the tail (No. 7953, U. S. N. M.), with which are provisionally associated dorsal vertebrae and ribs; tibia, fibula, and partly articulated hind foot from the left side, consisting of an astragulus, calcaneum, and 2 tarsals of the distal row, 4 metatarsals and a portion of a fifth, and 11 phalanges (No. 7957, U. S. N. M.).

*Paratype locality.*—Same as that of the type.

*Generic and specific characters.*—Typically of small size. Skull with facial portion much abbreviated and deep vertically. Supraorbital horn cores small and firmly united with postorbitals. Nasal horn core outgrowth from nasals, large, slightly recurved, laterally compressed, and divided longitudinally by median suture. Frill with comparatively sharp median crest, fenestrae apparently of small size, and entirely within the median element. Border of frill scalloped but without separate marginal ossifications. Dentition as compared with *Triceratops* greatly reduced. Five digits in the pes, the fifth being vestigial. Ilium with greatly expanded anterior blade that curves strongly outward.

*The specimens.*—The specimens of *Brachyceratops* on which the present description and restoration are based were found on Milk River within a small rectangular area of about 6 by 7 feet. (See Pl. II, *C*.) With the exception of two hind feet and three series of caudal vertebrae, one of which (No. 7953; Pl. III, *A* p. 20) was entire and articulated with the sacrum and closely associated with the pelvic bones and femora, all the skeletal parts were disassociated and too closely intermingled to show to which individuals they belonged.

The proper association of the bones of the different individuals was rendered still more difficult by the fact that all the specimens were of approximately the same size. Comparison of portions of no less than nine ischia showed that at least five individuals were present, and it is quite possible that there were one or two more. In the type (the disarticulated skull, No. 7951) the sutures interlocked so perfectly as to leave no doubt that the assembled elements belonged to the same cranium.

## OSTEOLOGY OF BRACHYCERATOPS.

### THE SKULL.

*General features.*—When found the skull was entirely disarticulated, but the excellent preservation of the bone and the absence of distortion rendered the assembling and correct articulation of the scattered elements comparatively easy. This specimen is of the utmost importance in the proper interpretation of the cranial elements, especially of those parts of the ceratopsian cranium that are now somewhat in controversy.

The type of the genus and species, as was stated, is small. This statement is true so far as applied to the known specimens, but it should be added that to some extent the small size of these specimens may be due to immaturity. The open sutures of the skull, sacrum, and vertebræ all testify to the youth of the individuals.

The facial portion of the skull is greatly abbreviated, as compared with that of the ceratopsians of the Lance formation. (See fig. 2.) It is to this shortening that the generic name refers.

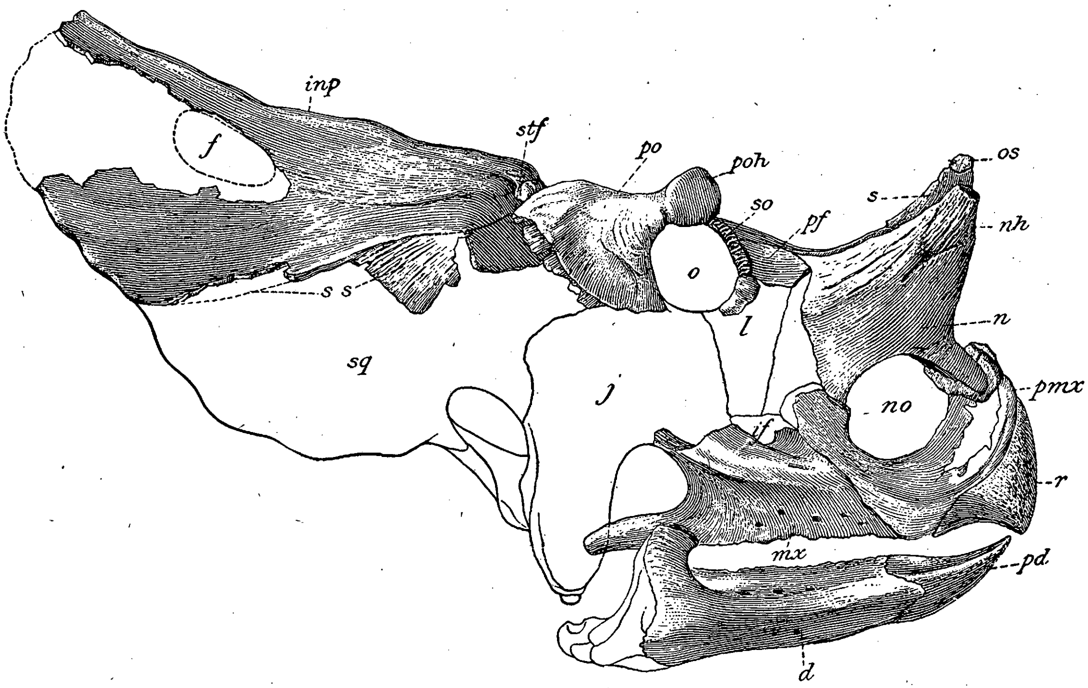



FIGURE 2.—Skull of *Brachyceratops montanensis* Gilmore. Type. No. 7951, U. S. N. M. One-third natural size. Lateral view. *d*, Dentary; *f*, fenestra in frill; *if*, infraorbital foramen; *inp*, interparietal; *j*, jugal; *l*, lachrymal; *mx*, maxillary; *n*, nasal; *nh*, nasal horn cores; *no*, anterior narial opening; *o*, orbit; *os*, ossicle on top of nasal horn core; *pd*, predentary; *pf*, prefrontal; *pmx*, premaxillary; *po*, postorbital; *poh*, postorbital horn core; *r*, rostral; *s*, suture separating halves of nasal horn; *sq*, squamosal; *so*, sutural border on prefrontal for small supraorbital; *ss*, sutural surfaces for squamosal; *stf*, supratemporal fossa.

The narial opening, as in other known Judith River and Belly River forms, is well forward and under the nasal horn, whereas in the later and more highly specialized *Triceratops* this orifice is entirely posterior to that horn. The distance between the nasal and supraorbital horns is exceedingly short, owing largely to the shortened nasal bones, the great fore and aft development of the basal portion of the nasal horn, and the forward position over the orbits of the small brow horns.

The exact pitch of the frill portion in relation to the anterior part of the skull can not be positively determined. In figure 2 it has been placed in accordance with the evidence of articulated skulls.

An entirely new phase of nasal horn development and one which appears to be unique among dinosaurs appears in the longitudinal separation of the horn core into two halves by the nasal suture. The nasal horn itself appears to be an outgrowth from the nasal bones instead of having originated from a separate center of ossification, as in the more specialized *Triceratops*.

It appears quite probable that some of the described Belly River species will be found to show a similar mode of nasal horn development when juvenile specimens are found.

There is no trace of an epinasal bone such as was found by Lambe [1] in *Eoceratops*, and the curved groove on the *Brachyceratops* horn which suggested to Lambe the upper boundary of the epinasal ossification appears to be only one of the vascular grooves.

*Nasals.*—The nasals are especially deep and massive, owing to the development on their superior surfaces of the nasal horn cores. Posteriorly they present a pointed process with a beveled underlapping surface for contact with the prefrontals (the frontals and lachrymals of authors). Laterally they send down a deep extension to meet the premaxillary, and anteriorly the arched ventral borders of the nasal bones from the upper half of the boundary of the narial orifice. Anteriorly they send out vertically flattened processes (*p*, fig. 4) between which are received the ascending processes of the premaxillae. These nasal processes appear to end about 32 millimeters in advance of the forward line of the horn core, so that the upper outline of the beak is formed largely by the premaxillaries. The horn has a broad fore and aft extent at its

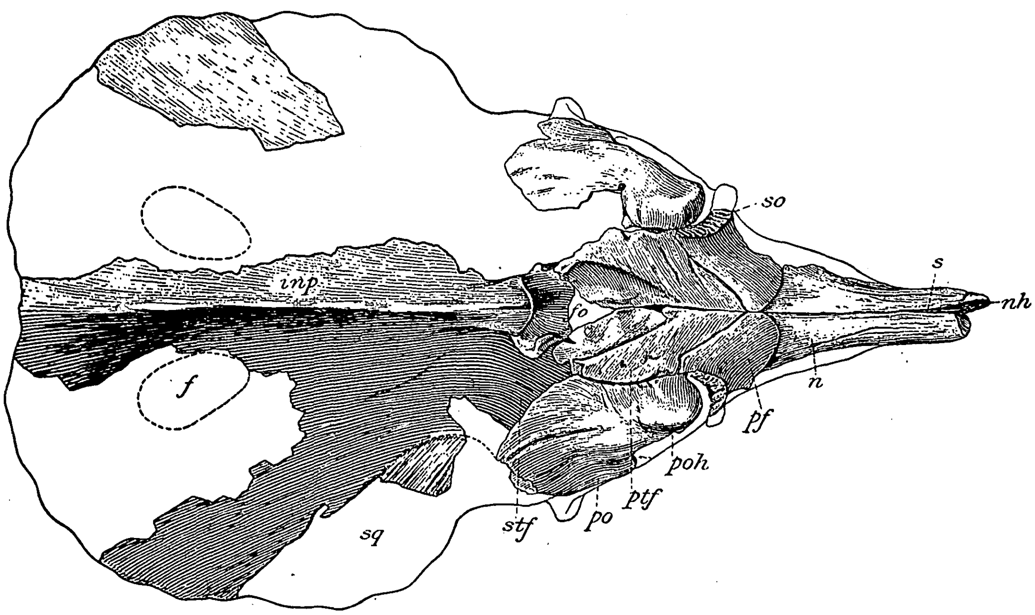



FIGURE 3.—Skull of *Brachyceratops montanensis* Gilmore. Type. No. 7951, U. S. N. M. One-third natural size. Superior view. *f*, Fenestra in frill; *fo*, postfrontal foramen; *inp*, interparietal; *n*, nasal; *nh*, nasal horn core; *pf*, prefrontal; *po*, postorbital; *poh*, postorbital horn core; *ptf*, postfrontal; *s*, suture representing halves of the nasal horn core; *so*, sutural border for missing supraorbital bone; *sq*, squamosal; *stf*, supratemporal fossa.

base but tapers sharply to a blunt, moderately high point. Transversely it is much compressed at the base, though inclined to expand somewhat toward the summit. The horn as a whole is directed somewhat forward, but the curve of the posterior side is such as to give the impression that its upper part is slightly recurved. The surfaces of the upper half are roughened and grooved by vascular impressions.

On the left half of the nasal horn, at the apex, a small, flattened oval ossicle (*os*, fig. 4) rests in a shallow depression or pit. This ossicle is distinct from the underlying bone and may represent the incipient horn of later ceratopsians, in which it is known to be developed from a center of ossification distinct from the nasal bones.

*Prefrontals.*—The prefrontals (the frontals and lachrymals of authors) are deeply emarginate anteriorly and receive between them the pointed posterior ends of the nasals.

The prefrontal is a quadrangular plate of bone diagonally placed so as to fill the interspace between the postfrontal and nasal bones. Its thickened posterior end contributes to the inner part of the anterior boundary of the orbit. (See *o*, fig. 5.) Near the posterior termination on the

[1] Lambe, L. M., On *Eoceratops canadensis* gen. nov., with remarks on other genera of Cretaceous horned dinosaurs: Canada Geol. Survey Mus. Bull. 12, p. 7, 1915.

external side a narrow vertical sutural surface (*so*, fig. 2) was for the articulation of the small supraorbital bone, which is missing. This element would have completed the thickened orbital border which projects immediately in front of the eye and which forms so conspicuous a feature of the ceratopsian skull. On the upper posterior end of the prefrontal a pointed peglike projection is received in a corresponding pit in the anterior border of the postfrontal, thus strengthening the union of these two bones. The prefrontal is just barely in contact with the postorbital at the base of the postorbital horn core.

*Postfrontals.*—The true extent of the postfrontals in the ceratopsian skull is here correctly determined for the first time. Authorities have heretofore considered the postfrontal as extending from the median line outward and including all of that portion of the skull here designated as postfrontal and postorbital. (See fig. 3.) In this specimen a longitudinal suture just internal to the base of the supraorbital horn core divides the so-called postfrontal into two

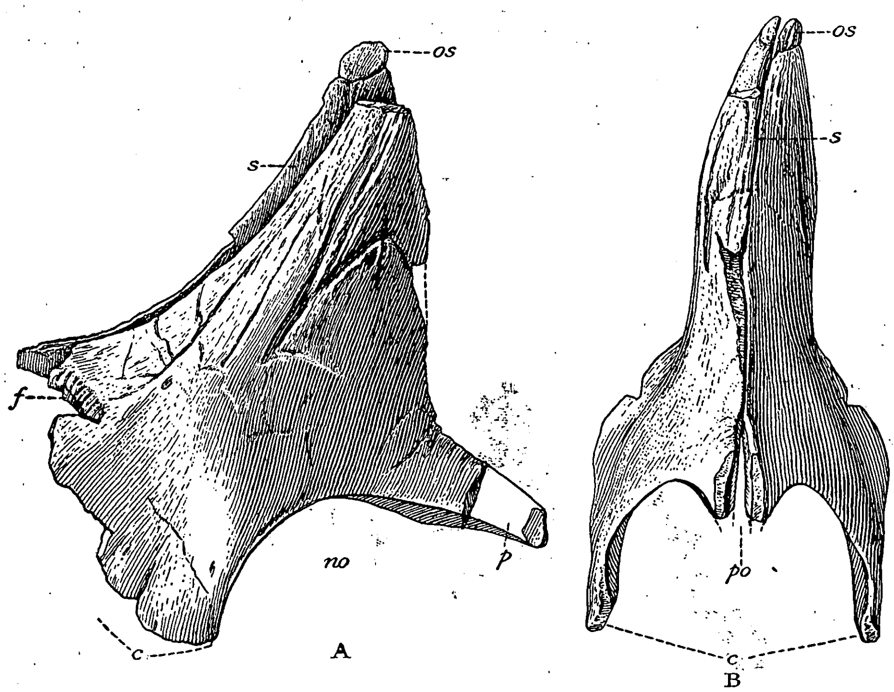



FIGURE 4.—Nasals and nasal horn cores of *Brachyceratops montanensis*. Type. No. 7951, U. S. N. M. One-half natural size. A, Side view; B, front view. *c*, Surface for contact with the premaxillaries; *f*, surface for articulation of prefrontal; *no*, anterior nasal opening; *os*, bony ossicle on top of horn core; *p*, anterior process of nasal; *po*, orifice for superior processes of premaxillaries; *s*, suture separating two halves of nasal horn.

distinct elements. The inner portion all paleontologists agree in calling the postfrontal; the outer appears without question to represent the postorbital. Von Huene [1] in 1912 regarded the portion forming the posterior boundary of the orbit in a skull of *Triceratops prorsus* as representing the whole of the postorbital, but the writer questions the correctness of this determination in the genus *Triceratops*.

In *Brachyceratops* the postfrontal is a somewhat irregularly triangular bone, longer than wide, which unites by suture on the median line with its fellow of the opposite side. (See fig. 6.)

Anteriorly the combined postfrontals terminate in a pointed projection interposed between the deeply emarginate posterior borders of the prefrontals. Posteriorly and on either side of the postfrontal foramen these bones articulate by suture with the median element of the frill. A toothed external border unites with the postorbital. Beginning between the horn cores the median upper surfaces of the postfrontals are angularly depressed, gradually deepening and widening transversely as they approach the postfrontal foramen, much as in *Styracosaurus albertensis* Lambe.[2]

[1] Huene, Friedrich von, Beiträge zur Kenntnis des Ceratopsidenschädels: Neues Jahrb., 1912, Band 2, fig. 3, p. 151.
[2] Lambe, L. M., A new genus and species of Ceratopsia from the Belly River formation of Alberta: Ottawa Naturalist, vol. 27, No. 9, pl. 2 *B*, 1913.

The relation of the prefrontals and postfrontals in *Brachyceratops* is unusual, for in most dinosaurian crania the frontal is interposed between them, the relation shown in *Brachyceratops* being found elsewhere, so far as the writer is aware, only in *Stegosaurus* among the Dinosauria and in some of the Permian Reptilia. Von Huene has shown (correctly, the writer believes) that the frontal in *Triceratops* has been entirely excluded from the dorsal surface of the skull.

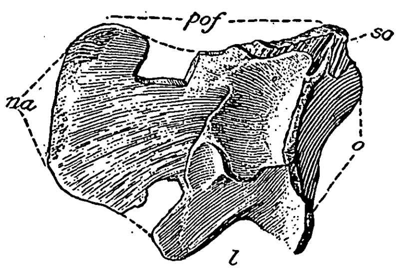



FIGURE 5.—Right prefrontal of *Brachyceratops montanensis*. Type. No.7951, U.S. N.M. Three-fourths natural size. Internal view. *l*, Side opposed to the lacrymal; *na*, side articulating with nasal; *o*, orbital border; *pf*, side articulating with the right postfrontal; *so*, supraorbital border.

*Postorbital.*—The postorbital gives rise to the small supraorbital horn core and forms nearly one-half of the orbital border. Posterior to this horn, which is situated on the extreme anterior end, the bone flares into a wide expanded portion, much deflected externally, with a curved posterior border, the inner half forming a portion of the outer boundary of the supratemporal fossa and the outer half having an underlapping sutural edge for articulation with the squamosal. The straight inferior edge meets the jugal, which is missing in this specimen.

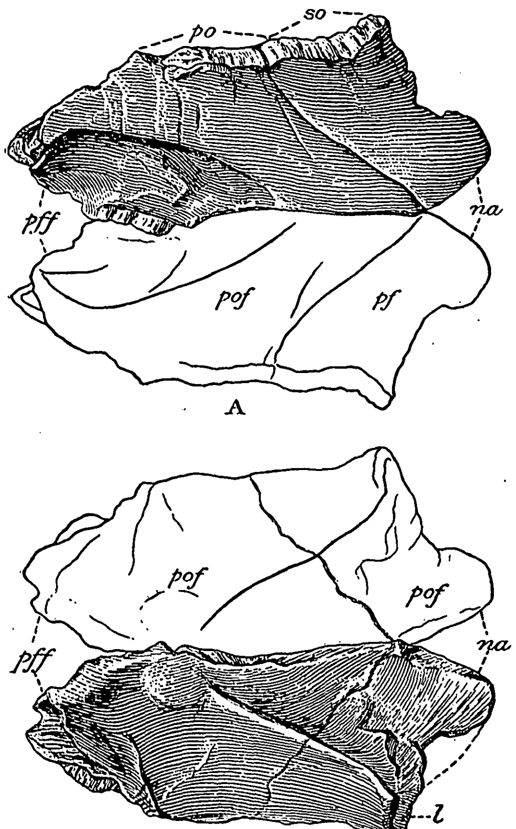



FIGURE 6.—Postfrontals and prefrontals of *Brachyceratops montanensis*. Type. No. 7951, U. S. N. M. One-half natural size. A, Superior view; B, inferior view. *l*, Pit for reception of peg on the lachrymal; *na*, notch between prefrontals which receives posterior ends of nasals; *pf*, prefrontal; *pff*, postfrontal foramen; *po*, postorbital border; *pof*, postfrontal; *so*, supraorbital border.

The thickened anterior border shows a sutural edge for union with the missing supraorbital bone. On the median inferior surface is a shallow pit which receives the outer end of the alisphenoid, as it does in *Stegosaurus*, *Camptosaurus*, and *Triceratops*. (See also *alsp*, fig. 7.)

Immediately above the orbit on the anterior part of the postorbital there rises a low horn core, whose upper extremity is obtusely rounded longitudinally (see *poh*, fig. 2) but is sharply pointed transversely. The external surface of this horn is plane, the internal strongly convex, with the antero-posterior diameter greatly exceeding the transverse. Its total height above the orbit is 31 millimeters. These horn cores appear to be outgrowths from the postorbital bones unless they include a posterior supraorbital element such as has recently been found in the skull of *Stegosaurus*.[1] The type specimen shows no trace of such an element, but its possible existence again raises the question of the proper designation of these horns, which have been called successively postfrontal and supraorbital horn cores. If they are outgrowths from the postorbital bone, as the present specimen appears to indicate, postorbital horn core would be the more appropriate designation.

*Dermosupraoccipital.*—The frill is represented by the median elements from two individuals. (Nos. 7950 and 7951, U. S. N. M.) Portions of each are missing, but the better-preserved specimen is provisionally associated with the type as shown in figures 2 and 3. This association, however, is only provisional in so far as it applies to the actual individual, for without question all the bones belong to the same kind of an animal.

[1] Gilmore, C. W., Osteology of the armored Dinosauria in the United States National Museum, with special reference to the genus *Stegosaurus*: U. S. Nat. Mus. Bull. 89, p. 33, 1914.

The dermosupraoccipital or interparietal, for as clearly shown by Hay [1] and Von Huene [2] it can not be the parietal, is united by suture with the anterior portion of the skull at the postfrontal foramen. The median part of the interparietal is sharply ridged except at the posterior extremity, where it flattens into a thinner portion with an emarginate median border. Between the fenestrae the median bar, in cross section, is triangular. (See fig. 8.) The superior surface of this ridge forward of its narrowest part between the fenestrae presents low longitudinal swellings arranged one in front of the other. Proximally the median portion is greatly compressed transversely into a short neck, forward of which it again widens into a much depressed end that articulates laterally with the postfrontals and with them forms the upper boundaries of the postfrontal foramen (*fo*, fig. 3). Between these two lateral portions the median surface is deeply concave and slopes downward to a heavy truncated border that in all probability was suturally united with the parietals (*ps*, fig. 9). In *Brachyceratops* at least, the parietal was entirely hidden in the dorsal aspect, and it is presumed that similar conditions obtained in *Triceratops*, although Von Huene was inclined to regard a small portion of the median part of the frill posterior to the postfrontal foramen in that genus as being parietal.

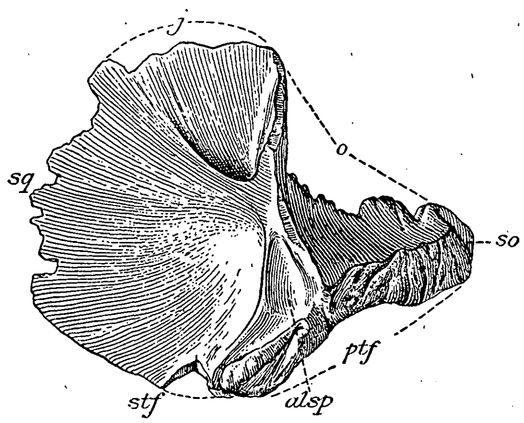



FIGURE 7.—Right postorbital of *Brachyceratops montanensis*. Type. No. 7951, U. S. N. M. One-half natural size. Internal view. *alsp*, Pit for reception of outer end of alisphenoid; *j*, border in contact with the jugal; *ptf*, border in articulation with the postfrontal; *o*, orbital border; *so*, surface for articulation of supraorbital bone; *sq*, border for squamosal articulation; *stf*, free border contributing to the boundary of the supratemporal fossa.

The bone surrounding the frill fenestrae is very thin, but it thickens toward the lateral free edges and posteriorly. Proximally it remains thin where it forms the floor of the supratemporal fossae but thickens toward the sutural border for the squamosal (*sq*, fig. 9). The exact shape and extent of the frill fenestrae can not be accurately determined from the available specimens, but it is readily apparent that they were comparatively small. The surfaces of the frill are relatively smooth and lack the ramifying system of vascular grooves of the later ceratopsians. There were no epoccipital bones on the margins of the frill, but a series of prominences on either side of the median emargination give the periphery a peculiar scalloped effect much like that imparted by the separate ossifications of the *Triceratops* frills.

Laterally the median portion unites with the squamosal by a straight sutural edge that is directed forward and inward toward the center of the skull. A triangular outward projection with an upper striated surface at the anterior termination of the squamosal suture represents a surface that was overlapped by the articulated squamosals (*ss*, fig. 2; *sq*, fig. 9). A low, sharp, diagonally directed ridge apparently indicates the posterior overlap of the squamosal. The squamosals are missing but appear, as in other primitive ceratopsians, to have been short and broad. (See fig. 10.)

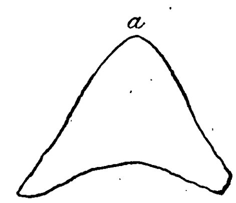



FIGURE 8.—Cross section of dermosupraoccipital of *Brachyceratops montanensis*. No. 7950, U.S.N.M. Three-fourths natural size. Taken posterior to middle of the bone. *a*, Crest of the frill.

*Lachrymal.*—Since the first description and illustrations of the species were published [3] a portion of the left lachrymal has been recognized, and it is shown in the corrected drawing of the skull (fig. 2).

In the type specimen only the orbital border remains, but this shows the orbit to be more nearly circular than was indicated in the first restoration of the skull. It articulates with the

[1] Hay, O. P., On the skull and the brain of *Triceratops*, with notes on the brain cases of *Iguanodon* and *Megalosaurus:* U. S. Nat. Mus. Proc., vol. 36, p. 97, 1909.

[2] Huene, Friedrich von, Beiträge zur Kenntnis des Ceratopsidenschädels: Neues Jahrb., 1912, Band 2, pp. 150–156, figs. 3, 4, 5, and 6.

[3] Gilmore, C. W., A new ceratopsian dinosaur from the Upper Cretaceous of Montana, with note on *Hypacrosaurus:* Smithsonian Misc. Coll., vol. 63, No. 3, 1914.

prefrontal on the outer border by a short, blunt, peglike projection which is received in a pit on the outer anterior border of the prefrontal. It would be scarcely in contact, if at all, with the supraorbital bone, which is missing in this specimen. It also shows that the supraorbital is triangular, the posterior end being especially heavy where it abuts against the postorbital at the base of the postorbital horn core. The forward extension of the lachrymal is missing.

*Alisphenoid.*—The alisphenoid of the left side is preserved, but like all other elements of the skull, was disarticulated in this specimen. In outline it is subtriangular, resembling closely the homologous element in the *Triceratops* skull. The outer extremity has a smooth-finished rounded

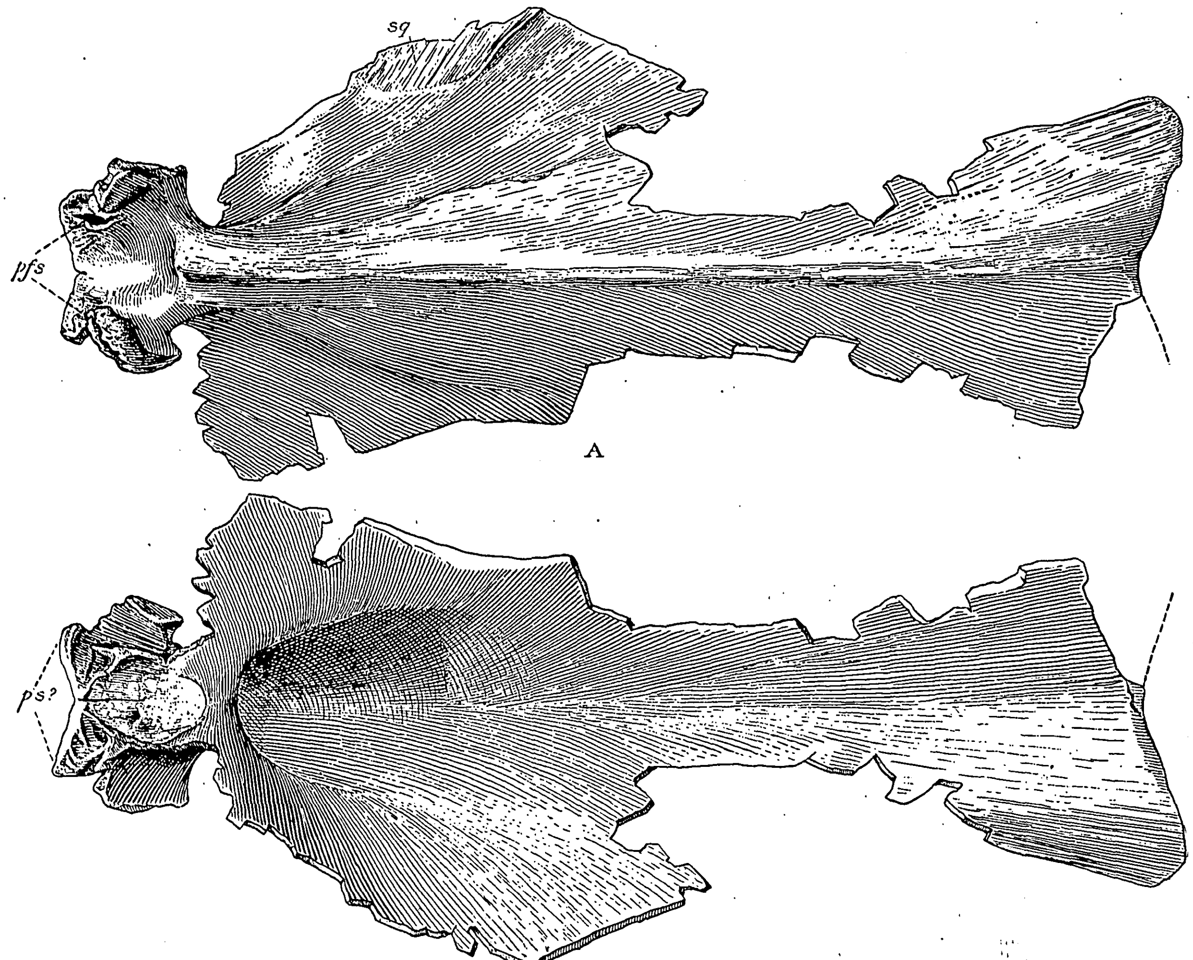



FIGURE 9.—Dermosupraoccipital or interparietal of *Brachyceratops montanensis*. No. 7950, U. S. N. M. One-half natural size. A, Dorsal view; B, ventral view. *pfs*, Borders that united with the postfrontals; *ps?*, borders that united with the parietal; *sq*, surface for overlap of squamosal.

end that is received in a pit on the ventral surface of the postorbital just posterior to the orbit at the base of the horn core. Posteriorly it presents a heavy sutural border that united with the prootic. Its inner portion is hollowed out and forms the wall of the portion of the brain case that lodges the cerebral hemisphere. As in *T. sulcatus* (No. 2416, U. S. N. M.), it has on its inner dorsal surface a sutural surface with which the parietal united. As in *Stegosaurus*, *Camptosaurus*, *Trachodon*, and *Triceratops*, the alisphenoid in *Brachyceratops* forms a portion of the anterior and inner boundaries of the supratemporal fossa. The border forming the boundary of the foramen ovale is broken in the specimen, but no doubt it is present in a perfect bone.

*Exoccipital.*—The front side of a somewhat fragmentary bone that is regarded as being the exoccipital from the left side of the skull is shown in figure 11. It was found in the float at some distance from the type specimen, but it is quite possible that it pertains to that individual.

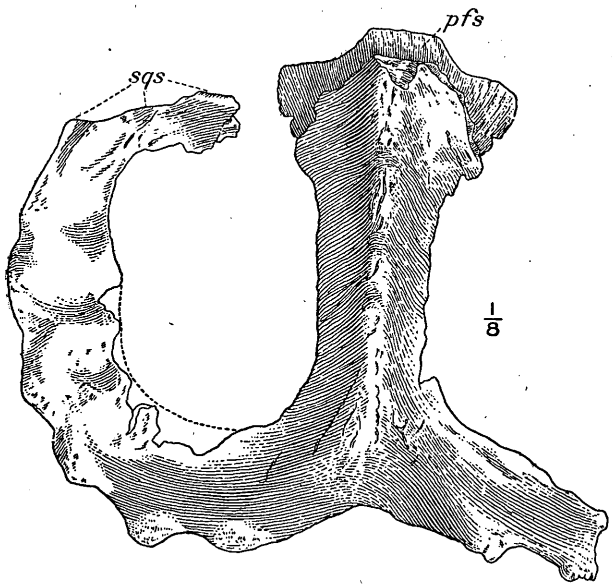



FIGURE 10.—Dermosupraoccipital of *Monoclonius crassus*. Type. No. 3398, American Museum of Natural History. One-eighth natural size. Superior view. *sqs*, Surface for articulation with squamosal; *pfs*, surface for postfrontal. (After Hatcher.)

The bone is flattened and platelike and has a broadly rounded external end or paraoccipital process that unites with the squamosal (*sq*, fig. 11). The inner end is cut off obliquely, with a toothed sutural border which articulates with the supraoccipital (*so*, fig. 11). On the lower internal angle of this end, seen best in posterior aspect, is a smooth concave surface which represents the upper portion of the exoccipital contribution to the boundary of the foramen magnum. The exoccipital of *Brachyceratops* corroborates Huene's determination [1] that in the Ceratopsia the supraoccipital enters the formation of the foramen magnum, as it does in many other dinosaurs, and is not excluded from it by the exoccipital, as determined by earlier authorities.

The pedical portion for articulation with the basioccipital is missing. On the anterior side, near the internal end, it is suturally roughened and diagonally ridged, presenting a surface for the overlapping of the outwardly directed process of the prootic (*pro*, fig. 11), as in *Triceratops*, *Camptosaurus*, and *Stegosaurus*. On the posterior side, near the lower border, is a sharp longitudinal ridge which fades out before reaching the external end; below this ridge, at the inner end, the entrance to the foramen ovalis occurs exactly as it does in *Triceratops serratus* Marsh, as determined by Hay.[2] The greatest length of this bone is 102 millimeters.

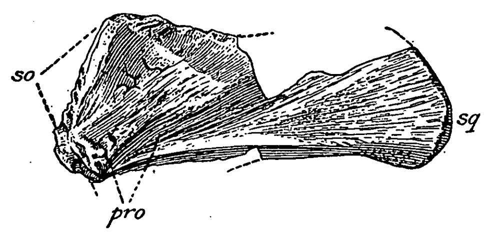



FIGURE 11.—Left exoccipital of *Brachyceratops montanensis*. Type. No. 7951, U.S.N.M. One-half natural size. *pro*, Sutural surface for prootic; *so*, sutural border for supraoccipital; *sq*, end which meets the squamosal.

*Premaxillaries.*—The premaxillaries of *Brachyceratops* are less massive and lack the lateral foramina found in those of *Triceratops*. They are compressed, thin bones and are closely applied to one another along the median line on the anterior half. Posteriorly they send backward and upward diverging processes with expanded posterior extremities that wedge between the maxillary and the descending branch of the nasal.

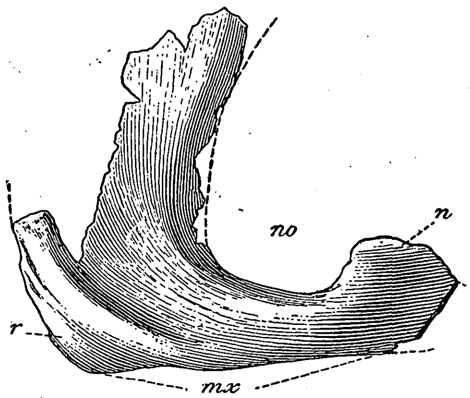



FIGURE 12.—Left premaxillary of *Brachyceratops montanensis*. Type. No. 7951, U.S.N.M. One-half natural size. *mx*, Border uniting with the maxillary; *n*, border uniting with the nasal; *no*, anterior narial opening; *n*, surface over which the rostral laps.

The median superior border of this part of the premaxillary is transversely rounded and forms the lower boundary of the anterior narial opening (*no*, fig. 12). All the premaxillae in the collection were badly mutilated before fossilization, and none of them have their anterior ascending portions complete. The best-preserved one (see fig. 12) exhibits a thin platelike ascending

[1] Huene, Friedrich von, Beiträge zur Kenntnis des Ceratopsidenschädels: Neues Jahrb., 1912, Band 2, pp. 148–150, fig. 2.

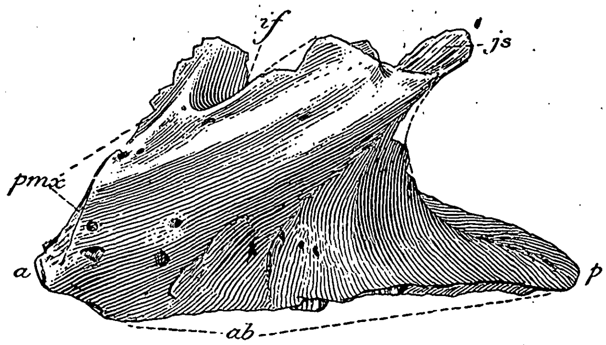
[2] Hay, O. P., On the skull and the brain of *Triceratops*, with notes on the brain cases of *Iguanodon* and *Megalosaurus*: U. S. Nat. Mus. Proc., vol. 36, p. 101, pl. 1, fig. 1, 1909.

process that is closely opposed to the one on the opposite side, the two rising to the nasals, where they are received in the deep groove (see fig. 4) at the base of the nasal horn core. It seems quite possible that the bony septum extends down farther into the narial opening from the base of the nasal bones than has been indicated in the restoration of the skull (fig. 2), resembling in this respect *Styracosaurus* (*Monoclonius*) *sphenocerus* (Cope).

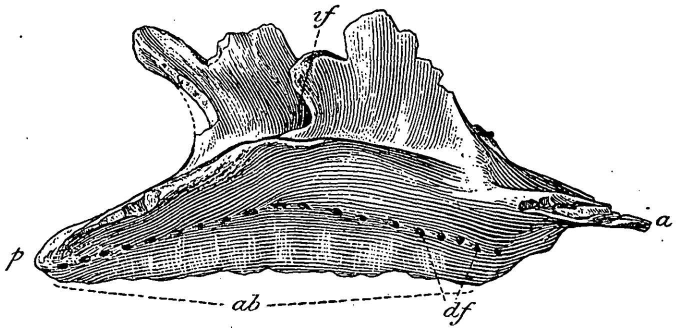
There is no indication of an interpremaxillary fontanelle, as in *Triceratops*, and it appears probable that the opening through the premaxillaries (see fig. 2) would, if perfect, be a thin septum of bone extended from the narial border to the thickened anterior border over which the rostral articulates. The rostral does not extend so far back as in *Triceratops*, and the premaxillary therefore contributes more to the superior borders of the beak than it does in that genus.

Palatine foramina are also wanting in this specimen, though they are conspicuous in the palatal surface of all Lance ceratopsians.

*Maxillaries.*—The maxillaries are of irregular triangular outline, with alveoli in the functional row for 20 teeth—much fewer than in *Triceratops*, which has 40 alveoli. In the specimen all the functional teeth have fallen out, but two or more germ teeth remain and give some idea of their character. Posteriorly the maxillary is divided into two branches, an ascending process that articulates with the jugal (*js*, fig. 13), and an inferior horizontal branch that is relatively heavier than in *Triceratops*. On its superointernal side a longitudinal roughened border is overlapped by an anterior process from the pterygoid and is in contact with the palatine. Anteriorly and superiorly the maxillary has an extended articulation with the premaxillary (*pmx*, fig. 13). Between the premaxillary and jugal articulations the lachrymal and possibly the nasal were in contact with this bone. (See fig. 2.)




A




B

FIGURE 13.—Left maxillary of *Brachyceratops montanensis*. Type. No. 7951, U. S. N. M. One-half natural size. A, External view; B, internal view. *a*, Anterior end; *ab*, alveolar border; *df*, dental foramina; *if*, infraorbital foramen; *js*, articulating surface for jugal; *p*, posterior end; *pmx*, groove for articulation with premaxillary.

On the anterointernal side a horizontal plate extends inward, meeting a similar projecting plate from the opposite maxillary on the median line, the inferior sides forming a portion of the forward palatal surface, as in *Triceratops*. The anterior half of the extended surface is perforated by a number of foramina, irregularly placed. On the internal side a curved row of 20 dental foramina (*df*, fig. 13, B), one to each dental groove, extends the entire length of the dental magazine.

The infraorbital foramen (*if*, fig. 13) occupies approximately the same position as in the *Triceratops* maxillary. The dental series occupies a longitudinal space of 155 millimeters. Internally the dental border is slightly concave from end to end.

*The rostral.*—The rostral is missing from the type, but is present in a slightly smaller individual (No. 7952, U. S. N. M.). (See fig. 14.) In general aspect it resembles the rostral of *Triceratops* but has a less curved anterior border. Externally the surfaces are pitted and grooved and in life were doubtless covered by a horny sheath.

*Predentary.*—The predentary (in fig. 15), except for its much smaller size, is indistinguishable from that of *Triceratops*. It is to be distinguished from the predentary of *Brachyceratops dawsoni* (Lambe) by the upward-turned apex of the anterior end.

*Dentary.*—The dentary is stout, gradually narrowing vertically toward the front, the anterior end being especially depressed and unusually broad transversely and being nearly at right angles to the posterior portion. Near the posterior end on the external surface a stout coronoid process (*c*, fig. 16) extends well above the dental border. It is compressed transversely but widens anteroposteriorly with a hooked forward process, as in other primitive ceratopsians. From its base a low, broad ridge extends forward at about midheight along the outer side of the dentary. Above and below this ridge the outer surface retreats obliquely inward.

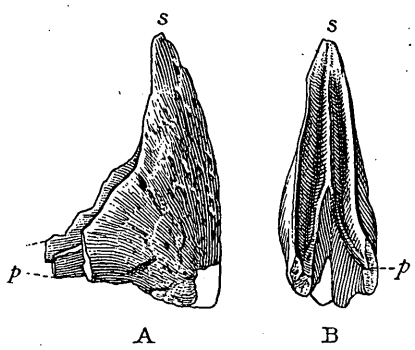



FIGURE 14.—Rostral of *Brachyceratops montanensis*. Paratype. No. 7952, U. S. N. M. One-half natural size. A, Side view; B, posterior view. *s*, Superior process; *p*, posterior processes.

Viewed from above (see fig. 17, B) the dental border is straight but is obliquely placed in relation to the lower portion—that is, it passes from the inner posterior margin to the outer anterior margin of the jaw. Beneath the coronoid process there is a deep mandibular fossa which extends forward about one-third the length of the dentary. On the inner side is the usual row of foramina (*df*, fig. 17) leading into the dental chamber. The exact number of alveoli can not be determined, but the tooth series is relatively shorter than in either *Ceratops* or *Triceratops*, probably not more than 17 dental grooves being present.

*Teeth.*—The dentition is represented by only a few germ teeth, the functional ones having fallen out before the jaws were entombed. That the teeth of *Brachyceratops* in both upper and lower jaws are much less numerous than those of *Triceratops* is indicated by a study of the maxillae and dentary. In *Brachyceratops* the maxillae have alveoli for 20 teeth and the dentary for 16 or 17, whereas in *Triceratops* the maxillae have more than 40, and the dentary 30 or more.

In the left maxillary of the type specimen the third tooth from the front is retained in position in the alveolus. (See fig. 18.) It is a young tooth and not fully erupted. A longitudinal keel divides its external surface into two unequal portions, the larger being anterior. The point of the crown posterior to the external keel is broken so that the contour of the crown is not known, but doubtless it is more pointed than is indicated in the drawing. The anterior border is finely serrated. On the inner side is a heavy keel, more centrally placed than that on the opposite side.

The lower dentition is represented by the crowns of two germ teeth (*t*, fig. 17) attached to the dentary. These germ teeth have a thin but very high median keel on the internal side. (See fig. 19.) The crown is pointed, as in all unworn ceratopsian teeth and its borders are serrated, those of the anterior border being finer than those of the posterior border. The alveolar border of the dentary measures 106 millimeters and the maxillary 155 millimeters. A detached tooth, supposed to pertain to the type, is shown in figure 20.

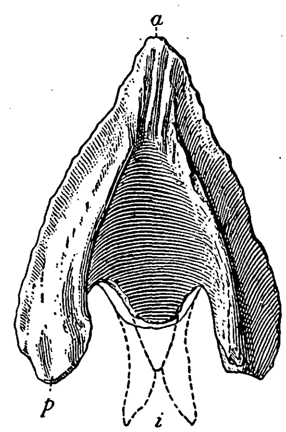



FIGURE 15.—Predentary of *Brachyceratops montanensis*. Type. No. 7951, U. S. N. M. One-half natural size. Superior view. *a*, Anterior end; *p*, posterior end; *i*, inferior processes that underlap the dentary.

*Supratemporal fossae.*—The supratemporal fossae (*stf*, figs. 2, 3) open widely behind, as in all Edmonton and Belly River ceratopsians. These large excavations extend forward beneath the postorbital and postfrontal and laterally at its exit beneath the squamosal. These three bones form the roof as it were over the fossa, the upper boundaries of the fossa exit being formed by their sharp overhanging edges. The posterior floor of this fossa is formed by the smooth bone of the dermosupraoccipital or interparietal.

Hay [1] dissents from the generally accepted determination that these lateral openings in the ceratopsian skull represent the supratemporal fossae. He says: "It is difficult to under-

[1] Hay, O. P., On the skull and the brain of *Triceratops*, with notes on the brain cases of *Iguanodon* and *Megalosaurus*: U. S. Nat. Mus. Proc., vol. 36, pp. 97, 98, 1909.

stand how these bones became modified in such a way as to transfer the supratemporal fossae behind the paraoccipital processes of the exoccipitals. * * * These passages must represent the posttemporal fossae." He then proceeds to show that "the two supratemporal fossae have been pushed into one at the midline," having their exit through what other authorities have designated the postfrontal foramen.

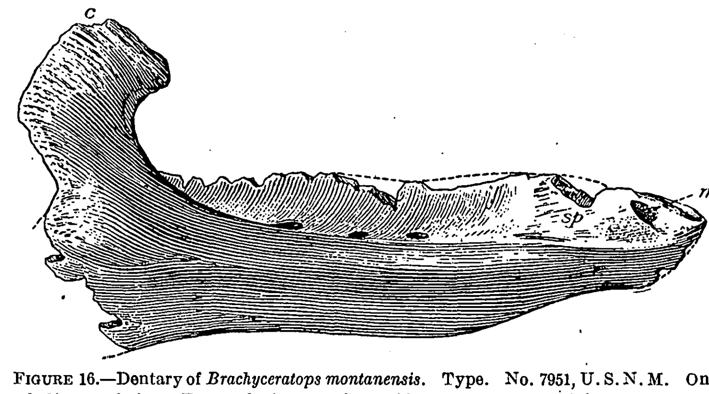



FIGURE 16.—Dentary of *Brachyceratops montanensis*. Type. No. 7951, U.S.N.M. One-half natural size. External view. *c*, Coronoid process; *m*, mental foramen; *sp*, surface for overlap of predentary.

The position of the posterior exit of the supratemporal fossae behind the paraoccipital processes appears to be explained by the unusual posterior winglike development of the postorbital, which roofs the top of this fossa and thus carries its external exit back to the posterior free edge of that bone. Moreover, did they represent the post-temporal openings their exit would be below not above the dermosupraoccipital portion of the skull. That the vertical portion of the supratemporal fossa in the ceratopsian skull sustains its usual relations to the surrounding elements is clear. It has been determined that the alisphenoid in *Triceratops* and *Brachyceratops* has the same position and articulates with the same elements as in other dinosaurian skulls (*Stegosaurus*, *Camptosaurus*, *Diplodocus*, *Trachodon*, *Allosaurus*, and *Tyrannosaurus*). In other words, in all these forms the alisphenoid forms the wall of a portion of the brain case, turning outward and uniting at the external end with the postorbital and articulating posteriorly with the prootic and thus always forming the lower anterior boundary of the supratemporal fossa. If this fossa were continued upward in the ceratopsian skull it would open in its usual position on the superior surface of the skull at the posterior base of the postorbital horn core, and thus would be entirely in front of the paraoccipital processes; but, as stated, the roofing over of this region by the overlying bones carries its exit far posterior.

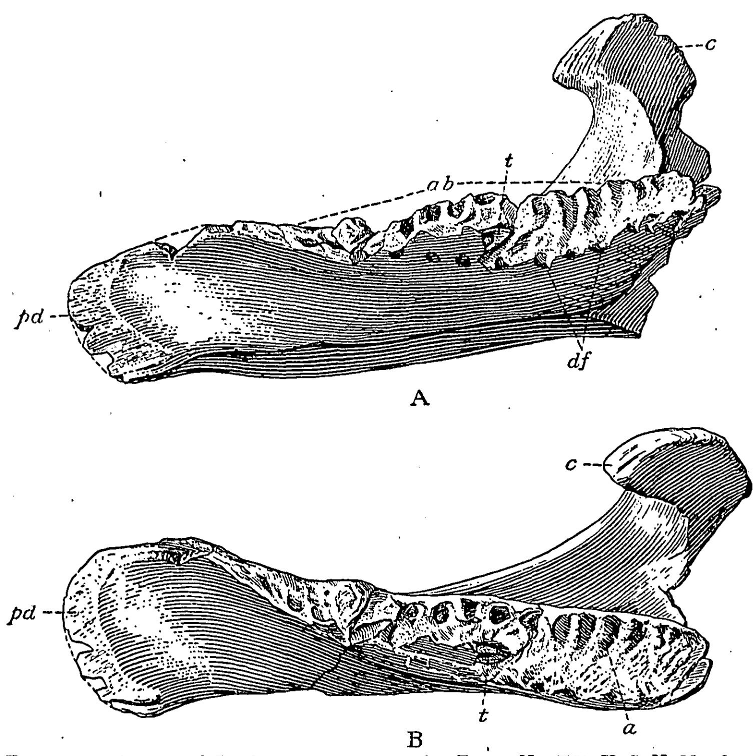



FIGURE 17.—Dentary of *Brachyceratops montanensis*. Type. No. 7951, U. S. N. M. One-half natural size. A, Viewed internally; B, viewed from above. *a*, Alveolus; *ab*, alveolar border; *c*, coronoid process; *df*, dental foramina; *pd*, border for predentary; *t*, crown of an unused tooth (see fig. 19).

The modifications found in the ceratopsian skull are greater perhaps than in any other known group of reptiles, living or extinct. The chief specialization, as has been so clearly stated by Hatcher, is in the "direction of affording increased protection and in the development of more efficient organs for procuring food." The inclosed and compact nature of the skull was of the greatest value as a means of protection, and it contrasts strongly with the open structure of most other dinosaurian skulls. These modifications have led to a rearrangement of the elements of the cranium, that until interpreted is as confusing as it is unusual. The bones of the skull become coossified early in life and thus still further add to the difficulties of interpreting their relationships.

The fortunate discovery of the skull of this juvenile specimen of *Brachyceratops*, taken in connection with the studies of Hay and Von Huene, clears up many of the doubtful points relating to the cranial anatomy that were so puzzling to earlier investigators. It now appears that the prefrontals and postfrontals, which in the normal reptilian cranium are lateral to the parietals and frontals, have in the ceratopsian skull pushed upward and inward above those bones, completely covering their dorsal aspect.

That the postfrontals were formerly separated is indicated in the Judith River and Belly River ceratopsians by the noncoalescence of their posterior borders, which in the later members of the Lance are always ankylosed. This brings up the question of the function of the "pineal fontanelle" of Marsh; the "postfrontal foramen" of Hatcher; the "postfrontal fontanelle" of Lull; the "supratemporal fossae" of Hay; and the "pseudopineal foramen" of Huene. All authorities, I think, are now agreed that it is not a pineal foramen and that it can not represent the combined supratemporal fossae as interpreted by Hay. The term "postfrontal foramen" is perhaps the most appropriate designation, for it is not, as suggested by Lull,[1] in any sense analogous to the fontanelle of human anatomy. Lull appears to

FIGURE 18.

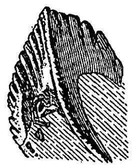


FIGURE 19.

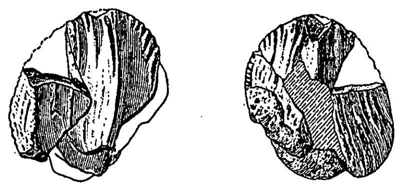




FIGURE 20.

FIGURE 18.—Third upper tooth of *Brachyceratops montanensis*. Type. No. 7951, U. S. N. M. Twice natural size. External view. Found in place in the right maxillary.

FIGURE 19.—Unworn lower tooth of *Brachyceratops montanensis*. Type. No. 7951, U. S. N. M. Twice natural size. Internal view. Found in place in the right dentary. (See *t*, fig. 17.)

FIGURE 20.—Detached tooth of *Brachyceratops montanensis*. No. 7951(?), U. S. N. M. Twice natural size. A, External view; B, internal view.

be right, however, in saying that this opening transmits neither nerves nor blood vessels. It is probably only an opening not yet roofed by bone; in other words, the coalescence of the postfrontals with the dermosupraoccipital, which commenced prior to Two Medicine time had not been perfected in Lance time except in an occasional individual.

*Measurements of the skull.*—The following measurements, actual and estimated, were obtained from the type specimen:

| | Millimeters. |
|---|---|
| Skull: | |
| Greatest length, about | 565 |
| Greatest breadth, estimated | 400 |
| Expanse of frontal region at base of brow horn cores | 90 |
| Greatest width of nasals | 58 |
| Length of interparietal along median line | 315 |
| Height of nasal horn core above border of narial orifice | 125 |
| Greatest width of postfrontals | 80 |
| Greatest length of combined postfrontals and prefrontals | 126 |
| Breadth between center of orbits | 130 |
| Postorbital horn cores at base: | |
| Anteroposterior diameter | 34 |
| Transverse diameter | 27 |
| Length of postorbital from front to back | 112 |
| Horizontal diameter of orbit | 57 |
| Nasal horn cores at base: | |
| Anteroposterior diameter | 90 |
| Transverse diameter | 41 |
| Height above nasal orifice | 127 |

[1] Lull, R. S., The Ceratopsia: U. S. Geol. Survey Mon. 49, p. 24, footnote, 1907.

#### THE VERTEBRAL COLUMN.

*General features.*—The vertebral column of *Brachyceratops* in front of the sacrum is known only from dissociated centra and neural processes, none of which were found in sequential position. Presumably, however, it consists as in *Triceratops* of 22 vertebrae, 8 in the neck and 14 in the thoracic region. The remainder of the vertebral column is known from specimen No. 7953 and comprises the sacrum and a complete articulated series of caudal vertebrae, the first complete tail of a ceratopsian dinosaur to be found. This material is supplemented by articulated portions of two other tails from the same fossil deposit. The vertebral formula may be tentatively given as C 8 ?, D 14 ?, S 6, C 50.

*Cervicals.*—The cervical region is represented in the collection by a single neural process (see fig. 21), which evidently pertained to one of the posterior cervicals and is complete except for the extremity of the spine. The arch is articulated with the centrum by heavy expanded pedicles. The neural canal is large. The diapophyses, which are heavy and extend outward horizontally from the side of the arch, are high up on the side of and somewhat anterior to the neural process. They are flattened anteroposteriorly but expanded dorsoventrally. The posterior zygapophyses would overhang the end of the centrum. The neural spine rises almost vertically and is much narrower fore and aft than any of the succeeding dorsals.

None of the detached centra can be attributed to the cervical region, for none show a capitular facet on the side for the articulation of the cervical rib. In *Triceratops* it is known from an articulated presacral series that this facet does not change its position on the centrum to the side of the arch until the third dorsal is reached. The process has a greatest transverse diameter of 88 millimeters.

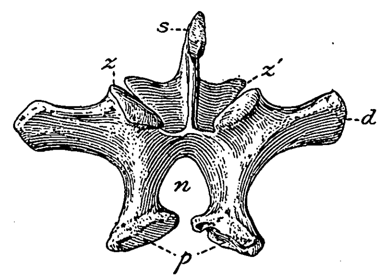



FIGURE 21.—Posterior cervical process of *Brachyceratops montanensis*. No. 7953(?), U. S. N. M. One-half natural size. Viewed from the front. *d*, Diapophysis; *n*, neural canal; *p*, surfaces that articulate with the centrum; *s*, spinous process; *z*, anterior zygapophysis; *z'*, posterior zygapophysis.

*Dorsals.*—The dorsal region is represented by 12 detached processes and an equal number of centra, from which processes representing the anterior, median, and posterior dorsal regions have been selected for illustration (figs. 22, 23, and 24). The centra shown in the illustrations have been arbitrarily placed, in so far as their relations with the associated dorsal processes are concerned, for none were found articulated. They at least give an idea of the shape and proportions of the centra.

Figure 22 shows front and side views of a vertebra regarded as belonging to the anterior dorsal region. Probably it was the fourth or fifth vertebra, for, as will be observed, the paraphophysis on the side of the arch is at the base of the transverse process and is a little removed toward the diapophysis, a condition observed on the fifth dorsal of *Triceratops*. As in *Monoclonius*, *Agathaumas*, and more especially *Triceratops*, the transverse processes incline upward 45° from the horizontal. (See fig. 22.) The transverse processes are long with a beveled articular end for the tuberculum of the rib. The spine is thin transversely, with a backward inclination, its upper extremity only slightly exceeding in height the transverse processes when viewed laterally. The top appears to be without transverse thickening and is somewhat pointed, as in the anterior dorsals of the type specimen of *Triceratops calicornis* Marsh. The centrum provisionally associated with this neural process, when viewed from the front, is seen to have the typical pear-shaped outline of other ceratopsian dorsal centra. The diameter anteroposteriorly appears to be relatively the same as in *Triceratops*, and as in that genus the articular ends are shallowly biconcave. As compared with the cervical process the neural canal is very small. The anterior and posterior zygapophyses are sharply inclined and extend well beyond the center of the vertebra. This vertebra has a greatest transverse width of 100 millimeters; greatest height of 130 millimeters; length of centrum 32 millimeters; height of centrum at center 41 millimeters.

The median dorsal (see fig. 23) shows a higher position of the parapophysis on the inferior side of the transverse process and a broader spinous process with a slight transverse thickening at its upper extremity. The transverse processes are shorter and not so sharply inclined upward from the horizontal. They are also compressed dorsoventrally and are wider anteroposteriorly than in the more anterior dorsals. The zygapophyses are also not so highly inclined. All these changes are approximated in the *Triceratops* backbone. The greatest transverse width of this vertebra is 99 millimeters; greatest height 132 millimeters; length of centrum 32 millimeters; height of centrum at center 40 millimeters.

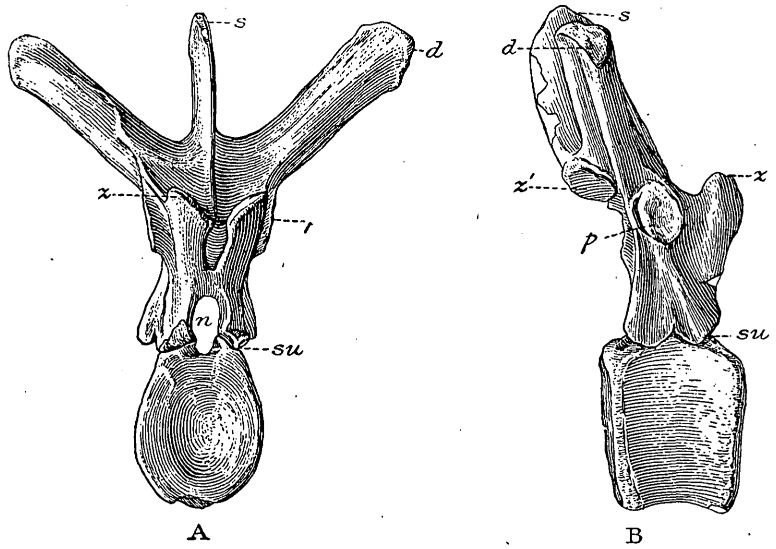



FIGURE 22.—Anterior dorsal vertebra of *Brachyceratops montanensis*. No. 7953(?), U. S. N. M. One-half natural size. A, Front view; B, side view. *d*, Diapophysis; *n*, neural canal; *p*, parapophysis; *s*, spinous process; *su*, suture between centrum and process; *z*, anterior zygapophysis; *z'*, posterior zygapophysis.

The position in the vertebral column of the posterior dorsal (see fig. 24) may at once be recognized by the horizontal plane of the anterior and posterior zygapophyses, by the broader and shorter spine, and by the shorter, weaker, and more depressed transverse process. Moreover, the parapophysis is well out on the lower side of the transverse process toward the diapophysial articular surface for the rib. The incisions for the prezygapophyses and postzygapophyses are much deeper than in the preceding dorsals. The greatest transverse width of this vertebra is 95 millimeters; greatest height 100 millimeters; greatest length of centrum 32 millimeters; greatest height of centrum at center 35 millimeters.

The sutural surfaces of the centra (see fig. 25) nearly all agree in having two lateral pits separated by a short median transverse ridge.

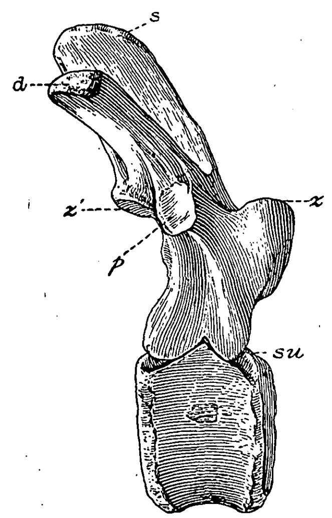



FIGURE 23.

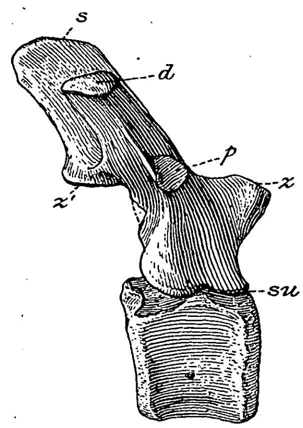



FIGURE 24.

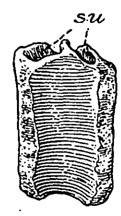
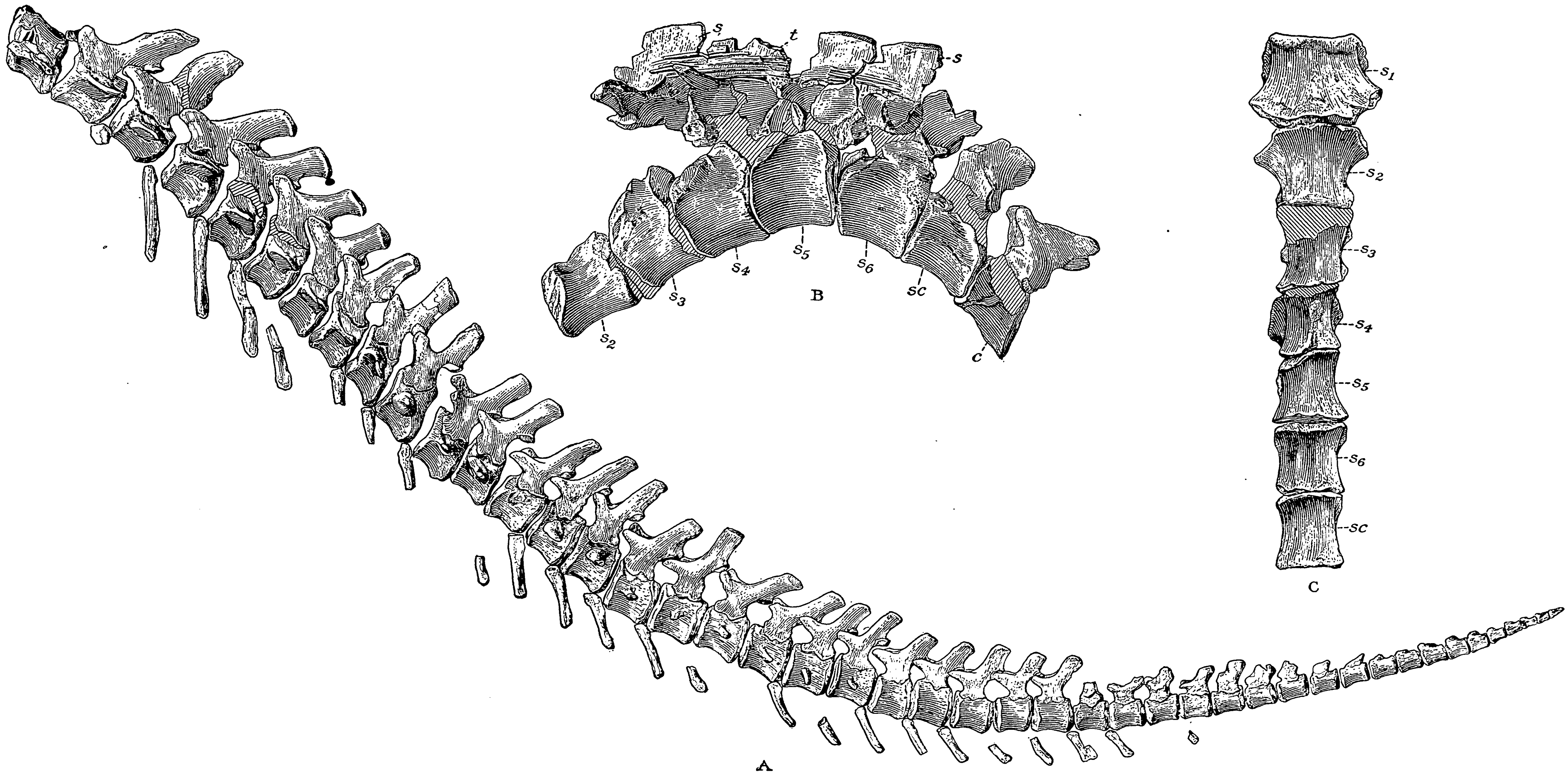



FIGURE 25.

FIGURE 23.—Median dorsal vertebra of *Brachyceratops montanensis*. No. 7953(?), U. S. N. M. One-half natural size. Lateral view. *d*, Diapophysis; *p*, parapophysis; *s*, spinous process; *su*, suture between centrum and process; *z*, anterior zygapophysis; *z'*, posterior zygapophysis.
FIGURE 24.—Posterior dorsal vertebra of *Brachyceratops montanensis*. No. 7953(?), U. S. N. M. One-half natural size. Lateral view. *d*, Diapophysis; *p*, parapophysis; *s*, spinous process; *su*, suture between centrum and process; *z*, anterior zygapophysis; *z'*, posterior zygapophysis.
FIGURE 25.—Centrum of dorsal vertebra of *Brachyceratops montanensis*. No. 7953(?), U. S. N. M. One-half natural size. Lateral view. *su*, Suture for the spinous process.

The last or sacrodorsal is represented only by the centrum in No. 7953. Though found detached from the first sacral of that specimen, it was in close association with it in the matrix and in an adult individual would undoubtedly have been firmly coossified with the sacral as indicated by the sutural surface of its posterior end. The centrum is slightly longer and more massive than any of the centra attributed to the dorsal region. A measurement taken at the




BONES OF BRACHYCERATOPS MONTANENSIS.

Paratype, No. 7953, U. S. National Museum. One-half natural size. A, Articulated caudal vertebrae, lateral view. B, Sacrum, lateral view; *c*, second caudal vertebra; *s*, spinous processes; $s_2$ to $s_6$, sacrals 2 to 6; *sc*, sacrocaudal; *t*, ossified tendons. C, Sacral vertebrae, ventral view; $s_1$ to $s_6$, sacrals 1 to 6; *sc*, sacrocaudal.

end shows it to be wider than high. The lateral surfaces are flattened in a vertical direction, and the ventral surfaces are broadly flattened with two shallow longitudinal grooves. A heavy articular facet on the posterior external angle contributes to the support of the first sacral rib. The greatest length of centrum is 35 millimeters; and the greatest height, taken at the center, is 31 millimeters.

*Sacrum.*—The sacrum in the paratype, No. 7953, is represented by all the centra, portions of the neural processes of the posterior vertebrae, and numerous detached sacral ribs. (See Pl. III, *B*, *C*; text fig. 26.) These parts have been compressed, but taken all in all give a fairly

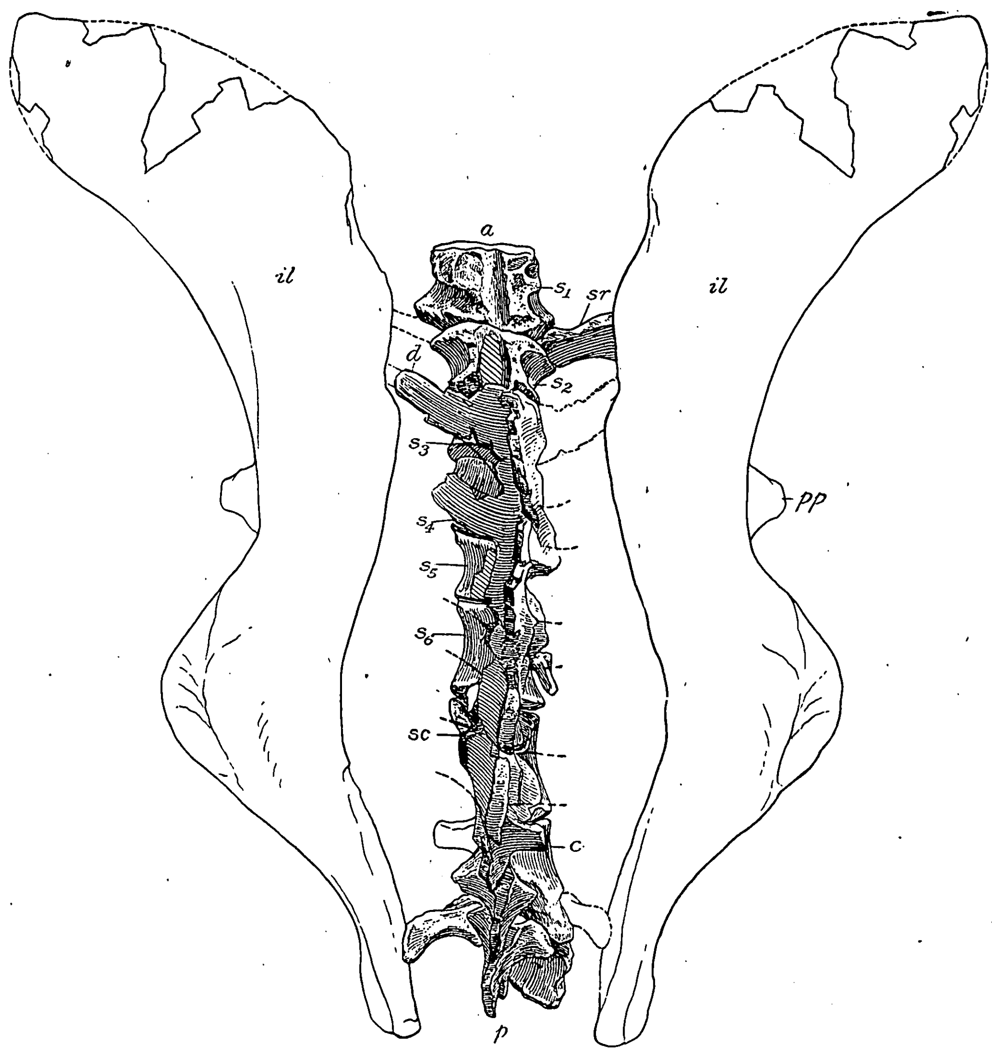



FIGURE 26.—Sacrum of *Brachyceratops montanensis* with ilia in position. Paratype. No. 7953, U. S. N. M. One-fourth natural size. Superior view. *a*, Anterior end; *d*, diapophysis; *il*, ilium; *p*, posterior end; *pp*, pubic peduncle; $s_1, s_2, s_3, s_4, s_5, s_6$, sacral vertebrae Nos. 1 to 6; *sc*, sacrocaudals; *sr*, sacral ribs.

good idea of the chief characteristics of the sacrum in *Brachyceratops*. The centra are all suturally united and in an adult individual would doubtless be firmly coossified, as in other ceratopsians. The paratype has nine articulated centra, of which the anterior six are regarded as true sacrals and the posterior two as true caudals. The remaining intermediate vertebra between tail and sacrum constitutes a modified caudal that functions to a certain extent as a sacral and can therefore be designated a sacroc udal (*sc*, fig. 26).

The sacrum of the paratype, including the sacrodorsal and the sacrocaudal, had eight centra with sutured articular ends. whereas *Monoclonius* and *Triceratops* had ten such vertebrae.

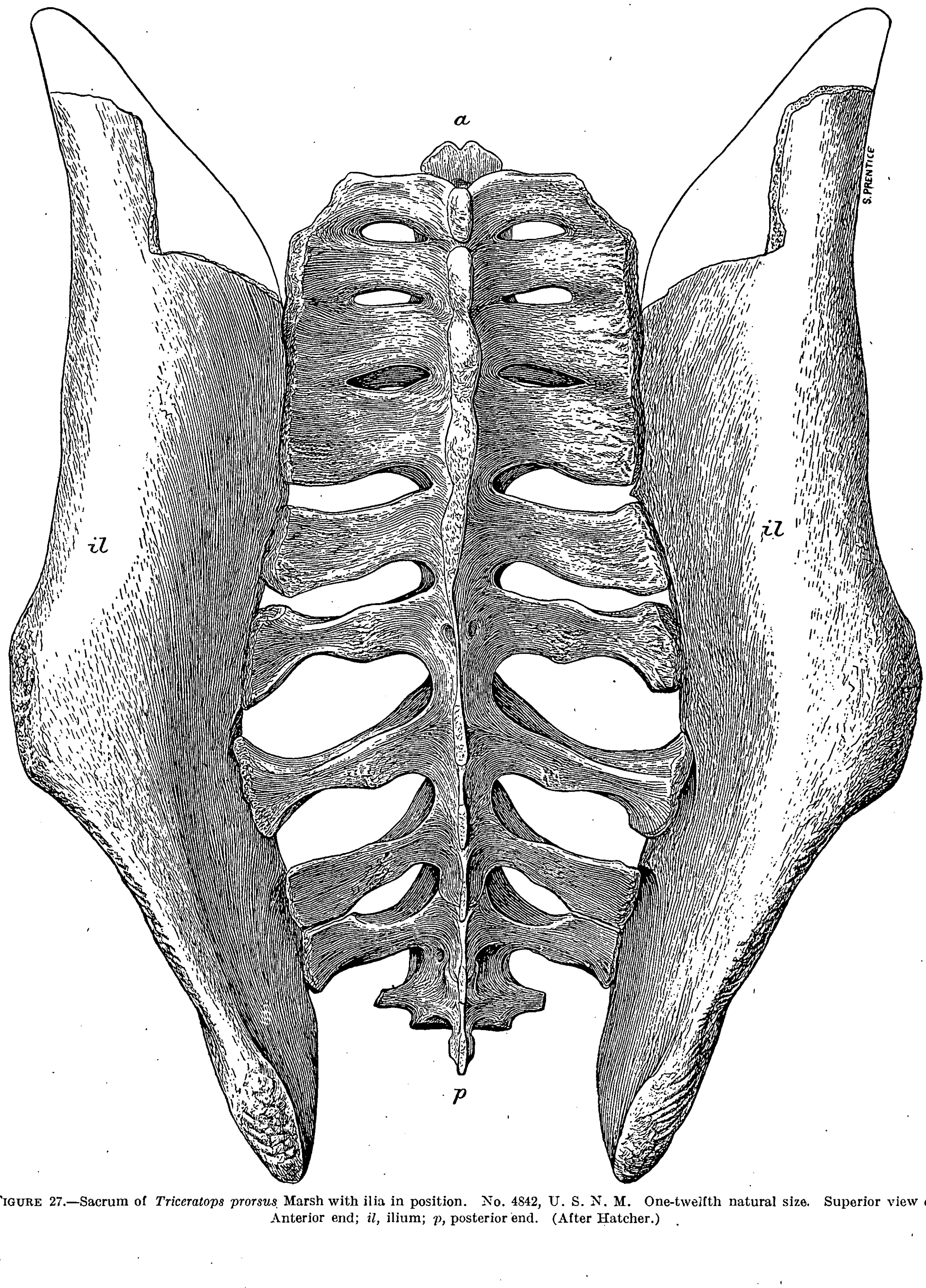



FIGURE 27.—Sacrum of *Triceratops prorsus* Marsh with ilia in position. No. 4842, U. S. N. M. One-twelfth natural size. Superior view *a*, Anterior end; *il*, ilium; *p*, posterior end. (After Hatcher.)

This, however, may not constitute a constant difference between these genera, for it is quite possible that in some specimens of *Brachyceratops* one or more caudals have acquired such an articulation, thus bringing the total number up to 10, as in known ceratopsian sacra.

The first sacral may be recognized at once by the great transverse breadth of the centrum, its flattened ventral surface, and the inferior position of the posterior articular facets for the second sacral rib ($s_1$, Pl. III, *C*). The second sacral centrum is also distinguished from all others by the much greater breadth of the anterior as compared with the posterior extremity. The centra of the remaining sacrals are of about equal dimensions, higher than wide, constricted medially, with slightly flattened inferior surfaces.

A second specimen (No. 8072, U. S. N. M.), however, shows centra that are broader than high and that have a shallow longitudinal depression on their inferior surfaces. The differences are in all probability due to crushing. The first three vertebrae of the sacral region, which include the sacrodorsal, are decidedly heavier than any that succeed them. The sacral ribs are borne jointly by all the centra. The first rib joins the centra by well-developed facets on the superior, posterior, external angle of the dorsosacral and on the superior, anterior, external angle of the first sacral. The second and strongest sacral rib of the series articulates jointly with the first and second dorsals low down on the sides of the centra, the inferior surface of the rib being on a level with the ventral surface of the sacrals. (See Pl. III, *C*.) The succeeding ribs articulate with facets that are but little below the level of the floor of the neural canal.

Longitudinally the sacrum is strongly arched (see Pl. III, *B*), though in all probability this arching has been much exaggerated in this specimen by post-mortem causes.

The few spinous processes are exceedingly short thin plates of bone with little transverse thickening of their superior extremities. That these were united into a bony plate is indicated by a detached sacral process belonging to another individual (No. 8072, U. S. N. M.), which shows sutural edges fore and aft that continue to the top of the spine. The same condition prevails on the spine of the fifth sacral (see Pl. III, *B*), so it would appear that this plate may have been continuous from the first to the fifth, much as it is in *Triceratops*. The relative shortness of the spines in *Brachyceratops* would at once distinguish its sacrum from that of the former genus.

As in *Triceratops* the spinal cord appears to have been only slightly enlarged in the anterior sacral region. The diapophyses are comparatively weak and are given off on a horizontal plane from the neural arches, with thin ends directed forward. (See fig. 26.) Their inferior borders extend obliquely downward and inward and present a narrow sutural edge for articulation with the upper and inner borders of the sacral ribs, which they overlap superiorly. Nearly all the transverse processes are missing, but their point of origin, as shown by the broken surfaces, is indicated in figure 26 by parallel dotted lines.

Though many sacral ribs were found none were articulated and a description of them would add little to the positive knowledge of the structure of the sacrum.

*Measurements, in millimeters, of centra of sacral vertebrae.*

| | I | II | III | IV | V | VI |
|---|---|---|---|---|---|---|
| Greatest length | 36 | 35 | 32 | 29 | 30 | 30 |
| Greatest transverse diameter: | | | | | | |
| Anterior end | 39 | 47 | ........ | 25 | 24 | 28 |
| Posterior end | 58 | 33 | 32 | 23 | 28 | 28 |

*Caudal vertebrae.*—For the first time since the discovery of ceratopsian dinosaurs a complete caudal series of 50 vertebrae (paratype No. 7953) is available for study.

The greater number were found articulated, and such displacement as existed was so slight that there can be no question that they represent a consecutive series. Forty-six of them are represented in Plate III, *A*, the remaining four being attached by the matrix to the sacrum. (See Pl. IV.)

The centrum of the first or sacrocaudal (*sc*, Pl. III, *C*) is longer than wide and has an articular facet on its superoantero lateral angle for the articulation of the last sacral rib. The neural arch, although poorly preserved, indicates that the spine was distinct from the spines forward of it. It had a decidedly backward inclination. The anterior and posterior zygapophyses are also differentiated, not coalesced, as in all preceding sacral vertebrae. The diapophyses on the first and second caudals are given off from the sides of the arch well below the zygapophyses but above the neurocentral suture, but that on the fourth caudal is below that suture. The centrum of the third caudal is so badly crushed that it gives a poor idea of its proportions. The arch, however, shows the spine to be narrower, anteroposteriorly, than it is in the first and second caudals, and the diapophysis is somewhat lower on the side of the arch than it is in the first caudal.

The third and fourth caudals are represented by the centra only, which, like all that follow, are short and have slightly biconcave ends and a transverse width that usually exceeds both the longitudinal and the vertical diameters.

Transverse processes are present on the first 25 vertebrae. The anterior ones, except possibly the first two or three, are long and flattened and have heavy expanded articular ends that unite about equally with the centrum and the pedicles of the arch. (See fig. 28.) These

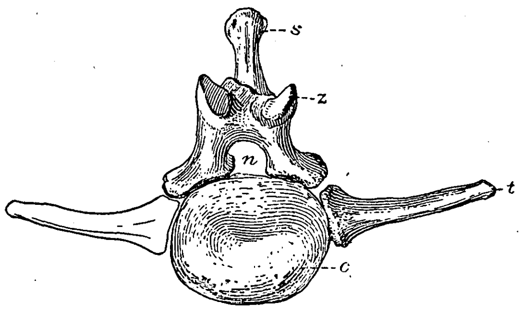



FIGURE 28.

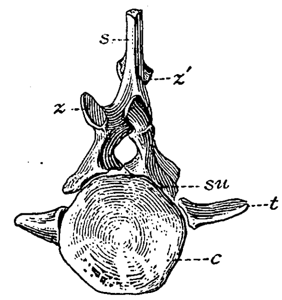



FIGURE 29.

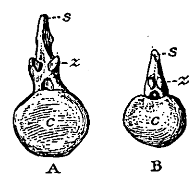



FIGURE 30.

FIGURE 28.—Anterior caudal vertebra (eighth) of *Brachyceratops montanensis*. Paratype., No. 7953, U. S. N. M. One-half natural size. Front view. *c*, Centrum; *n*, neural canal; *s*, spine; *t*, transverse process; *z*, anterior zygapophysis.

FIGURE 29.—Median caudal vertebra of *Brachyceratops montanensis*. Paratype. No. 7953, U. S. N. M. One-half natural size. Front view. *c*, Centrum; *s*, neural spine; *su*, neurocentral suture; *t*, transverse process; *z*, anterior zygapophysis; *z'*, posterior zygapophysis.

FIGURE 30.—Distal caudal vertebrae of *Brachyceratops montanensis*. Paratype. No. 7953, U. S. N. M. One-half natural size. Front view. A, Twenty-third; B, twenty-sixth. *c*, Centrum; *s*, spine; *z*, anterior zygapophysis.

gradually shorten posteriorly. In the twentieth centrum the transverse is united entirely with the centrum and all trace of sutural articulation is obliterated, though in the nineteenth it is visible and slightly in contact with the pedicle of the arch.

The neural arches throughout the caudal region are low. The short compressed spines of the anterior caudals with transversely expanded upper extremities (see Pl. III, *A*) gradually narrow and become smaller and in the midcaudal region show no thickening of their upper ends. (See fig. 29.)

The anterior zygapophyses are finger-like and extend forward with articular faces that face upward and inward. (See fig. 28.) The posterior zygapophyses are well up on the posterior border of the spine and overhang the ends of the centra. Functional zygapophyses persist down onto the distal fourth of the tail. In the distal caudals (fig. 30) the neural processes are present on the second to the last, but are without spines; also the processes, instead of occupying the middle of the centrum, have shifted their position forward toward the anterior end, as in *Stegosaurus*. These most distal caudals also have convex distal extremities and concave proximal articular ends and are without chevron facets. The anterior caudals as far back as the thirty-ninth caudal from the sacrum have oblique chevron facets on the posterior ends of the centra and may have had them nearly to the tip of the tail, as in *Stegosaurus*. The tip of the tail is composed of three coossified centra, the final one being hardly more than a short, rounded obtusely pointed ossicle.

THE RIBS.

*Brachyceratops*, like other members of the Ceratopsia, doubtless had cervical ribs, but none of them have been preserved. A considerable number of thoracic ribs, however, have been found and serve to illustrate the various modifications in the dorsal region. (See fig. 31.) All are double headed. The more anterior dorsal ribs are distinguished by the straightness of their shafts and the elevation of the tuberculum above the capitular process, which is given off

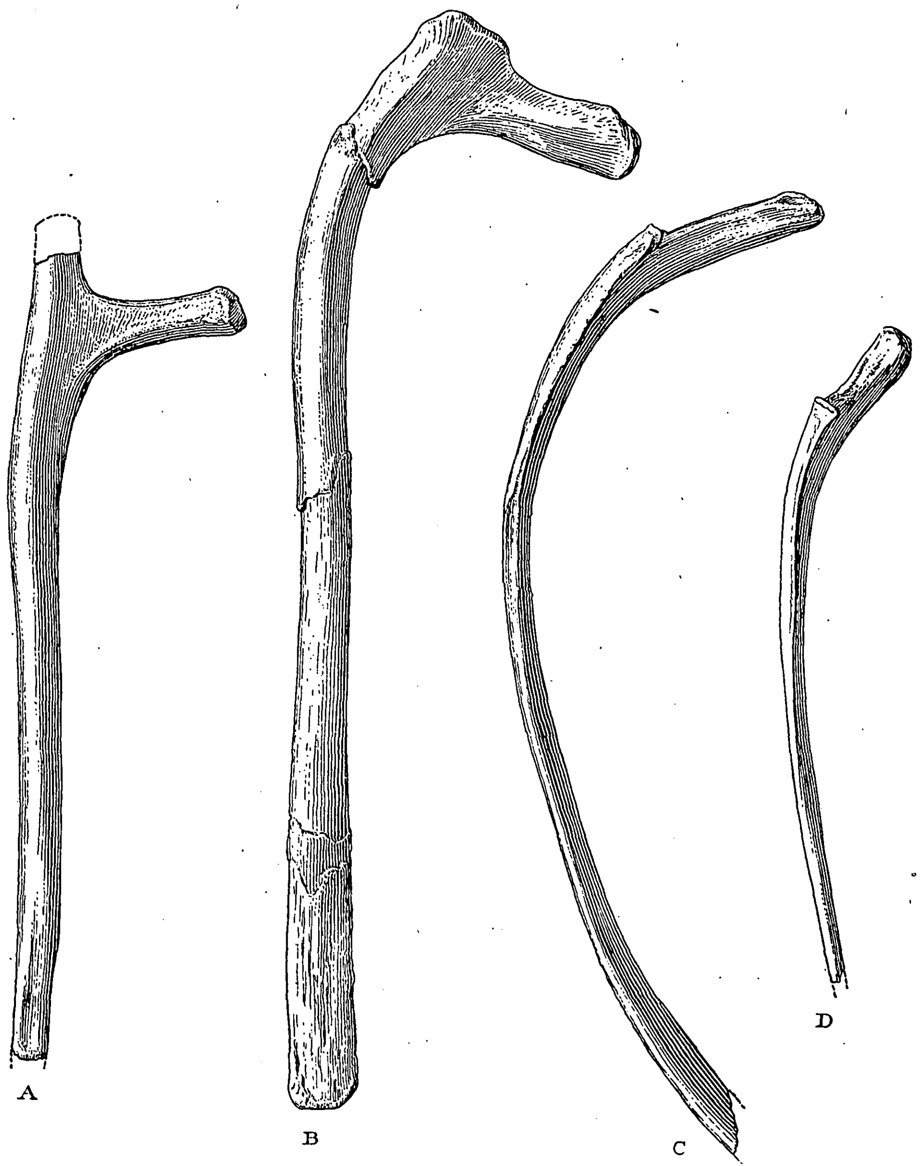



FIGURE 31.—Dorsal ribs of *Brachyceratops montanensis*. No. 7953(?), U. S. N. M. A, Second dorsal rib from the right side; B, anterior dorsal rib; C, median dorsal rib; D, posterior dorsal rib. All one-half natural size.

at nearly right angles to the shaft, which is subcylindrical in cross section. A good example of what is regarded as a second dorsal rib from the right side is shown in figure 31, A, and is succeeded by the type shown in figure 31, B. These two are the longest of the series, having a more arched upper extremity which throws the capitular process downward at more than a right angle to the longer axis of the shaft, thus forming a flattened lank body cavity like that in *Stegosaurus* and *Diplodocus*. The shaft of these ribs is flattened, of fairly uniform width, and has a truncated distal extremity that shows no thickening. The median ribs (see fig. 31, C) are more curved from end to end, with an upward inclination of the capitular process and a reduced tubercular facet. The posterior ribs (see fig. 31, D) are slenderer and straighter, with a capitular process but little angulated in relation to the shaft. The capitulum and tuberculum are not so far removed from one another as in more anterior ribs, this being due to the shifting of the facets on the dorsal vertebrae. In figure 32 is shown a small curved bone that is doubtfully regarded as representing the last dorsal rib. It has a single cupped articular face (*a*, fig. 32) on its proximal extremity, and if correctly identified it probably curved down from the diapophysis on the inside of the ilium, with which it was doubtless in contact, as in *Stegosaurus*, *Thescelosaurus*, and presumably many other dinosaurs.

#### THE CHEVRONS.

No. 7953 includes chevrons from the anterior, middle, and posterior parts of the tail. In the anterior portion they are longer than the spines of the vertebrae with which they articulate, but posteriorly they appear to reduce more rapidly than the spinous processes. Throughout the series they have the usual Y shape, though a few of the anterior ones have the articular ends in contact on the median line, thus bridging the cleft between the branches. More posteriorly, however, all have these ends separate.

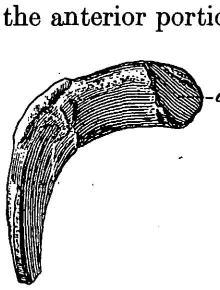



FIGURE 32.

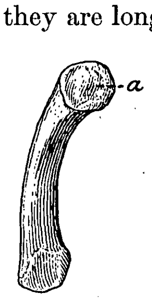



FIGURE 33.

FIGURE 32.—Posterior dorsal rib of *Brachyceratops montanensis*. No. 7953(?), U. S. N. M. One-half natural size. Posterior view. *a*, Articulating face.

FIGURE 33.—Chevron of *Brachyceratops montanensis*. Paratype. No. 7953, U. S. N. M. Three-fourths natural size. *a*, Articulating face.

The great length of the upper branches as compared with the extremely short ones of the distal portion serves to distinguish the chevrons of *Brachyceratops* from those of other described dinosaurs. The articulating facets are confined to the posterior face, though they look somewhat upward in the anterior caudal region, but in the median and distal portions of the tail they are more on the proximal face. The free end is bluntly truncated throughout the series. The shaft is rounded in the anterior members and is somewhat flattened transversely in the median and posterior chevrons. All are unusually straight and none have expanded free ends. An anterior chevron measures 44 millimeters in length.

A number of small bones found in the matrix surrounding the anterior portion of the tail of No. 7953 have a flattened, rounded articular facet very similar to those of the anterior chevrons, the opposite end being slightly expanded in the same plane. (See fig. 33.) The shaft is also greatly curved from end to end. It was at first thought these might be caudal ribs, but the absence of articular ends on the transverse processes (the true caudal ribs in this specimen) does not adapt itself to this explanation, and the only alternative that suggests itself is that they are chevron bones, the two branches being separate at their free extremities. Such a condition is unknown in any reptile living or extinct, and it is quite probable that this explanation is incorrect.

#### OSSIFIED TENDONS.

Ossified tendons (*t*, Pl. III, *B*) were found attached by matrix along both sides of the neural spines of the sacrum in the paratype No. 7953. That these ossifications were also present on the anterior portions of the tail is indicated by a few fragments still attached to the vertebrae by matrix. Numerous fragments of these tendons were found in the soft matrix immediately surrounding the tail, and doubtless they also extended forward along the dorsal region, as in *Triceratops*. They are slender, rounded, rodlike ossifications, averaging about 2 millimeters in diameter.

#### THE SHOULDER GIRDLE AND FORE LIMB.

*Scapula*.—The complete scapula of *Brachyceratops* is as yet unknown, but fragmentary portions of two bones of paratype No. 7958 supplement one another sufficiently to give a very accurate conception of its general shape and proportions. (See fig. 34.)

The scapula is long and narrow and is somewhat bent longitudinally to better conform to the curve of the thoracic cavity. The articular end is heavy and has a cupped surface (*g*, fig.

34) for the articulation of the humerus. The thinner upper portion of this end is missing. The verti al breadth of the shaft decreases to its mid length and again gradually expands to the square y cut-off upper extremity. The lower border on the proximal half is broadly rounded

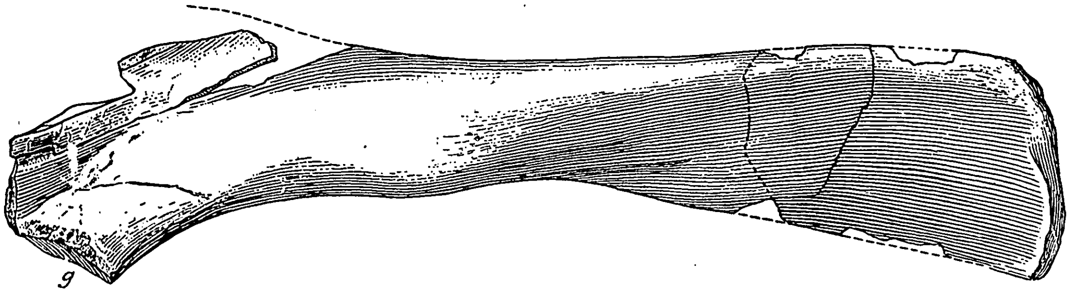



FIGURE 34.—Left scapula of *Brachyceratops montanensis*. No. 7958, U. S. N. M. One-half natural size. External view. *g*, Glenoid cavity. The drawing is a composite made from two bones, their overlap being indicated by the dotted line.

but gradually thins toward the upper end to a sharp edge. The upper end is without transverse thickening. A heavy rounded ridge extends upward on the outer surface diagonally from the posterior border of the glenoid cavity to the upper anterior border, whence it continues backward as a thickening of this margin. In general proportions and outline the scapula of *Brachyceratops*, although less than half the size, very closely resembles the scapula of *Monoclonius dawsoni* as described and figured by Lambe.[1] It is to be distinguished from the scapula of *Triceratops* as figured by Hatcher [2] by its lack of an upward expansion of the anterior upper border of the blade and by the less prominent development and more diagonal direction of the ridge on the external surface.

At present the coracoid and humerus are unknown.

*Ulna.*—The ulna is, of course, very much smaller than in *Triceratops* but is otherwise similar, being heavy above and but little expanded on the distal end. The olecranon process is massive and is produced far above the main articulating surface for the humerus. The shaft is much flattened anteroposteriorly, its posterior side being shallowly concave transversely throughout the greater part of its length. The anterior face of the distal portion is broadly rounded transversely but, more proximally, changes to a decided concave surface for the reception of the rounded head of the radius. The distal articular end is smooth and extends considerably upward on the posterior side and is not visible from the front. (See fig. 35.)

The outline of the olecranon was drawn from a second specimen, and its shape is correct. The greatest length of the left ulna (see fig. 35) is estimated at about 213 millimeters.

*Radius.*—The radius is more slender than the ulna and has expanded ends, of which the distal is the heavier. The proximal end is angularly rounded and has a shallow cupped articular surface. The shaft in cross section near its middle is oval. The distal end is expanded transversely but is somewhat compressed anteroposteriorly. A complete radius is not known, but proximal and distal portions of it are shown in figure 36.

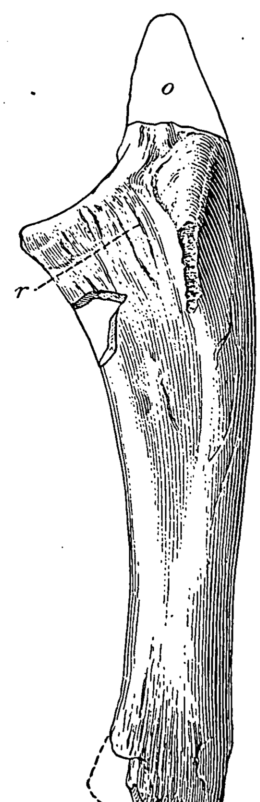



FIGURE 35.—Left ulna of *Brachyceratops montanensis*. No. 8076, U. S. N. M. One-half natural size. Anterior view. *o*, Olecranon process; *r*, concavity for proximal end of radius. Olecranon restored from the ulna of a second individual.

*Fore foot.*—Nothing is known of the structure of the carpus and but little of the metacarpus. Figure 37 shows all the bones in the collection from Montana that are regarded as pertaining to the fore foot of *Brachyceratops*.

[1] Lambe, L. M., On Vertebrata of the mid-Cretaceous of the Northwest Territory: Contr. Canadian Paleontology, vol. 3, pt. 2, p. 60, pl. 19, fig. 4, 1902.

[2] Hatcher, J. B., The Ceratopsia: U. S. Geol. Survey Mon. 49, p. 78, fig. 84, 1907.

The metacarpus is represented by one fragmentary and two complete metacarpals (*a, b, c,* fig. 37), but nothing is positively known of the positions they occupied in the foot.[1] The phalanges (*d, e, f, g, h,* fig. 37) are depressed rectangular elements. It was on account of their thin depressed nature that they were assigned to the manus, for otherwise they appear indistinguishable from the phalanges of the pes. Similarly, the ungual phalanx (*i,* fig. 37) is assigned to the fore foot, being elongated and more sharply pointed than the shorter, more broadly rounded unguals associated with the partly articulated hind feet. (See figs. 46, 47, pp. 34, 35.)

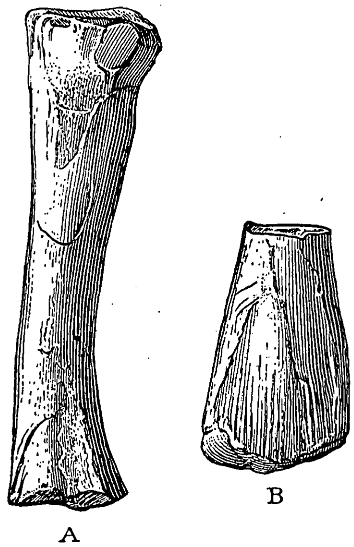



FIGURE 36.—Proximal and distal portions of the radius of *Brachyceratops montanensis.* Nos. 8077 and 8078, U. S. N. M. One-half natural size. A, Proximal portion; B, distal portion.

#### THE PELVIC GIRDLE AND HIND LIMB.

*Ilium.*—The ilium is an elongate, irregularly shaped bone, consisting of a comparatively thin, horizontal, expanded anterior part and a nearly vertical but narrower posterior part. (See figs. 38 and 39.) The inner and outer borders of the dorsal face (see fig. 26, p. 21) each describe a sigmoid curve. The transversely expanded anterior plate of the ilium has a convex dorsal and a concave ventral surface. The external border is not continuous from end to end, as in the ilium of *Triceratops* and *Monoclonius* (compare figs. 39 and 40), but extends backward and downward from the anterior portion and fades out on the external side above the pubic peduncle. Above and somewhat forward of this termination a second rounded border arises from the outer side of the convex superior surface of the anterior plate of the ilium and continues posteriorly, completing the outer border of the middle section and the upper border of the posterior portion.

In contrast with the ilia of *Monoclonius, Agathaumas,* and *Triceratops* (compare figs. 39 and 40), the ilium of *Brachyceratops* is not only much smaller, but the transverse expansion of its anterior plate, its greater inclination outward, and the differentiation of the thickened deflected border above the ischiac peduncle all distinguish it from the other described forms. In the development of this heavy deflected process above the ischiac articulation and in being longer than the femur it somewhat resembles the *Stegosaurus* ilium. (Compare figs. 26 and 27, pp. 21 and 22.)

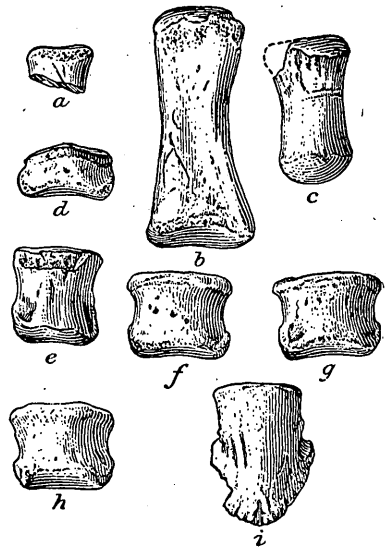



FIGURE 37.—Bones provisionally identified as pertaining to the fore foot of *Brachyceratops montanensis.* No. 8079, U. S. N. M. Superior view. *a, b, c,* Metacarpals; *d, e, f, g, h,* phalanges; *i,* ungual phalanx.

Near the middle the internal border is greatly thickened dorsoventrally and is produced downward to form the superior border of the acetabulum and the pubic and ischiac peduncles. The anterior peduncle is rather slender, but the posterior one is exceedingly heavy in all dimensions, as shown in figures 38 and 39. The posterior plate, when the ilium is in a vertical position, has its superior border inclined slightly outward from the perpendicular. In *Brachyceratops* this upper border is relatively thin, its posterior end is cut off obliquely and its inferior border is concave from end to end; whereas in *Triceratops* it is much thickened, its posterior end is bluntly rounded, and its inferior border is slightly convex from end to end. On the internal side the usual cupped articulating surfaces for the diapophyses and sacral and caudal ribs appear.

[1] For convenience in reference these foot bones are catalogued under one number. This does not imply that they belonged to one individual, for they were found among the scattered surface fragments.

The measurements of the left ilium of paratype No. 7953 are as follows:

| | Millimeters. |
|---|---|
| Greatest length of ilium | 362 |
| Greatest width of anterior blade | 65 |
| Greatest width at center, transversely | 39 |
| Greatest depth of posterior blade | 37 |
| Greatest depth at center of acetabulum | 51 |
| Greatest width across deflected external process | 56 |

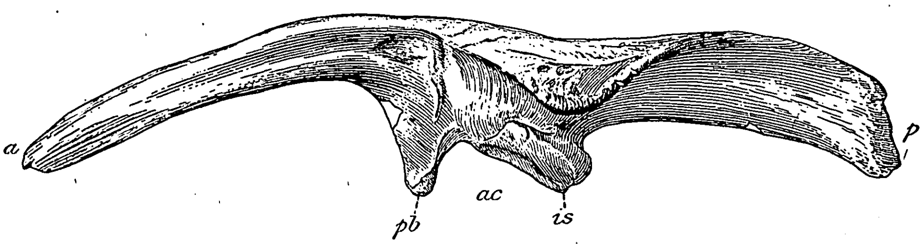



FIGURE 38.—Left ilium of *Brachyceratops montanensis*. No. 7953, U. S. N. M. One-third natural size. External view. *a*, Anterior end; *ac*, acetabulum; *is*, ischiac peduncle; *p*, posterior end; *pb*, pubic peduncle.

*Pubis.*—The pubis in *Brachyceratops* consists of an elongated, transversely flattened plate of bone, a prepubic portion, and a short, slender, curved, somewhat rudimentary posterior postpubis. The anterior portion is expanded dorsoventrally into a broadly rounded end but is little thickened transversely. The rugose articulating surface for the peduncle of the ilium is relatively not so heavy as in *Triceratops*, but the broad posteriorly directed process forming the internal wall of the acetabulum is as well developed as in that genus and contributes to the same extent to the formation of the inner boundary of the acetabulum. In none of the

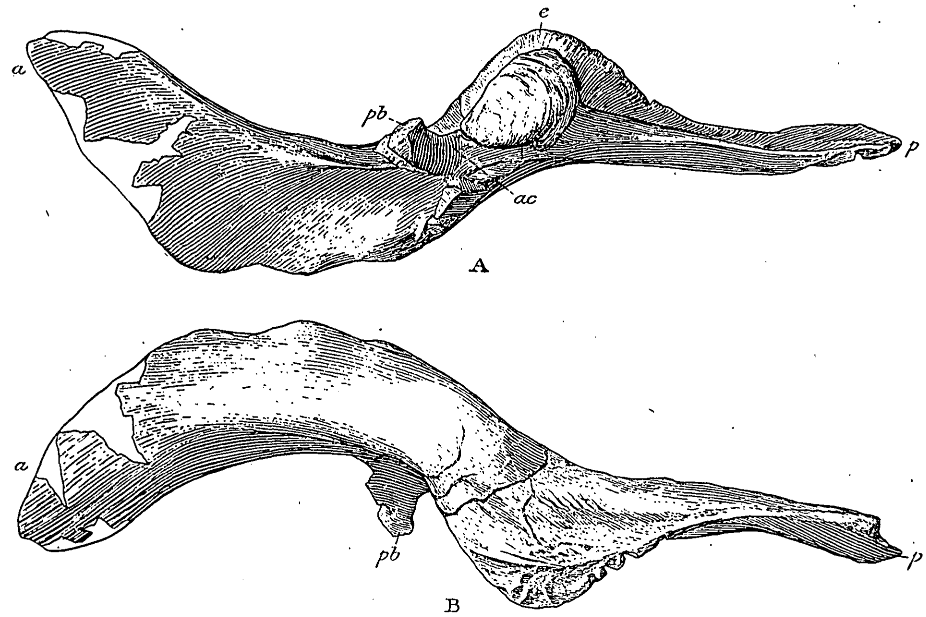



FIGURE 39.—Left ilium of *Brachyceratops montanensis*. No. 7953, U. S. N. M. One-third natural size. A, Ventral view; B, oblique dorsal view. *a*, Anterior end; *ac*, acetabulum; *c*, overhanging crest; *p*, posterior end; *pb*, pubic peduncle.

pubes before me is the postpubis entire, all specimens lacking portions of their distal ends; their extension posteriorly appears to be about the same as in *Triceratops*. There is no distinct pubic foramen, but an elongated cleft between the postpubis and the flattened posterior end of the prepubis probably functioned as such. The greatest length of the left pubis of No. 7953 is 192 millimeters. The chief characteristics of this bone are well shown in figure 41.

*Ischium.*—In the collection from Montana there are portions of no less than nine ischia of *Brachyceratops*, but only one of them is complete. (See fig. 42.) It is a long, slender curved bone with an expanded proximal extremity, carrying a heavy articulation for the ischiac peduncle of the ilium and sending forward and upward a process which articulates at its extremity with the pubis. The articulated ischia curve toward the median line and were probably united by cartilage for a short space near their distal extremities. The shaft is subcircular throughout the median part of its length but becomes somewhat triangular toward its reduced distal end. The right ischium, shown in figure 42 (No. 8073, U. S. N. M.), has a greatest length of 340 millimeters.

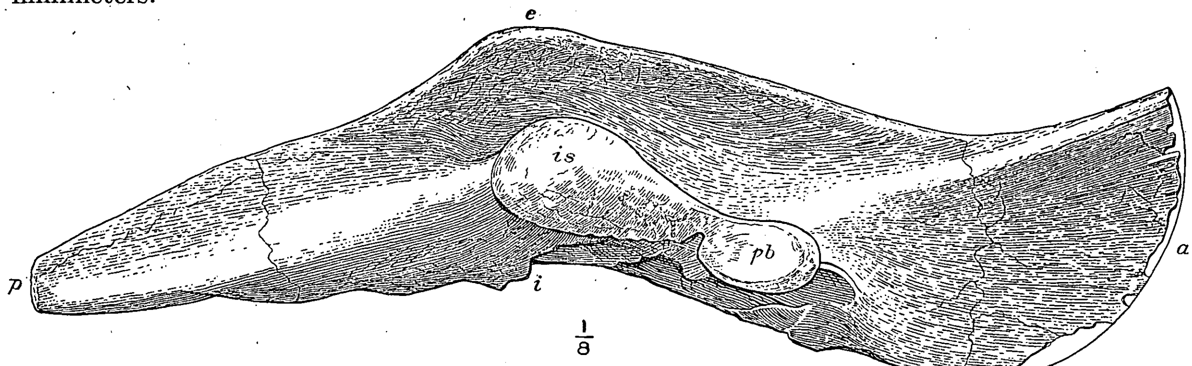



FIGURE 40.—Right ilium of *Triceratops flabellatus* Marsh. No. 1821, Yale Museum. One-eighth natural size. Inferior view. *a*, Anterior end; *e*, external border; *i*, internal border; *is*, ischiac peduncle; *p*, posterior end; *pb*, pubic peduncle. (After Hatcher.)

*Femur.*—The femur is represented in the collection by one complete bone and good-sized portions of four others. All are the same size and differ only in minor details, which may be entirely attributed to post-mortem causes.

In *Brachyceratops* the femur is slightly more than one-fourth as long again as the tibia and in *Triceratops* it is half as long again. In other words, in *Brachyceratops* the ratio of length of the tibia to the femur is 1 to 1.28, and in *Triceratops* it is 1 to 1.59. Proximally the head is differentiated from the shaft and the greater trochanter by a short neck that is less well defined than that found in the femur of *Triceratops* and that much more closely resembles the same bone in *Monoclonius crassus* Cope. Viewed from above the head is subglobular in outline, with a rounded notch or groove on the external posterior border. The great trochanter (*b*, fig. 43) is expanded anteroposteriorly. On the anterior external angle and separated from the great trochanter by a deep cleft is a flattened finger-like lesser trochanter (*a*, fig. 43), which rises nearly to the height of the greater trochanter. This process is also present in *Triceratops* but is shorter and broader and is about equally prominent externally and anteriorly, whereas in *Brachyceratops* it is more prominent externally. Though doubtless preserved in *Monoclonius* this process is not shown in the figures of that bone by Hatcher.

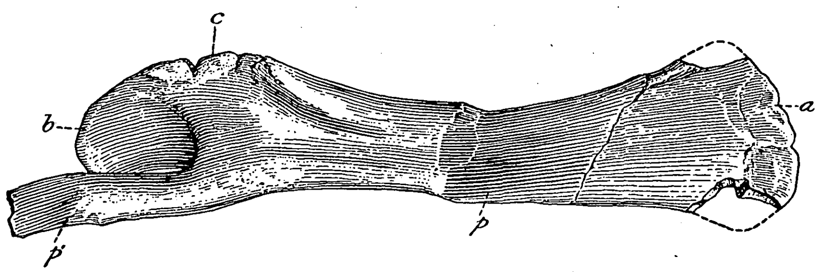



FIGURE 41.—Left pubis of *Brachyceratops montanensis*. No. 7953, U. S. N. M. One-half natural size. Internal view. *a*, Anterior end; *b*, posterior end; *c*, articulating surface for pubic peduncle; *p*, prepubic portion; *p'*, postpubic portion.

An elongated fourth trochanter rests wholly on the proximal half of the posterointernal border of the shaft. In *Triceratops* the center of this trochanter is about midway between the proximal and distal ends. The condyles of the distal end are heavy, the internal being larger than the external. The intercondylar notch is deep and narrow, and the anterior intercondylar groove is wide and concavely rounded transversely and extends well up on the anterior face of the bone. The principal characters of the femur are well shown in figure 43. The measurements of specimen No. 7953 are as follows:

| | Millimeters. |
|---|---|
| Greatest length | 337 |
| Greatest breadth: | |
| Proximal end | 100 |
| Distal end | 83 |
| Least breadth of shaft | 45 |

*Tibia.*—The tibia is relatively short and is constricted medially but has expanded ends. The greatest proximal expansion is anteroposterior (see fig. 44), and the greatest distal measurement is transverse. The proximal surface is rugosely roughened. This end shows a division into two backward projecting condyles, about subequal in size and separated by a narrow intercondylar notch of moderate depth. The enemial crest is heavy and projects well forward of the median part of the shaft.

The distal end is divided into two surfaces, an inner with a beveled distal surface that articulates with the astragalus and constitutes more than one-half of the transverse diameter of this end, and an outer that extends distally to the level of the inferior border of the articulated astragalus and closely embraces that element on the external side. The anterior side of this part of the tibia is flattened for the articulation of the fibula. The measurements of tibia No. 7957 are as follows:

| | Millimeters. |
|---|---|
| Greatest length | 268 |
| Greatest diameter: | |
| Proximal end: | |
| Anteroposteriorly, estimated | 99 |
| Transversely | 41 |
| Distal end: | |
| Anteroposteriorly | 30 |
| Transversely | 71 |

*Fibula.*—The fibula is shorter than the tibia. It is slender and has expanded extremities, and its shaft is flattened in the proximal half but subcylindrical below. The bone is bowed longitudinally, and the ends are angulated to one another, that is, planes passed through their longer diameter if produced would cut one another at 45°.

At the proximal end the face toward the tibia is slightly concave and that away from the tibia is convex anteroposteriorly. The lower articular face is flattened and was closely applied to the anterior flattened face of the tibia. The distal articular end is shallowly cupped and triangular in outline, its widest portion being internal, with a knoblike projecting facet for the calcaneum as in *Camptosaurus*. A side view of the fibula is shown in figure 45. The greatest length of the fibula of paratype No. 7957 is 246 millimeters, and the greatest width of the distal end is 34 millimeters.

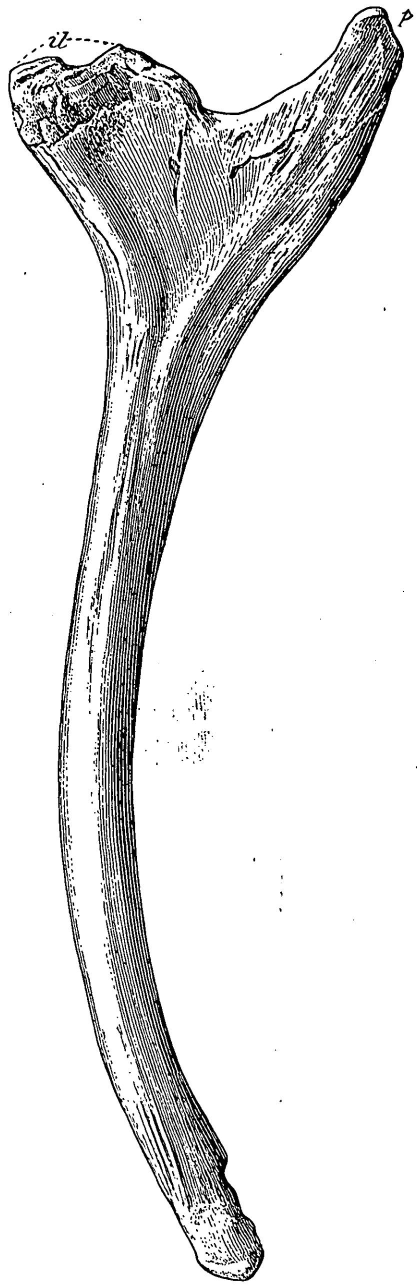



FIGURE 42.—Right ischium of *Brachyceratops montanensis*. No. 8073, U. S. N. M. One-half natural size. External view. *il*, Process for articulation with ilium; *p*, process that articulated with pubis.

### THE HIND FOOT.

*The specimens.*—Notwithstanding the great number of ceratopsian remains collected in the Rocky Mountain region since 1855, the present specimens are the first to be described that give an adequate conception of the complete skeletal structure of the pes in the horned Dinosauria. They are of additional interest because they pertain to one of the earliest known members of the ceratopsian group of dinosaurs and will be of especial value in determining the structural changes that have taken place in the hind feet of the later and more highly specialized ceratopsians of the Lance when these are found.

Except the vestigial digit V, the complete hind foot of *Brachyceratops* is shown in figure 46 The elements drawn in outline have been introduced from the evidence of the partly articulated foot No. 7956 (see fig. 47), in which the phalanges of digit I were present but were turned back beneath the other metatarsals. The fourth phalanx of digit IV is also present in that foot and is articulated with the third, which agrees perfectly with the third phalanx of foot No. 7957.

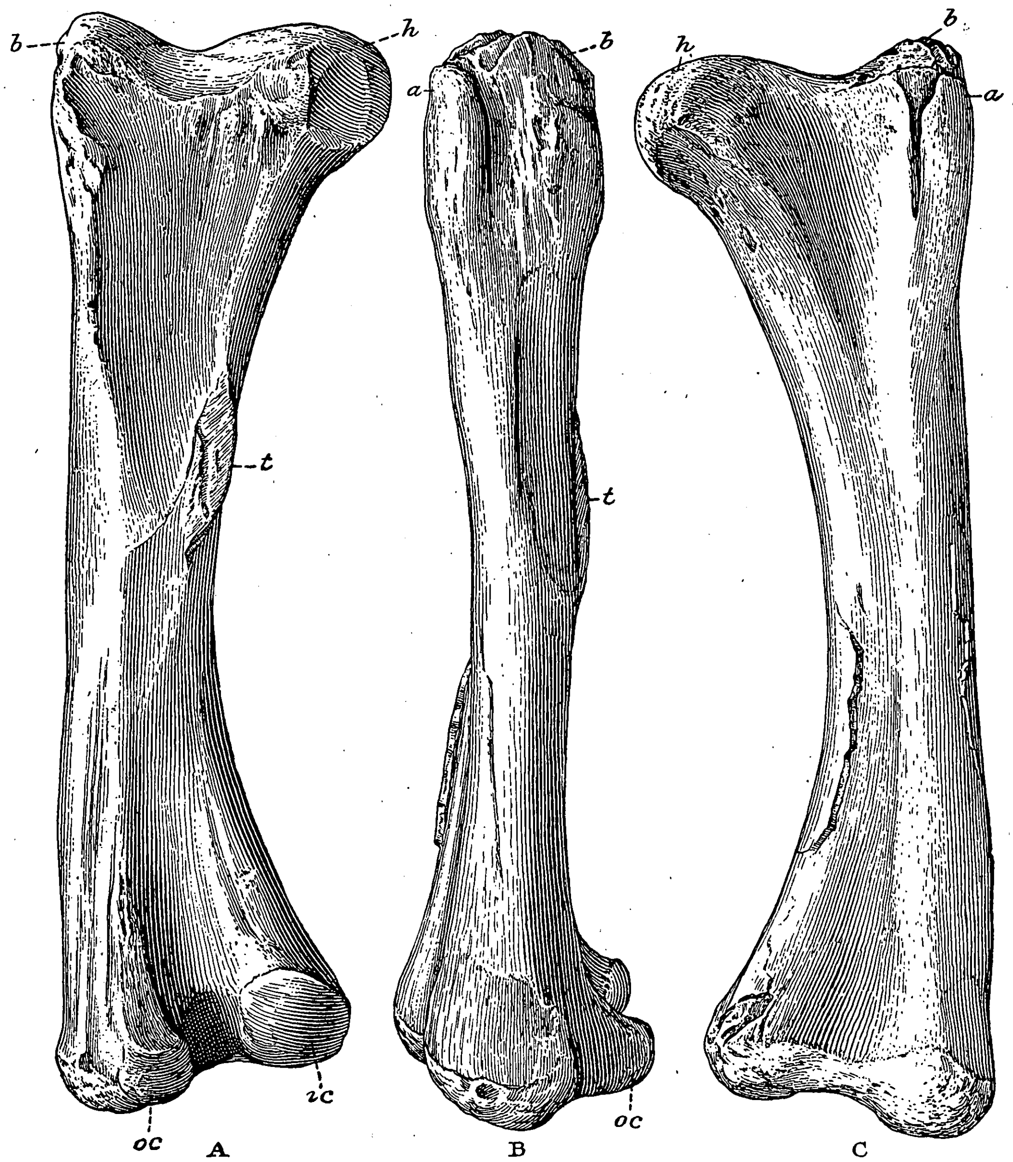



FIGURE 43.—Femur of *Brachyceratops montanensis*. No. 7953, U. S. N. M. One-half natural size. A, Posterior view; B, external view; C, anterior view. *a*, Finger-like trochanter; *b*, great trochanter; *h*, head; *ic*, inner condyle; *oc*, outer condyle; *t*, fourth trochanter.

The pes in *Brachyceratops* consists of four functional digits and one which is vestigial. From these semiarticulated feet the phalangial formula has been determined as 2, 3, 4, 5, 0? In figure 46 the foot is drawn with the toes spread wide apart, the pose being that assumed by metatarsals I, II, and III, which are firmly united by matrix. Study of the second foot (No. 7956) and of the opposing surfaces of the metatarsals lends convincing evidence that the surfaces of their shafts were more closely applied throughout most of their length. They interlock with one another at their proximal ends and thus form a compact, strong foot.

*Tarsus.*—The known tarsus consists of four bones, the astragalus, calcaneum, and two tarsalia of the distal row.

The astragalus is represented by three bones, one belonging to the foot (No. 7956), a second firmly coossified with the tibia shown in figure 44, and a third, somewhat fragmentary, which was found in the float. The astragalus of No. 7956 is an elongated, rectangular, blocklike bone having a slightly rugose distal surface that is convex anteroposteriorly. The proximal surface is concave in the same diameter. The external end is thickened, but the internal end thins out to a liplike rounded end, deeply notched at the center. When articulated with the tibia (see fig. 44) it appears relatively larger than in *Triceratops*. The greatest transverse diameter of astragalus of No. 7956 is 59 millimeters, and the greatest anteroposterior diameter is 27 millimeters.

The calcaneum is represented by two bones, one belonging to the foot of No. 7957 and a second to No. 7956. The calcaneum pertaining to specimen No. 7957 is the better preserved and was found in close association with the foot, as shown in figure 47. The surface opposed to the distal end of the tibia is cupped, the anteroinferior face is broadly rounded dorsoventrally, and the superior surface presents a triangular articulating surface for the distal end of the fibula. This bone has a greatest vertical diameter of about 34 millimeters; anteroposteriorly it measures 30 millimeters.

The ossified tarsal bones of the distal row are irregularly rounded discoidal elements with upper surfaces concave and lower convex. In figure 47 they are shown as found in place and in all probability are not far removed from their proper position in the tarsus. The largest articulates with the proximal end of metatarsal II, the smallest with metatarsal III (see fig. 46), to which it was found securely attached by matrix. The third tarsal was wholly in apposition to metatarsal IV.

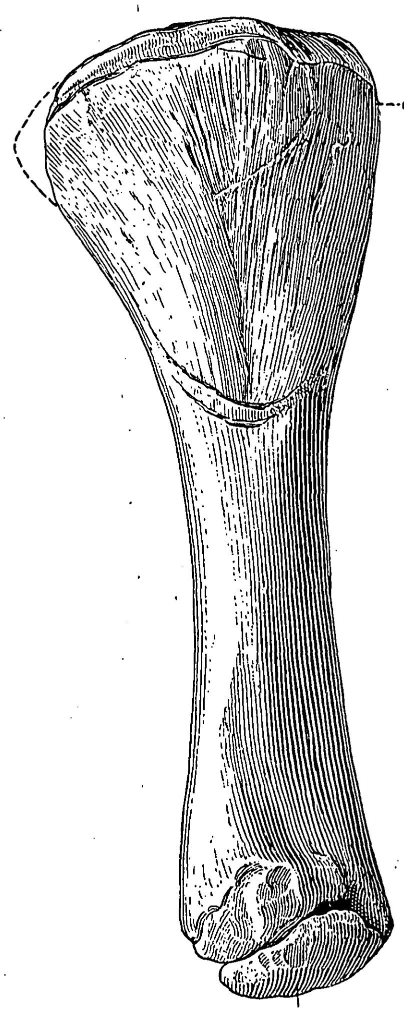



FIGURE 44.—Tibia of *Brachyceratops montanensis*. No. 7957, U. S. N. M. One-half natural size. Oblique external view. *a*, Astragalus; *e*, cnemial crest.

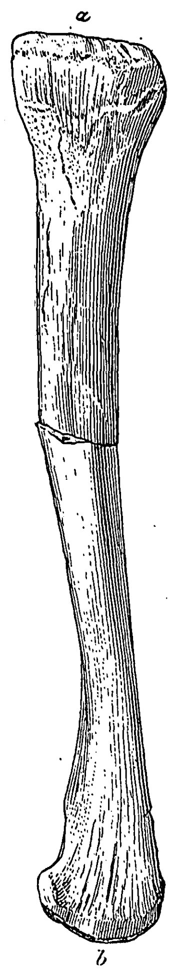



FIGURE 45.—Fibula of *Brachyceratops montanensis*. No. 7957, U. S. N. M. One-half natural size. Lateral view. *a*, Proximal end; *b*, distal end.

*Metatarsus.*—The metatarsus, as already stated, comprises four functional metatarsals and one that is vestigial. Metatarsal I, the shortest of the functional series, is robust and has expanded articular ends, more especially the distal, which is rectangular in outline, its articular surface being cut off obliquely to the longer axis of the shaft. In the articulated foot its proximal end extends above the upper articular surface of metatarsal II and probably shows the correct articulation of these bones, for the two feet (Nos. 7956 and 7957) have these elements preserved in almost identical positions.

Metatarsal II is nearly twice the length of metatarsal I but is shorter than metatarsal III. The proximal end is expanded anteroposteriorly, and the distal end has its greatest diameter transverse. The internal surface of the proximal end is shallowly concave for better articulation with metatarsal I. The opposite side is slightly convex and articulates with the concave surface of metatarsal III.

Metatarsal III is the longest bone of the foot and in general resembles the median element of the *Triceratops* foot. The expansion of the proximal end is chiefly anteroposteriorly, and that of the distal end, as in metatarsal II, is transverse. The distal articular ends of both metatarsals II and III of foot No. 7957 are peculiarly flattened and are not convex anteroposteriorly, as in most dinosaurian metatarsals. The ends are also cut off somewhat obliquely to the longer diameter of the shafts, their faces being directed slightly inward.

Metatarsal IV is shorter than metatarsal II and may be distinguished from the other metatarsals by the anteroposteriorly compressed shaft. The transverse diameter of the proximal end also exceeds the anteroposterior diameter. The inner side near the proximal end has a slightly concave triangular area which articulates well with the convex surface of metatarsal III. The proximal end is slightly cupped as in metatarsal IV of *Camptosaurus* and *Thescelosaurus,* for the better articulation of the distal tarsal element. The shaft, although somewhat constricted, is relatively wider than in the other metatarsals.

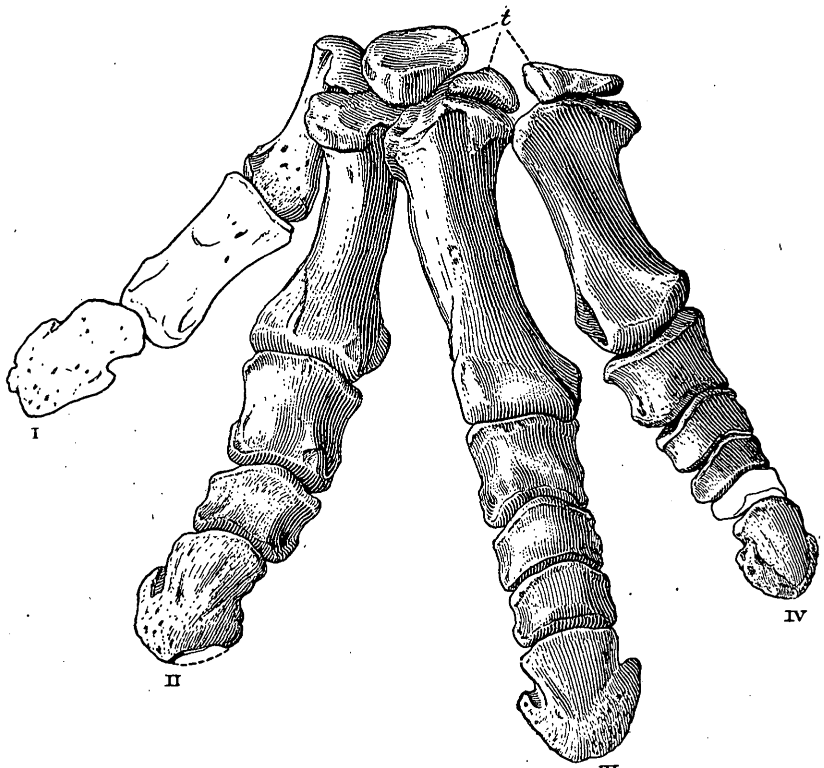
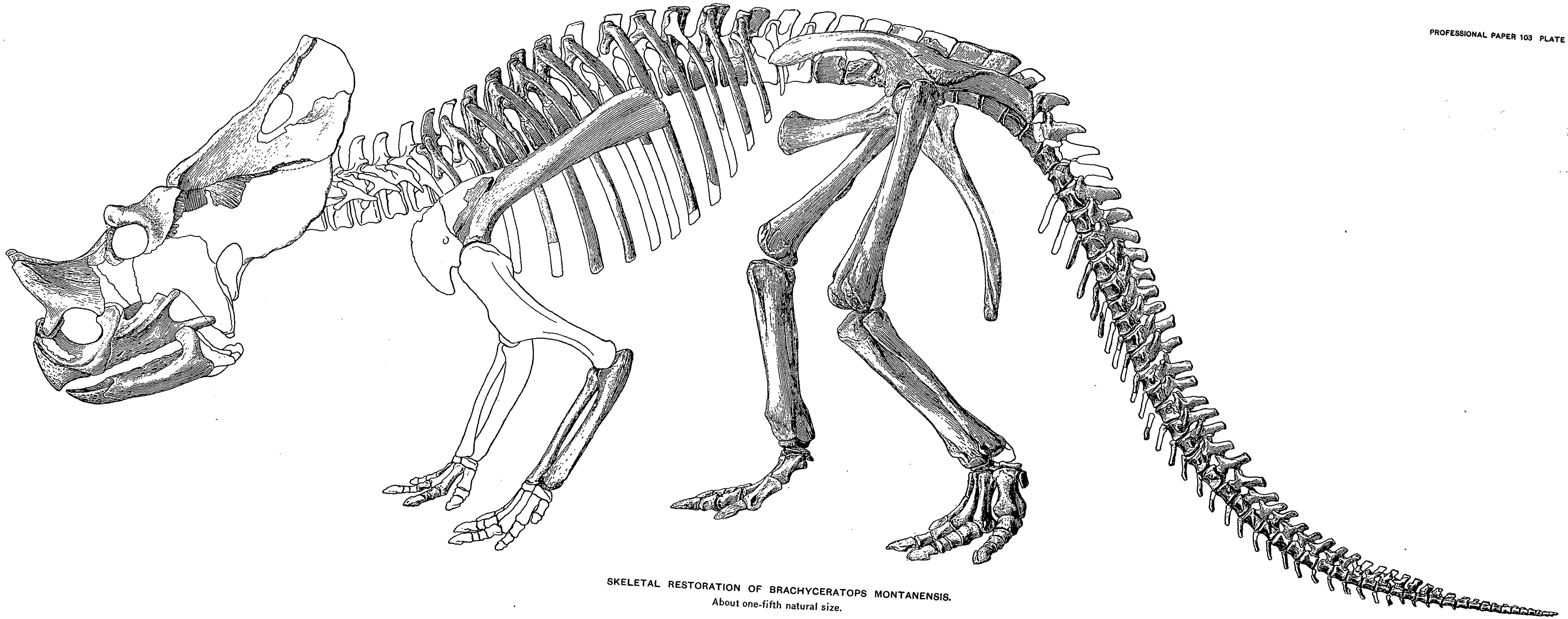



FIGURE 46.—Left hind foot of *Brachyceratops montanensis*. No. 7957, U. S. N. M. One-half natural size. Anterior view. *t*, Tarsal bones of the distal row; I, II, III, and IV, digits 1 to 4, respectively. Bones in outline have been introduced upon the evidence furnished by the foot of specimen No. 7956, shown in figure 47.

The distal face is nearly square in outline, though all four sides are decidedly concave on their median surfaces. The articular end is convex anteroposteriorly.

Metatarsal V is known only from two fragmentary ends which are regarded as representing proximal articular portions. One of these was associated but not articulated with foot No. 7957. It is a thin flattened bone with a rounded articular end that in all probability was attached to the posterior side of metatarsal IV. The distal portion is unknown.

*Phalanges.*—The proximal phalanges are somewhat longer than the intermediate ones. The proximal phalanx of digit I is especially elongated, equaling in this measurement the metatarsal of digit I. Its upper surface is beveled off toward the inner side of the foot. All the phalanges are flattened, blocklike elements, with concave proximal and convex distal extremities, but lacking the pulley-shaped finish of the *Camptosaurus* phalanges with their vertical interlocking keels. Many of the phalanges show shallow lateral pits for the attachment of ligaments. The second, third, and fourth phalanges of digit IV are considerably more shortened than are the phalanges of the other toes. The unguals are flattened and have broadly rounded anterior borders with pitted surfaces. As in *Triceratops* and *Stegosaurus,* in life these were probably incased in flat hoofs. Their articular ends are shallowly concave and have elon-



SKELETAL RESTORATION OF BRACHYCERATOPS MONTANENSIS.
About one-fifth natural size.

gated oval outlines. In a general way they resemble the unguals of *Trachodon* more than those of *Triceratops*, as figured by Hatcher.[1]

*Measurements.*—Measurements of the left hind foot of the paratype No. 7957 follow:

*Measurements, in millimeters, of the left hind foot of Brachyceratops montanensis (No. 7957).*

| | I. | II. | III. | IV. | V. |
|---|---|---|---|---|---|
| Greatest length of metatarsals | 53 | 92 | 97 | 73 | ..... |
| Proximal end of metatarsals: | | | | | |
| Greatest anteroposterior diameter | 27 | 43 | 36 | 24 | 12 |
| Greatest transverse diameter | 20 | 30 | 27 | 38 | ..... |
| Distal end of metatarsals, greatest transverse diameter | 30 | 33 | 34 | 28 | 6 |
| Phalanges, greatest length: | | | | | |
| First row | [a] 51 | 34 | 28 | 24 | ..... |
| Second row | [a] 37 | 24 | 20 | 18 | ..... |
| Third row | ..... | 37 | 18 | 13 | ..... |
| Fourth row | ..... | ..... | 36 | [a] 95 | ..... |
| Fifth row | ..... | ..... | ..... | 28 | ..... |

[a] Measurements from another individual of about the same proportions (No. 7956).

## RESTORATION OF BRACHYCERATOPS.

A complete skeletal restoration of *Brachyceratops montanensis*, about one-fifth natural size, is shown in Plate IV. The total length of the animal from the end of the nose to the tip of the tail is about 6 feet 9 inches, and its height at the hips about 2 feet 4 inches.

This restoration is based on the remains of several individuals and is the first attempt thus to depict one of the earlier ceratopsians. The bones drawn in outline were not represented in the collections and have been supplied in a modified form from other specimens, preferably from those found in the Judith River formation. The presacral region has been given the same number of vertebrae as are found in the articulated series belonging to the type specimen of *Triceratops brevicornus* Hatcher.

The sacrum, pelvis, femora, and tail were found in so close association that they unquestionably pertain to one individual (No. 7953, U. S. N. M.). In fact, the caudal vertebrae were nearly all articulated, and this complete series is of especial interest as giving us the first adequate conception of the ceratopsian tail. It shows this appendage to be considerably longer than has been represented in previous restorations of Lance ceratopsians. Whether this lengthening is peculiar to the primitive forms from the Judith River and Belly River formations remains to be determined.

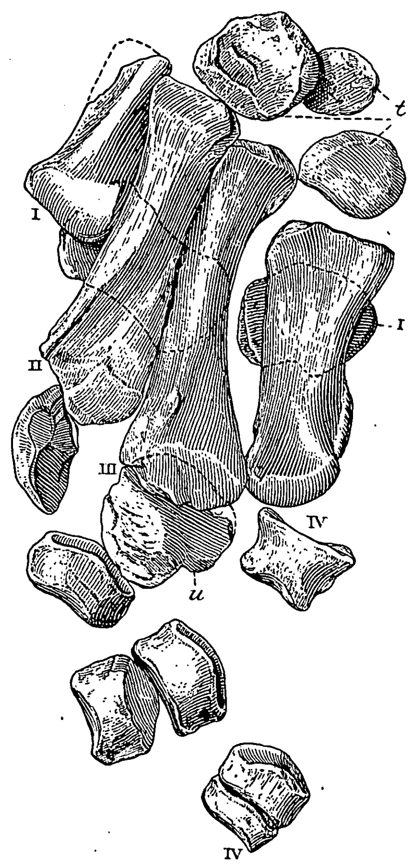



FIGURE 47.—Left hind foot of *Brachyceratops montanensis*. No. 7956, U. S. N. M. One-half natural size. Shown as found in place. *t*, Tarsal bones of the distal row; *u*, ungual; I, II, III, and IV, digits 1 to 4, respectively.

The structure of the fore foot as shown is perhaps somewhat conjectural, although it is based on an articulated fore foot of *Leptoceratops*, a ceratopsian from the Edmonton formation of Canada, a drawing of which was generously supplied by Mr. Barnum Brown, of the American Museum of Natural History.

The few bones of the manus present in the collection have been inserted in accordance with the evidence of this articulated foot.

[1] Hatcher, J. B., The Ceratopsia: U. S. Geol. Survey Mon. 49, fig. 73 (*d, e, f*), 1907.

The animal is represented standing, with the nose thrown downward, a position that is well adapted for the most effective use of the strong nasal horn, and that also brings the head within easy feeding distance of the ground.

The fore limbs are strongly flexed, principally on the evidence of the well-developed olecranon on the ulna. The tail drops rapidly from the sacrum, its distal portion, in life, evidently dragging upon the ground. The scapula has been placed in a somewhat horizontal position well down on the side of the ribs, in accordance with the evidence of the position of this bone in several articulated skeletons of the trachodont dinosaurs. The great elevation of the transverse processes of the dorsal vertebrae, reaching nearly to the top of the spinous processes, is well shown, as is also the relative shortness in height, compared with those of the anterior part, of the spinous processes of the posterior dorsal and sacral vertebrae, which in *Triceratops* are the highest of the column. The specimen throws little light on the proper articulation of the ischia with the other elements of the sacrum, and the restoration of these bones has been made in accordance with the mounted skeleton of *Triceratops* in the United States National Museum.

A life restoration of *Brachyceratops*, about one-sixth natural size, based on the articulated skeleton (Pl. IV) is shown in Plate I. The pose is much the same as that of the skeleton.

It is the first restoration of a ceratopsian dinosaur in which an attempt has been made to indicate the nonimbricating, scalelike texture of the skin. This feature of the restored animal is based on a recently discovered specimen [1] of *Protorosaurus*, with which well-preserved impressions of the skins were found.

It appears fair to assume that all the horned dinosaurs were covered by a scaled integument, although the pattern of the scales probably varied in the different genera. In the present restoration the skin pattern is modified after the figures and description given by Lambe. The impression of the integument shows the plates to have been generally five and six sided, with a sunken peripheral margin. In size they appear to increase from below upward. Other impressions low down on the body indicate that these parts were covered with small tubercles and that the large plates were absent. The pattern of the skin as here depicted is exaggerated in the size of the plates, as it was hardly practicable to reduce them to the same scale as the model.

Following Lull in his restorations of ceratopsian heads, I have represented the gape of the mouth as being short.

## RELATIONS OF BRACHYCERATOPS.

At this time it is difficult to arrive at a satisfactory conclusion regarding the true affinities of *Brachyceratops;* first, because of the fragmentary nature of some of the specimens on which the more primitive ceratopsian genera are based; and, second, because of the recent discoveries of new materials, much of which is as yet undescribed and which promises to materially change previously accepted views of relationships.

In the preliminary account [2] of *Brachyceratops* I stated that "it would appear most nearly allied to *Monoclonius*," and after an interval of more than two years still hold this opinion. Brown [3] has recently redefined the genus *Monoclonius*, and this definition, based entirely on skull characters, with two exceptions would apply equally well to the genus *Brachyceratops*. It is as follows:

> 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 and flattened on the outer surface. Nasals large; nares nearly separated by osseous septum formed by premaxillaries and nasals. Premaxillaries deep with vertical plate forming septum, nonfenestrated. Crest composed of short, broad squamosals and extension of elongate coossified postfrontals (parietals) [dermosupraoccipitals] perforated by large fenestrae; each fenestra wholly within the boundary of the postfrontal [dermosupraoccipitals]. Margin of crest crenulated, each prominence bearing a separate ossification. A pair of long curved hooklike processes on posterior border of postfrontals [dermosupraoccipitals]."

---

[1] Lambe, L. M., On the fore limb of a carnivorous dinosaur from the Belly River formation of Alberta, and a new genus of Ceratopsia from the same horizon, with remarks on the integument of some cretaceous herbivorous dinosaurs: Ottawa Naturalist, vol. 27, p. 132, pl. 14, January, 1914.

[2] Gilmore, C. W., A new ceratopsian dinosaur from the Upper Cretaceous of Montana, with note on *Hypacrosaurus*: Smithsonian Misc. Coll., vol. 63, p. 9, Mar. 14, 1914.

[3] Brown, Barnum, A complete skull of *Monoclonius*, from the Belly River Cretaceous of Alberta: Am. Mus. Nat. Hist. Bull., vol. 33, pp. 549-558, Oct. 8, 1914.

*Brachyceratops*, however, does not have separate ossifications on the prominences around the borders of the crest or frill, nor are there any "hooklike processes" on the median posterior border of the dermosupraoccipital. The fenestrae in the frill are decidedly smaller than in any recognized species of *Monoclonius*, and it has not yet been demonstrated that *Monoclonius* has its nasal horn divided longitudinally, as in *Brachyceratops*. The latter feature would represent a most important structural difference, provided such a difference can be shown to exist, but I am of the opinion that when juvenile specimens of *Monoclonius* are found they will also show a similar development of the nasal horn core.

Lambe[1] has proposed a division of the Ceratopsia into three subfamilies, the Centrosaurinae, the Eoceratopsinae, and the Chasmosaurinae, named from the most primitive member of each group. *Brachyceratops* is included with *Centrosaurus* (regarded by Brown[2] as being a synonym of *Monoclonius*) and *Styracosaurus* in the subfamily Centrosaurinae. This subfamily is characterized by genera having representatives with "small brow horns, a large nasal horn, and parietal [dermosupraoccipital] expanded behind short squamosals."

An article by Barnum Brown[3] described the new ceratopsian dinosaur *Leptoceratops gracilis*, which he considers a primitive, aberrant type related to *Brachyceratops*. Further he says: "The complete skeleton will probably show characters sufficiently diverse to warrant founding a new family to include *Leptoceratops* and *Brachyceratops*, * * * and from the material now available the two genera appear to be distinguished from allied genera by characters of at least subfamily rank." In so far as *Leptoceratops* is concerned the proposed classification is quite acceptable, but careful study of Brown's paper fails to disclose characters showing that *Leptoceratops* and *Brachyceratops* are so closely related. Certainly a comparison of the skeletal parts does not reveal such close affinities. Both, it is true, belong to the Ceratopsia and both are diminutive members of that order, but there, for the most part, their close resemblance ends. This is clearly shown by the comparison of their more important characters in the parallel columns below:

| | Leptoceratops. | Brachyceratops. |
|---|---|---|
| Skeleton | Small | Small. |
| Skull | Short and deep | Short and deep. |
| Nasal horn | None | Well developed. |
| Crest | High, thin sagittal ridge | Low, obtuse sagittal ridge. |
| Posterior border of crest | Smooth, without median emargination | Undulating, with median emargination. |
| Squamosal | Extending to extreme posterior border of crest. | Short, extending a little more than halfway to extreme border of crest. |
| Teeth | Single rooted | Not determined. |
| Dentary | Massive, short, and deep | Relatively slender, of medium length, narrow. |
| Do | Less than 15 rows of teeth | More than 15 rows of teeth. |
| Splenial | Large, extending to symphysis | Not present. |
| Predentary | Long and narrow | Moderate length and width. |
| Manus | Digits I, II, and III terminating in hoofs. | Not known. |
| Carpals | Ossified, ulnars and radials large | Do. |
| Femur | Straight; fourth trochanter comparatively large. | Straight; fourth trochanter moderately developed. |
| Tail | Long and deep, with high, slender spines and long chevrons. | Long, with short, heavy spines and relatively short chevrons. |

Other differences might be given, for only the generic and specific characters as enumerated by Brown are contrasted above. These, however, appear to show enough fundamental differences in the skeletal structure to preclude the conclusion that they are closely related.

That the genus *Brachyceratops* represents one of the more generalized forms of the Ceratopsidae is apparent; that it can not be included in either the *Ceratops-Torosaurus* or the *Eocera-*

[1] Lambe, L. S., On *Eoceratops canadensis* gen. nov., with remarks on other genera of Cretaceous horned dinosaurs: Canada Geol. Survey Mus. Bull. 12. p. 20, May 7, 1915.

[2] Brown, Barnum, op. cit., p. 551.

[3] *Leptoceratops*, a new genus of Ceratopsia from the Edmonton Cretaceous of Alberta: Am. Mus. Nat. Hist. Bull., vol. 33, pp. 567–580, 1914.

*tops-Triceratops* phylum is also evident, for it is hardly conceivable that an animal like *Brachyceratops*, having a nasal horn split longitudinally by suture and an outgrowth from the nasal bones, could be the progenitor of later ceratopsians having this horn developed from a center of ossification distinct from the nasal bones.

*Brachyceratops* apparently represents a phylum commencing prior to Judith River time, which either died out before the Lance or the representatives of which have not yet been discovered.

### Family TRACHODONTIDAE.

The great number of their remains appears to indicate that the trachodonts were the most abundant dinosaurs of Two Medicine time. Four genera of Trachodontidae are now generally recognized from the Judith River and Belly River formations, and these display nearly as much variety of form and structure as the contemporary Ceratopsidae. In the collection from the Two Medicine formation four distinct genera are recognized: (1) *Hypacrosaurus*, which has been regarded as the largest of all trachodonts; (2) *Stephanosaurus;* (3) a specimen which is too incomplete to describe but which apparently belongs to an undescribed genus that may be separated from the crested trachodonts (*Hypacrosaurus*, *Saurolophus*, and *Stephanosaurus*) by its possession of a long, straight ischium without terminal expansion of its distal end and with ilia that distinguish it generically from the Lance trachodonts; and (4) a very large humerus and scapula from the Two Medicine locality, comparable in its great size with a trachodont fore foot and limb from the Edmonton formation of Alberta, now in the American Museum of Natural History, New York City.

#### Hypacrosaurus altispinus? Brown.

*Hypacrosaurus altispinus?* Brown is represented in the collections by a partly disarticulated skeleton [1] (No. 7948, U. S. N. M.), the bones of which are in an excellent state of preservation. The specimen was found by Mr. Stebinger in 1912 and was collected by me the following summer from the south side of Milk River, in the NW. ¼ sec. 27, T. 37 N., R. 8 W., on the Blackfeet Indian Reservation, Teton County, Mont. (See Pl. II, *A*, p. 2.) It consists of the left ramus and jugal, two cervical processes, nine sacral centra with sacral ribs, five caudals, an anterior chevron, three posterior ribs, eight spines pertaining to the dorsal and sacral region, left ilium, both pubes, left femur, both tibiae and fibulae, both of metatarsi III, distal portion of metatarsal IV, five phalanges, both ulnae, metacarpal IV, and several fragments.

The specimen is of especial interest as greatly extending the known geologic and geographic range of the genus *Hypacrosaurus*. After a careful comparison with the description and figures of the type, I am unable to distinguish it from the only known species, *H. altispinus*, from the Edmonton Cretaceous of Canada, described by Brown.[2] The specimen is smaller and perhaps younger (as indicated by the open sutures of the skull and sacrum) than any of the typical specimens, but all of its bones, so far as they can be compared, are remarkably similar in shape and proportions to those of *H. altispinus*.

The left dentary, nearly perfect (see fig. 48), but without teeth, and the complete jugal (see fig. 49) of this specimen are all that is known of the head of *Hypacrosaurus*. Its "footed" ischium, however, suggests the probability of its having a crested skull of the *Saurolophus* or *Stephanosaurus* type.

The jugal (see fig. 49) is relatively short and in its contours and proportions is remarkably similar to the jugal of *Stephanosaurus marginatus* Lambe. It has a greatest length of 238 millimeters and a depth at center of 180 millimeters.

As compared with the Lance trachodonts the dentary of the present specimen is remarkably slender. (See fig. 48.) Its greatest length is 544 millimeters; its depth at the middle of the magazine is 86 millimeters; the distance in front of the magazine to the anterior end of the sym-

[1] Gilmore, C. W., A new ceratopsian dinosaur from the Upper Cretaceous of Montana, with note on *Hypacrosaurus:* Smithsonian Misc. Coll., vol. 63, No. 3, p. 10, 1914.

[2] Brown, Barnum, A new trachodont dinosaur, *Hypacrosaurus*, from the Edmonton Cretaceous of Alberta: Am. Mus. Nat. Hist. Bull., vol. 32, pp. 395–406, 1913.

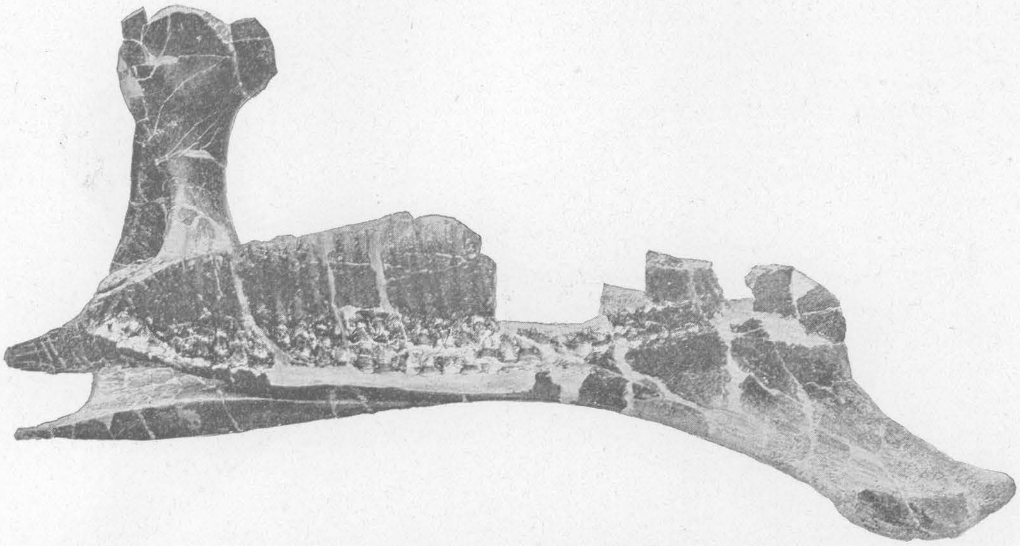


FIGURE 48.—Left dentary of *Hypacrosaurus altispinus?* Brown. No. 7948, U. S. N. M. One-fourth natural size. Internal view.


FIGURE 49.—Left lachrymal of *Hypacrosaurus altispinus?* Brown. No. 7948, U. S. N. M. One-half natural size. Lateral view. *a*, Anterior end; *p*, posterior end.

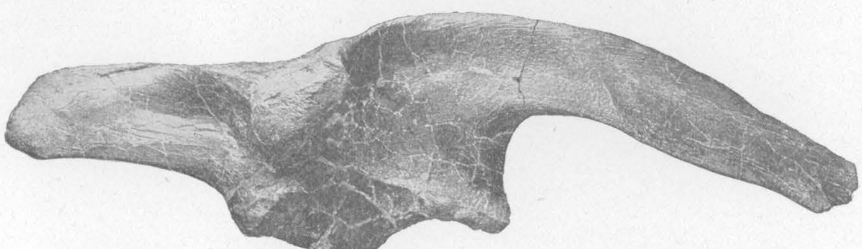


FIGURE 50.—Right ilium of *Hypacrosaurus altispinus?* Brown. No. 7948, U. S. N. M. One-eighth natural size. Lateral view.

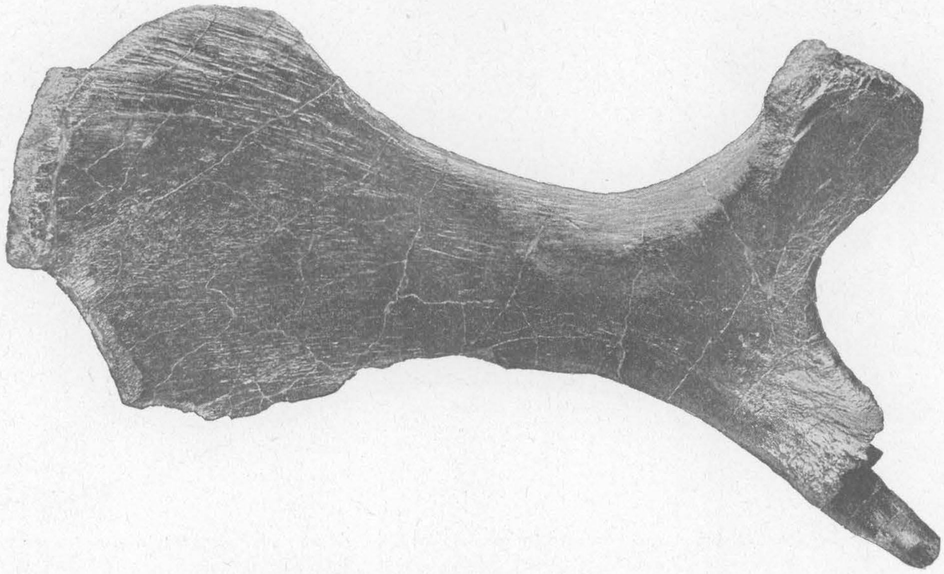
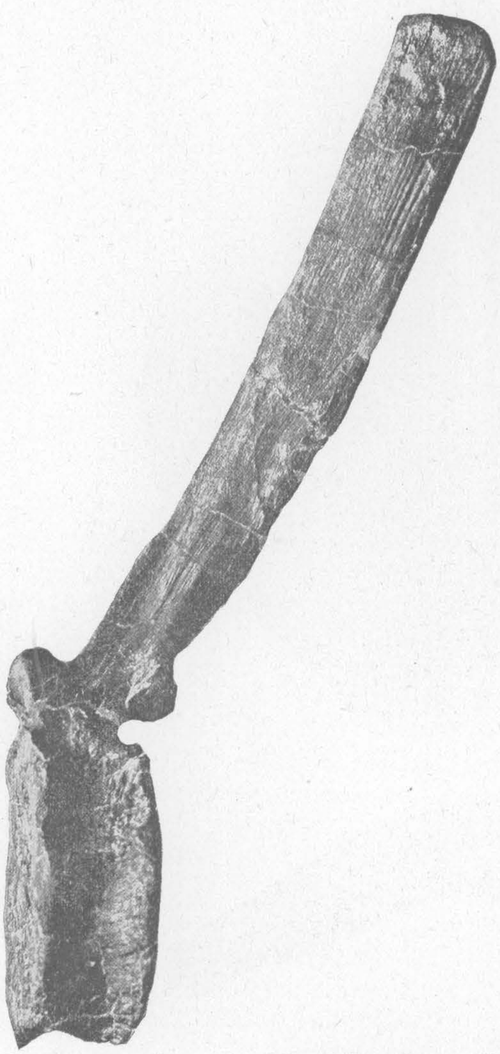


FIGURE 51.—Left pubis of *Hypacrosaurus altispinus?* Brown. No. 7948, U. S. N. M. One-fourth natural size. External view.



physial surface is 120 millimeters; the length of the dental magazine is 293 millimeters. It has 39, possibly 40, alveolar grooves.

The distance from the front of the dental magazine to the end of the symphysial surface is relatively shorter and has a more abrupt downward deflection in the Judith River forms than it has in those from the Lance.

The ilium (see fig. 50) has a strongly arched superior border, with a preacetabular process compressed and of almost uniform transverse thickness; the pubis (see fig. 51) is comparatively short and has its anterior portion broadly expanded.

Well-preserved anterior and median caudal vertebrae are shown in figures 52 and 53. The

FIGURE 52.—Anterior caudal vertebra of *Hypacrosaurus altispinus?* Brown. No. 7948, U. S. N. M. One-half natural size. Viewed from left side.

FIGURE 53.—Median caudal vertebra of *Hypacrosaurus altispinus?* Brown. No. 7948, U. S. N. M. One-fourth natural size. Viewed from right side.

spines are high and strongly inclined backward. The centrum of the anterior caudal is slightly more than one-quarter of the total height of the vertebra. The median caudal shows a lengthened centrum with shallowly biconcave ends. Well-defined chevron facets are present on both back and front.

The following measurements show the resemblance of the Milk River specimen (No. 7948, U. S. N. M.) to the type (No. 5204) and paratype (No. 5272) of *H. altispinus* in the American Museum of Natural History:

*Comparative measurements, in millimeters, of specimens of Hypacrosaurus altispinus.*

| | Am. Mus. Nat. Hist. Type No. 5204. | U. S. N. M. No. 7948. |
|---|---|---|
| Ilium: | | |
| Extreme length | 1,060 | 920 |
| Height | 320 | 270 |
| Pubis: | | |
| Greatest length at center | | 440 |
| Narrowest width of blade | 120 | 100 |
| Greatest width of blade | | 225 |
| Caudal vertebra: | | |
| Length of centrum, first or second | 90 | 60 |
| Width of centrum | 180 | 120 |
| Height over all | | 535 |
| Height of spine above neural canal | | 410 |
| | Paratype No. 5272, Am. Mus. Nat. Hist. | |
| Ulna, length | 750 | 670 |
| Metacarpal IV, length | 280 | 265 |
| Femur, length | | 1,035 |
| Tibia, length | 1,080 | 1,000 |
| Fibula, length | 1,000 | 935 |
| Metatarsal III, length | 430 | 400 |

#### Stephanosaurus marginatus? (Lambe).

The posterior portion of a right dentary without teeth (No. 8052, U. S. N. M.) provisionally identified as pertaining to *Stephanosaurus marginatus* (Lambe) was obtained from the Two Medicine River locality during the summer of 1913. (See fig. 54.)

The general proportions of this bone, with high coronoid process without marked antero-posterior expansion of its upper extremity, agrees perfectly with the dentary of *S. marginatus* as figured by Lambe [1] from the Belly River formation on Red Deer River in Alberta, Canada.

A second specimen (No. 7703, U. S. N. M.), provisionally referred to this genus and species, was obtained by Mr. Stebinger in 1912 from the Two Medicine formation on Two Medicine River. It consists of a fragment of a dentary containing several teeth whose lateral margins are decorated with small rounded projections or pappillae from a point near the apex downward to the place where the crown begins to narrow again.

#### Trachodont gen. and sp. undet.

A fragmentary skeleton (No. 8058, U. S. N. M.) of a trachodont dinosaur from the Two Medicine River locality is of interest as having ischia of the Lance trachodont style (that is, without expanded distal extremities) associated with ilia that resemble most nearly those of the crested forms like *Saurolophus* and *Hypacrosaurus*. Whether these remains represent an

[1] Lambe, L. M., On Vertebrata of the Mid-Cretaceous of the Northwest Territory: Contr. Canadian Paleontology, vol. 3, pt. 2, p. 73, pl. 4, fig. 1, 1902.

undescribed genus or pertain to one of the described members of this group that have been based on skulls it is not possible to say at this time.

The specimen was found about a mile below the abandoned ranch buildings of John Edwards, on the south side of the river, at the base of the high exposures (about the middle of the Two Medicine formation). (See fig. 1, p. 2.) The bones received are two ilia, two ischia, two dorsal and three caudal vertebrae, three chevrons, and fragmentary parts.

The ischia (see fig. 55) are slenderer than those in any described trachodont, having an extreme length of 880 millimeters and a diameter across the iliac and pubic heads of 230 millimeters. The most striking feature of the ischia is the presence on the inferior border of the expanded end of an elliptical foramen-like notch (*f*, fig. 55). In the Lance trachodonts there is usually a slight indentation at this point, and in *Saurolophus* the place is entirely inclosed

FIGURE 54.—Right dentary of *Stephanosaurus marginatus?* (Lambe). No. 8052, U. S. N. M. One-half natural size. Internal view.

by bone forming a foramen. In *Hypacrosaurus* the ischium shows a long, shallow indentation more like that in theLance trachodonts.

Below the expanded proximal end the shaft contracts abruptly and continues as a long, slender rod that expands only slightly toward the distal end. The inner surface of the distal two-thirds is longitudinally striated, indicating the ligamental union with its mate of the opposite side. The ilium (see fig. 56) has about the same outline and form as in *Saurolophus* and *Hypacrosaurus*. Vertically it is narrower than in *Hypacrosaurus*, and the preacetabular process is flattened and is relatively longer and narrower. It appears to agree with Cope's brief description [1] of the ilium of *Pteropelyx grallipes* Cope. Whether it should be referred to that form remains to be determined. Measurements of the right ilium are given below.

| | Millimeters. |
|---|---|
| Greatest length | 880 |
| Greatest height | 205 |
| Depth at center of acetabulum | 170 |
| Length of preacetabular process | 405 |
| Length of postacetabular process | 240 |

[1] Cope, E. D., Notes on the Dinosauria of the Laramie: American Naturalist, vol. 23, p. 904, 1889.

**Trachodont gen. and sp. undet.**

A scapula and humerus (No. 7955, U. S. N. M.) of an exceedingly large trachodont reptile were collected on Two Medicine River. (See Pl. II, *B*, and fig. 1, p. 2.) While the material is insufficient to determine the genus and species to which it belongs, the specimen is of interest on account of its resembling most nearly a fore limb and foot from the Edmonton Cretaceous of Canada, now in the American Museum of Natural History.

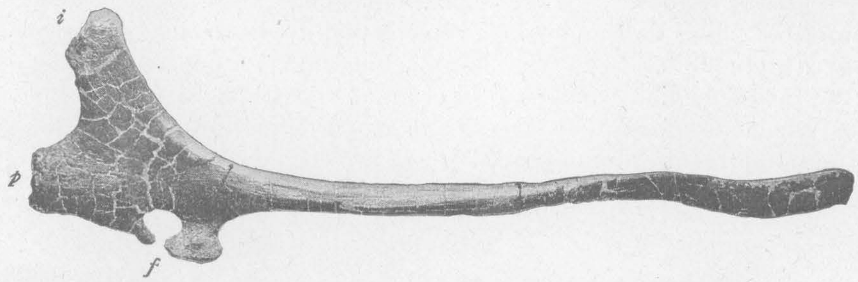



FIGURE 55.—Left ischium of unidentified trachodont reptile. No. 8058, U. S. N. M. One-eighth natural size. External view. *f*, Notch; *i*, ilium articulation; *p*, pubic articulation.

The measurements, however, show that the specimen has a smaller scapula and a much longer humerus than *Saurolophus osborni*,[1] and these differences at once separate it from that genus.

*Comparative measurements, in millimeters, of Trachodon sp., Trachodon annectens, and Saurolophus osborni.*

| | Type: *Trachodon annectens* (No. 2414, U.S.N.M.). | Trachodon sp. (No. 7955, U.S.N.M.). | Type: *Saurolophus osborni* (No. 5220, Am. Mus. Nat. Hist.). |
|---|---|---|---|
| Greatest length of scapula | 810 | 910 | 979 |
| Greatest width of blade of scapula | 200 | 208 | 230 |
| Greatest length of humerus | 501 | [a] 760 | 500 |
| Greatest transverse diameter, distal end | 105 | 180 | ............ |

[a] Estimated.

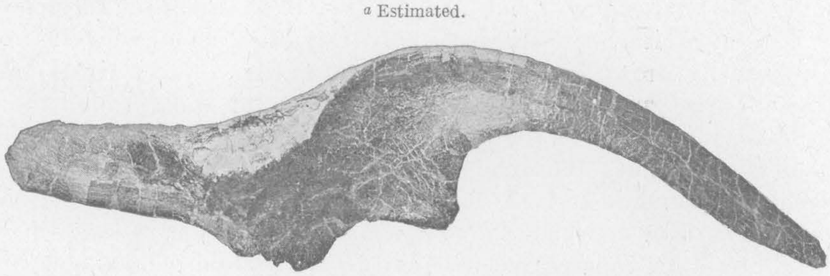


FIGURE 56.—Right ilium of unidentified trachodont reptile. No. 8058, U. S. N. M. One-eighth natural size. Lateral view.

### Family ANKYLOSAURIDAE.

**Europlocephalus sp.**

A coossified transverse row of dermal plates or scutes (see fig. 57) is identified as pertaining to this genus. The keeling of the scutes differs somewhat from a row of plates pertaining to the type of *Europlocephalus tutus* Lambe, from Belly River, Canada, as figured by Lambe.[2]

[1] Brown, Barnum, The skeleton of *Saurolophus*, a crested duck-billed dinosaur from the Edmonton Cretaceous: Am. Mus. Nat. Hist. Bull., vol. 32, p. 392, 1913.

[2] Lambe, L. M., On Vertebrata of the Mid-Cretaceous of the Northwest Territory: Contr. Canadian Paleontology, vol. 3, pt. 2, pl. 12, figs. 3, 4, 1902.

The specimen was found on Milk River, a short distance from the place where the type of *Brachyceratops montanensis* was discovered, at a slightly higher horizon. It consists of two entire scutes and a portion of a third, all firmly coossified. The under surface is arched transversely and probably represents the first row of plates posterior to the skull. The plates are subrectangular in outline, wider than long, with a raised median portion that is longer than wide, and is surmounted by a blunt nodelike spine asymmetrically placed, as contrasted with the sharply keeled scutes of *Europlocephalus tutus* Lambe.

The union of the plates on the dorsal surface is plainly discernible, but the sutures on the ventral side are entirely obliterated. Vascular markings are conspicuous on the upper surfaces, especially on the raised median portions. (See fig. 57.) Although this specimen is identified as pertaining to the genus *Europlocephalus*, it might with equal propriety be referred to *Ankylosaurus*, or it may represent an undescribed form.

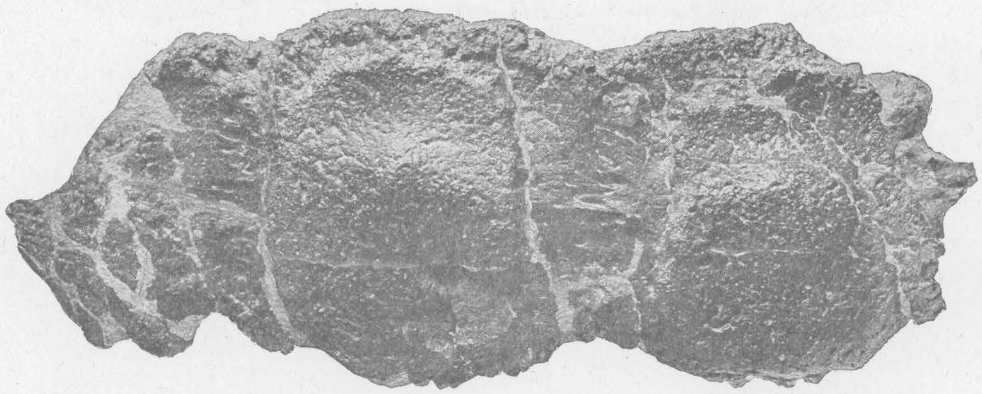


FIGURE 57.—Dermal plates of *Europlocephalus* sp. No. 7943, U. S. N. M. One-third natural size. Dorsal view.

## Class CHELONIA.

### Basilemys sp.

The genus *Basilemys* is represented by fragmentary parts of the carapace and plastron, several vertebral centra, one humerus, and fragments of other limb bones, all regarded as belonging to one individual (No. 8024, U. S. N. M.).

Dr. O. P. Hay was kind enough to spend some time in studying the specimen, and he is of the opinion that it belongs either to *Basilemys nobilis* Hay, the type of which is from the beds in New Mexico described by Brown as the Ojo Alamo formation, or to a closely related species. *B. nobilis* has as its distinguishing character a high ridge, or wall, around the upper side of the hinder lobe of the plastron. In the specimen this ridge is high in front but is reduced farther behind and is rather flat. This change may possibly be due to individual variation.

The specimen was found in sec. 27, T. 37 N., R. 8 W., on the south side of Milk River, somewhat below the horizon in which the *Hypacrosaurus* skeleton (No. 7948) was obtained. The specimen is of interest as apparently corroborating the dinosaurian evidence for the correlation of the Belly River formation with Brown's Ojo Alamo formation.[1]

[1] Sinclair, W. J., and Granger, Walter, Paleocene deposits of the San Juan Basin, N. Mex.: Am. Mus. Nat. Hist. Bull., vol. 33, pp. 302, 303, 1914.

# INDEX.