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CERATOPSIAN DINOSAURS FROM THE TWO MEDICINE FORMATION, UPPER CRETACEOUS OF MONTANA

By Charles W. Gilmore

Three expeditions for dinosaurian remains have now been conducted by me to the Two Medicine formation, as exposed on the Blackfeet Indian Reservation in northern Montana. These explorations have resulted in the accumulation of a considerable number of dinosaurian specimens, among which are several pertaining to the Ceratopsia that are of more than ordinary interest.

The first expedition, in 1913, under the auspices of the U. S. Geological Survey, discovered the type and other materials of *Brachyceratops montanensis*,[1] all juvenile specimens; the second, in 1928, recovered the type of *Styracosaurus ovatus*,[2] and portions of the skull and skeleton of a *Monoclonius flexus;* and the third, in 1935, yielded two fragmentary skeletons pertaining to the genus *Leptoceratops* and a disarticulated skull and a few bones of a nearly adult *Brachyceratops montanensis.* These specimens of the 1935 expedition are described in the present paper. The figures illustrating them were drawn by Sydney Prentice.

Family PROTOCERATOPSIDAE

Genus LEPTOCERATOPS Brown

LEPTOCERATOPS species

The two specimens of *Leptoceratops* found in the Two Medicine formation for the most part are very fragmentary, but sufficiently

[1] Gilmore, C. W., Smithsonian Misc. Coll., vol. 63, No. 3, pp. 1–10, 1914.
[2] Gilmore, C. W., Proc. U. S. Nat. Mus., vol. 77, art. 16, pp. 36, 37, pl. 10, figs. 1, 2, 1930.

diagnostic parts were present to indicate clearly that their affinities are with this genus. They are the first recognizable remains of *Leptoceratops* to be found in the Two Medicine formation, and their discovery considerably extends the known geological and geographical range of this little-known dinosaur. A nearly complete articulated hind limb and foot contributes to a better understanding of the skeletal anatomy, as a complete pes was previously unknown.

The genus *Leptoceratops* was founded [3] upon an incomplete skeleton from the Edmonton formation in southern Alberta, and in 1916 a fine skeleton lacking the skull was discovered near the bottom of the St. Mary River formation in Montana, which lies above the Two Medicine. This latter specimen is now mounted in the American Museum of Natural History.

The occurrence of *Leptoceratops* in the Two Medicine formation would suggest, on geological position alone, that it probably represents a species distinct from these found in the Edmonton and St. Mary River formations. Comparison, however, fails to disclose in the materials now available any character, except size, that would serve to distinguish them. Through the courtesy of Dr. Barnum Brown, limb and foot bones of *Leptoceratops gracilis* were lent me for direct comparison, but the closest agreement was found in all the bones contrasted. The much smaller size of the National Museum specimens is in all probability due to immaturity, as indicated by the open sutures of the skull parts and the noncoalescence of the vertebral processes. For the present I shall, therefore, regard these specimens specifically indeterminable in the hope that the discovery of more complete materials will eventually clear up the uncertainty of their specific identity.

Specimen U.S.N.M. No. 13863 consists of the incomplete right maxillary containing five worn teeth; a premaxillary portion containing the roots of two teeth; six scattered teeth; distal half of right femur; the tibia, fibula, tarsus, and nearly complete pes. All these limb and foot bones were found articulated. Included also are shaft portions of the radius and ulna. Collected by George B. Pearce, July 25, 1935, on the south side of Two Medicine River, Teton County, Mont.

Specimen U.S.N.M. No. 13864 was completely weathered out of the ground, but from the fragmentary parts the following recognizable elements have been pieced together: Nasals, supraoccipital, and portion of parietal; frontals; numerous other unidentified skull parts; four teeth; incomplete predentary; scapula; ischia; ilia; pubes all incomplete; parts of ulnae, radii, femora, and tibiae, a few foot bones. Dorsal, caudal, and sacral centra, pieces of ribs. Collected by George

[3] Brown, Barnum, Bull. Amer. Mus. Nat. Hist., vol. 33, pp. 567–580, 1914.

F. Sternberg, July 30, 1935, on the north side of Two Medicine River, Teton County, Mont.

Description of skull parts.—The frontals are represented by the median transverse portions of both elements, as shown in figure 1. Transversely between the orbital borders the superior surfaces of the cojoined frontals are concave from side to side, being much more strongly dished than the corresponding part of the *Protoceratops* skull. On the posterior border the surface dips downward but is slightly hollowed out on each side of a low longitudinal median ridge. The median posterior border is incomplete and thus gives no indica-

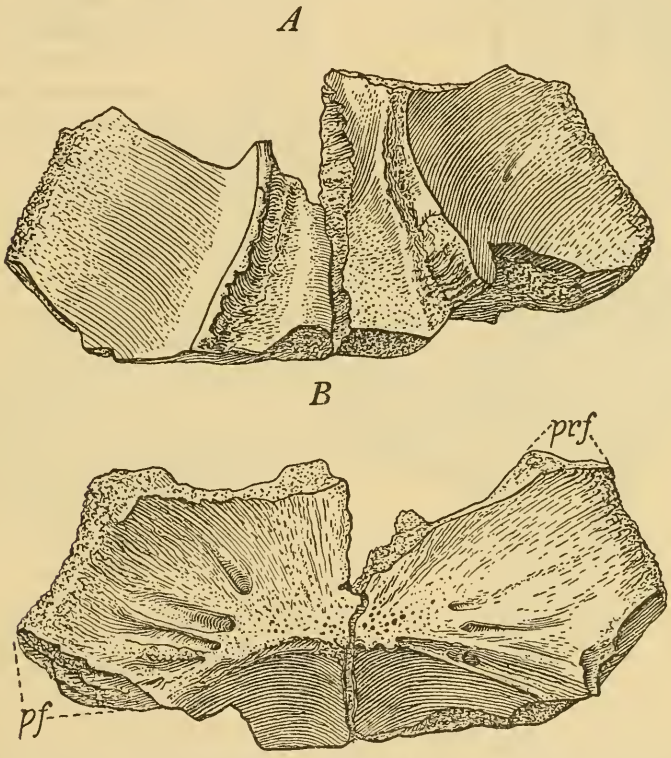

FIGURE 1.—Frontals of *Leptoceratops* sp. (U.S.N.M. No. 13864): *A*, ventral view; *B*, dorsal view. *pf*, Sutural union for postfrontal; *prf*, sutural union for prefrontal. One-half natural size.

tion of its contact with the parietal. The outer posterior border, which looks backward and outward, has a strongly grooved surface for sutural union with the postfrontal. The outer rounded edges, for a space of 22 mm., form the frontal contribution to the orbital rims. The anterior border presents broken surfaces except for portions of the sutural contact for the prefrontals on each side. The superior surface on each side of the midline is perforated by a number of

small foramina that probably carried nutrient blood vessels into the interior of the bones.

On the ventral side the subtriangular central portion forms the roof over the olfactory part of the brain. The roughened grooves at each side of this central area represent the sutural contacts of the frontals with the underlying ethmoid and orbitosphenoid bones. Outside of these sutures the surfaces are smoothly excavated, forming the roof of the orbital cavities. Measured at the center of the orbital rim the frontals have a greatest width of 77 mm. This part of the skull was apparently not recovered with any of the American Museum of Natural History specimens of *Leptoceratops*, and thus it cannot be contrasted with them. From the frontals of the related *Protoceratops* these may be distinguished by the greater concavity of the dorsal surfaces, relatively shorter contribution to the orbital rim, and the more transverse direction of the sutural union with the postfrontal.

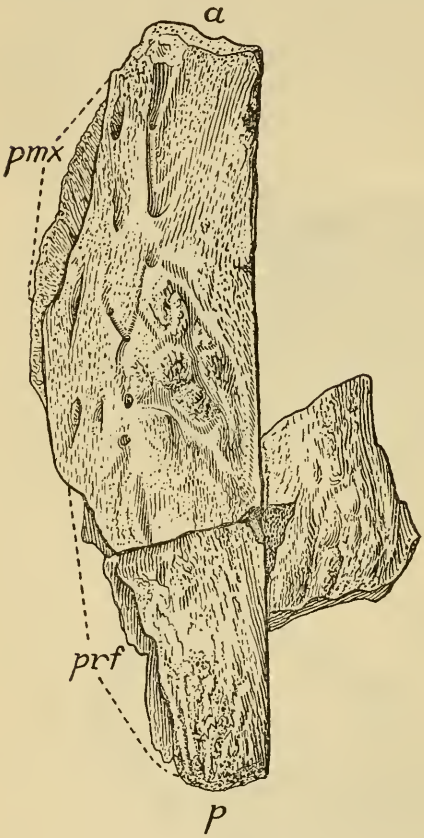

FIGURE 2.—Nasals of *Leptoceratops* sp. (U.S.N.M. No. 13864): Top view. *a*, Anterior; *p*, posterior; *pmx*, sutural surface for articulation with the premaxillary; *prf*, sutural surface for articulation with the prefrontal. One-half natural size.

The nasals are represented by the greater portion of the left, and a small median part of the right, as shown in figure 2. On the median line they are united by a continuous tongue-and-groove suture, as in *Leptoceratops gracilis* Brown.

The anterior end of the left nasal is broken off and missing, but most of its outer lateral border is complete, thus displaying the extent of the sutural contact between it and the ascending process of the premaxillary and with the prefrontal, as indicated in figure 2. Judged from the skull of *Protoceratops* the lachrymal probably filled the intervening space. The external surface of each nasal bone, more especially the median posterior portions, is roughened and further sculptured by shallow grooves, evidently for the transmission of nutrient blood vessels. These surfaces gave no evidence of the

presence of a nasal horn. The internal surface is smooth, with well-defined longitudinal grooves that mark the course of nares superiorly. On the underside at the posterior end the left nasal displays part of the strongly grooved sutural surface for union with the frontal. This end is slightly incomplete.

An incomplete right maxillary containing five posterior teeth is illustrated in figure 3. Most of the borders are incomplete except for the concave posterior border, which has a vertically striated sutural surface for the articulation of the ectopterygoid, and a short median portion of the upper border, which probably articulated with the premaxillary. In *Protoceratops* the pterygoid is said to articulate with this posterior border, no mention being made of the

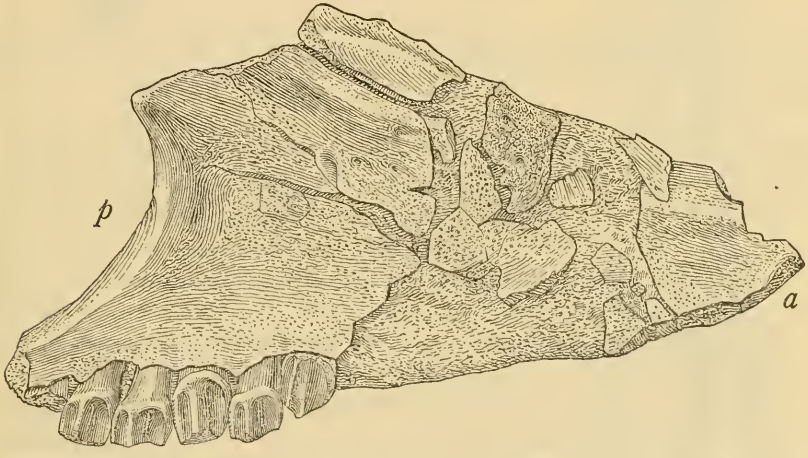

FIGURE 3.—Right maxillary of *Leptoceratops* sp. (U.S.N.M. No. 13863): Lateral view. *a*, Anterior end; *p*, posterior end. Nine-tenths natural size.

ectopterygoid. In *Triceratops*, however, as shown by Hatcher,[4] it is the ectopterygoid that unites with this border. It is quite possible that the ectopterygoid is fused with the pterygoid in *Protoceratops* and was not recognized as a separate element.

A fragmentary bone containing the simple roots of two teeth is identified as the dentigerous border of the premaxillary. Measured from center to center these roots are 8 mm. apart, showing the premaxillary teeth to be more widely spaced than in *Protoceratops*.

No recognizable parts of the frill portion of the skull were found.

Teeth.—The few teeth present except for being slightly smaller are in accord with those of *Leptoceratops gracilis*. The roots are simple, not bifid as in the Ceratopsidae. The fully adult teeth that have not

[4] U. S. Geol. Surv. Monogr. 49, p. 26, fig. 21, 1907

been subjected to wear have transversely compressed crowns that are rounded anteroposteriorly with dentate borders. The four posterior teeth retained in place in the maxillary of U.S.N.M. No. 13683 have the crowns much worn. Their outer surfaces have a characteristic sculp-

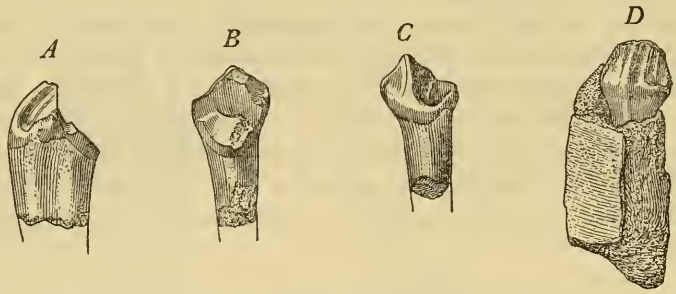

FIGURE 4.—Teeth of *Leptoceratops* sp. (U.S.N.M. No. 13864): Side (*A*), inner (*B*), and outer (*C*) views of worn upper tooth; *D*, inner view of slightly worn lower tooth. Natural size.

ture, consisting of a prominent vertical ridge placed slightly posterior to the middle of the crown and lesser ridges both in front and back of the main carina. While the main ridge merges into the cingulum at the base of the crown, the lesser ridges fade out before reaching the base. On the inner face the surface is sculptured by a series of lesser parallel ridges, which appear to correspond in number to the denticles on the cutting edge. The four teeth in the maxillary (fig. 3) occupy a space 33 mm. in length. In the figures of the teeth of *Leptoceratops gracilis* as illustrated by Brown,[5] they have been inadvertently mislabeled; the outer should be the inner, in both the upper and lower teeth.

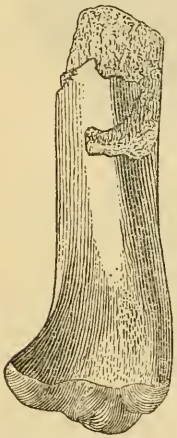

FIGURE 5.—Distal end of right femur *Leptoceratops* sp. (U.S.N.M. No. 13863): External view. One-half natural size.

Hind limb and foot.—The right hand limb and foot of U.S.N.M. No. 13863 were found articulated and for the first time give a complete knowledge of the pes and tarsus in the genus *Leptoceratops*. Only the distal third of the femur is preserved, but it shows the same straight shaft, round in cross section, with distal articular face at right angles to the shaft as found in *L. gracilis*. In outline the distal end is squarish with a deep intercondylar notch (fig. 5).

The tibia is complete, but the proximal end has been badly compressed. The ends are relatively less expanded than in the typical ceratopsians and the shaft is subround, but insofar as it can be com-

[5] Bull. Amer. Mus. Nat. Hist., vol. 33, figs. 2, 6, 1914.

pared with the incomplete tibia of *Leptoceratops gracilis*, except for its smaller size, the bones are in full accord.

The fibula is relatively slender with an expanded proximal end, especially the anterior border, which strongly overhangs the shaft. On the inner side of the upper fourth the fibula is longitudinally hollowed out. The distal end is slightly widened transversely and articulates closely with the calcaneum. The shaft is flattened, with a strong torque in the distal third of the shaft, which throws the greatest diameters of the ends at right angles to one another.

The astragalus is proportionately larger than in *Triceratops* and articulates with two-thirds of the distal end of the tibia (fig. 6). When articulated it shows considerably less from a posterior view than in *Leptoceratops gracilis;* otherwise they are in full accord.

The calcaneum when articulated is applied entirely to the anterior side of the tibia and is hardly visible from a posterior view of this bone. Its superior surface is cupped and receives the distal end of the fibula. Its outer surface is deeply excavated; anteriorly it projects forward prominently beyond the astragulus and presents a broadly convex articular surface dorsoventrally. Its inner side abuts the astragalus.

There are two ossified bones in the distal row of the tarsus. These were slightly displaced in the matrix so that their exact relationship to the metatarsals is somewhat uncertain. The outer one (fig. 7) was not far removed from the end of metatarsal IV, and the presence of a cupped upper articular surface for the calcaneum and a smooth hemispherical distal surface for articulation with the cupped articular end of metatarsal IV indicate its proper position in the tarsus. Viewed from above this bone is quadrangular, and it is thought that its longer diameter is anteroposterior in the articular foot. In this position, which puts the thickened end in front, it makes its most perfect articulation with metatarsal IV and with the calcaneum. The other tarsal is a flattened quadrangular bone, which may have articulated with metatarsals II and III. I find no clue as to its exact position.

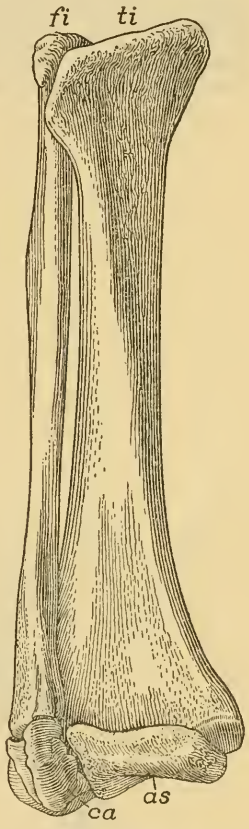

FIGURE 6.—Right tibia, fibula, astragalus, and calcaneums of *Leptoceratops* sp. (U.S.N.M. No. 13863): Anterior view. *as,* Astragulus; *ca,* calcaneum; *fi,* fibula; *ti,* tibia. One-half natural size.

TABLE 1.—*Hind-limb measurements of* Leptoceratops *sp.* (*U.S.N.M. No. 13863*)

Measurement	Mm.
Total length of tibia, including astragalus	200
Total length of fibula, about	190
Greatest diameter anteroposteriorly of tibia, proximal end	72
Greatest diameter transversely of tibia, distal end	62
Least diameter of midshaft of tibia	20
Greatest diameter anteroposteriorly of fibula, proximal end	26
Greatest diameter transversely of fibula, distal end	16
Least diameter of midshaft of fibula	7

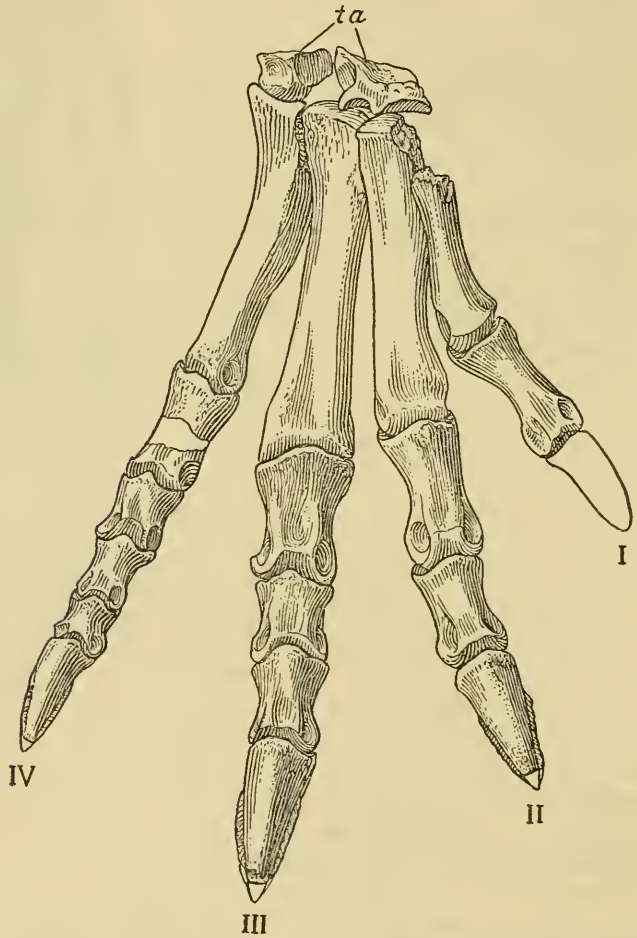

FIGURE 7.—Right pes of *Leptoceratops* sp. (U.S.N.M. No. 13863): *ta*, Distal row of tarsals; I, II, III, and IV, digits 1 to 4, respectively. One-half natural size.

The foot is complete except for the loss of the proximal end of metatarsal I and the ungual phalanx of digit I. It is possible that digit 5 may have been represented by a remnant of the metatarsal, but no trace of this bone was found.

Metatarsal I lacks its upper extremity, but it is quite evident from the relationships of the distal ends in the matrix (fig. 7) that it was about three-fourths the length of metatarsal II. The shaft is very slender, flattened on the inner side where it laps against metatarsal II,

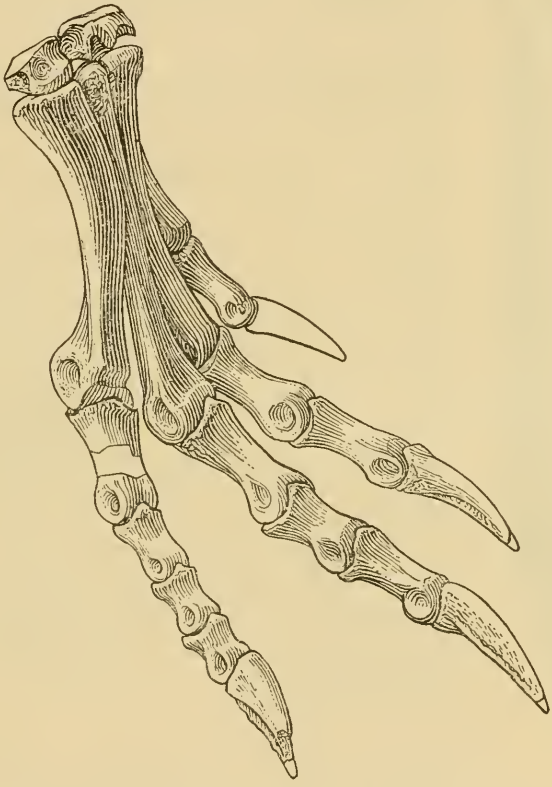

FIGURE 8.—Right pes of *Leptoceratops* sp. (U.S.N.M. No. 13863): Viewed diagonally. One-half natural size.

the lower end divaricated away from the axis of the foot. The articular face is subquadrangular, with the lateral sides of the end excavated, more especially the outer. Metatarsal II is slightly longer than metatarsal IV. The shaft is straight. The proximal end is elongated anteroposteriorly, the distal end transversely. Beginning about one-third its length from the distal end the outer side of the shaft thins out to a sharp edge and presents a flattened surface that looks more backward than outward and is closely opposed to meta-

tarsal III when articulated. Below this beveled articular surface there is a slight divarication of the distal end outward from the axis of the foot. The proximal end is somewhat damaged through crushing, so that its precise form cannot be determined from this specimen. The distal face is quadrangular, the articular surface rounding well up on the anterior face and broadly hollowed out on the posterior side. The outer lateral face is slightly hollowed out.

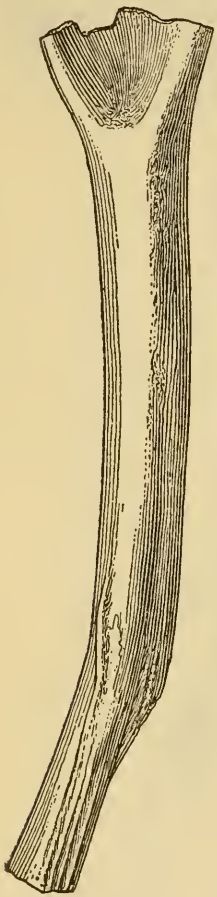

FIGURE 9.—Ischium of *Leptoceratops* sp. (U.S.N.M. No. 13864): Lateral view. One-half natural size.

Metatarsal III is the longest bone of the pes. Viewed from the front the distal end is widest, gradually narrowing to the proximal end where the greatest diameter is anteroposterior. The inner side presents a beveled surface that looks forward and inward for the articulation of metatarsal II. The outer border is flattened on the upper third for the articulation of metatarsal IV.

Metatarsal IV is widely expanded at the proximal end. The proximal articular face is subtriangular in outline, with a cupped surface. The shaft is flattened anteroposteriorly, with the outer border presenting a sharp edge. The inner side shows a hollowed-out proximal surface that becomes flattened ventrally and disappears below the middle of the bone. This flattened surface indicates the contact between metatarsal III and IV. Below this contact the bone is divaricated outward away from the axis of the foot.

The distal end has the greatest diameter anteroposteriorly, and the outer side of the distal end is hollowed out with a strong lip given off from the posterior border.

No trace was found of a vestigial metatarsal V.

The phalangial formula is the typical 2, 3, 4, 5, 0, and all but the ungual of digit I are present. The ends of both the metatarsals and the phalanges present smooth articular surfaces, thus indicating it to be a strong, compact, well-articulated foot.

The proximal phalanges have pully-shaped distal and concave proximal ends. A median, rounded, vertical ridge on the proximal end fits into a corresponding depression on the distal end of another, thus forming a strong union of the phalanges, which permits but little lateral motion. There are moderately deep, well-defined pits

on the sides for the attachment of ligaments on most of the phalanges. The ungual phalanges are depressed as in all predentate Dinosauria, rather bluntly pointed, and slightly curved longitudinally. Digit III bears the most robust ungual.

There is a striking resemblance between this pes and that of *Camptosaurus*, in its general structure. The compact, strong articulations of the metatarsals and phalanges show *Leptoceratops* to have one of the most specialized hind feet of any known quadrupedal dinosaur with the exception of *Protoceratops*, which it closely resembles.

TABLE 2.—*Measurements of hind foot of* Leptoceratops *sp.* (*U. S. N. M. No. 13863*)

Measurement	Digits			
	I	II	III	IV
	Mm.	*Mm.*	*Mm.*	*Mm.*
Greatest length of metatarsals	------	100	108	92
Greatest anteroposterior diameter, proximal end	------	16. 5	------	15. 5
Greatest transverse diameter, proximal end	------	17. 5	------	19
Greatest transverse diameter, distal end	15. 3	18	23	17
Greatest length of first row of phalanges	41. 4	38	37	------
Greatest length of second row of phalanges	------	31	27. 5	21
Greatest length of third row of phalanges	------	35—	29. 5	21
Greatest length of fourth row of phalanges	------	------	41	18. 5
Greatest length of fifth row of phalanges	------	------	------	31—

Pelvic bones.—Portions of both ilia preserved with specimens U.S.N.M. No. 13864 resemble those of *Protoceratops* in having the blade portion nearly vertical and without the reflected upper border, found in other members of the Ceratopsidae. These bones bear a much closer resemblance to the ornithishian ilium than to those of the true horned dinosaurs. Shaft portions of both ischia of this same specimen (fig. 9) show them to be somewhat curved, as contrasted with the straighter ischia of *Protoceratops*.

Both Brown (*loc. cit.*) and Lull [6] have already stressed many points of resemblance between *Leptoceratops* and *Protoceratops*, and these newly acquired materials still further emphasize the nearness of this relationship. The genera, however, are distinctly separate, and I am in full accord with Lull who points out their wide divergence from all other members of the Ceratopsidae.

[6] Mem. Peabody Mus. Nat. Hist., vol. 3, pt. 3, 1933.

Family CERATOPSIDAE

Genus BRACHYCERATOPS Gilmore

BRACHYCERATOPS MONTANENSIS Gilmore

A disarticulated skull and a few bones of the skeleton obtained by the 1935 Smithsonian expedition in northern Montana is clearly referable to the genus *Brachyceratops*. It is of interest in displaying for the first time some of the adult skeletal features of this genus. This specimen is nearly twice the size of the type on which the genus was established, and it further demonstrates the very young character of those materials.

Although the generic relationship is clear, there may be some question as to its specific affinities, but for the present I shall regard it as belonging to *Brachyceratops montanensis*, attributing to more advanced age such differences in structure as are observed between it and the type. The specimen was found about a mile distant from the spot where the type was discovered, and on the south side of Milk River at approximately the same level in the formation.

The following elements of the skull and skeleton (U.S.N.M. No. 14765) were recovered: Right half of the frill lacking the squamosal; articulated left postorbital, jugal, postfrontal and prefrontal, lachrymal and supraorbital; right maxillary containing several teeth; left premaxillary, rostral, a portion of the right half of the nasal horn core; fragment of the basioccipital; unidentified skull fragments; both femora, left scapula, first rib; one dorsal vertebra and two phalangial bones.

This is the first undoubted *Brachyceratops* specimen to be found since the discovery of the types in 1913, and it now enables me to make several corrections in the restoration of the skull published in 1914. Furthermore, several skull elements not present in the type are here described [7] for the first time.

It is in the frill that the greatest growth changes have taken place, and attention is especially directed to the presence of a series of well-developed processes projecting outward from the border of the frill (fig. 10). In my description of the frill of the type specimen,[8] it was pointed out that there were "no epoccipital bones on the margins of the frill but a series of prominences on either side of the median emargination gave the periphery a peculiar scalloped effect." In the light of the specimen now before me it is evident that these prominences were the incipient processes so prominently developed in the adult skull. It further substantiates my original statement that there

[7] Gilmore, C. W., Smithsonian Misc. Coll., vol. 63, No. 3, pls. 1, 2, 1914.
[8] Gilmore, C. W., U. S. Geol. Surv. Prof. Paper 103, p. 12, 1917.

were no epoccipital bones developed on the frill of *Brachyceratops*, these processes being direct outgrowths of the frill itself. There is no indication of sutural contact, and were these processes separate ossifications as in *Triceratops*, *Pentaceratops*, and many other ceratopsian genera, there would be evidence of their union, since all other sutural contacts of the skull are plainly visible.

FIGURE 10.—Interparietal? of *Brachyceratops montanensis* (U.S.N.M. No. 14765): Viewed from above. One-seventh natural size.

Hatcher [9] has pointed out that in *Monoclonius* "they [the epoccipitals] are not derived from separate centers of ossification, as are the epoccipitals in *Triceratops*, but are present even in young individuals, firmly attached to and forming a part of the squamosals and parietals." That he was mistaken in this conclusion is shown by

[9] U. S. Geol. Surv. Monogr. 49, p. 19, 1907.

both Brown [10] and Lull,[11] who have found epoccipitals to be distinct ossifications in skulls of *Monoclonius flexus* studied by them. In a recent letter Dr. Brown says: "In Cope's type of *Monoclonius crassus* I cannot be sure whether they [epoccipitals] are separate."

While it is true that many aged individuals of the Ceratopsidae have complete coalescence of the epoccipital bones with the frill, in *Brachyceratops* we appear to have a type of frill ornamentation whose origin is unlike that of other horned *Dinosauria*.

Most of the epoccipital processes are incomplete, as this portion of the frill was protruding from the bank. There were certainly six, possibly seven, of these processes on the border of the interparietal? as contrasted with four on the *Monoclonius* frill. These decrease in size from above downward. On the left side of the median emargination the first two processes, although incomplete, are abnormal in development, either as the result of a diseased condition or of an old injury. There is no indication of forwardly directed processes at the rear of the fenestra as found in specimens of *Monoclonius*.

Although none of the borders of the fontanelle are preserved, this specimen demonstrates this opening to be farther removed from the central bar than indicated in the first restoration. Viewed laterally (fig. 11) the interparietal? is more concave from end to end than in the juvenile specimens.

The anterior median end is almost completely preserved, and it displays the same sutural borders for articulation as those of the juvenile specimen, which have been fully described.

At the time of describing the detailed skull structure of *B. montanensis*, following Hay [12] and von Huene,[13] the median element previously called parietal was referred to as the dermosupraoccipital or interparietal. Since that time two important papers have been published, Lull's [14] "Revision of the Ceratopsia" and Sternberg's [15] "Homologies of Certain Bones of the Ceratopsian Skull." The former returns to the use of parietal for the median element but without discussing the dissenting opinions; Sternberg, however, presents arguments based on a further study of the type skull of *Styracosaurus albertensis*, in which he attempts to prove this median element of the frill is the parietal, and further dissents from my identification of the postfrontals, which he calls frontals. Although willing to concede that there is reason for a difference of opinion as to my original interpretation of the bones in question, I

[10] Bull. Amer. Mus. Nat. Hist., vol. 33, p. 551, 1914.
[11] Mem. Peabody Mus. Nat. Hist., vol. 3, pt. 3, pp. 33, 34, 1933.
[12] Proc. U. S. Nat. Mus., vol. 36, p. 97, 1909.
[13] Neues Jahrb., Band 2, pp. 150–156, 1912.
[14] Mem. Peabody Mus. Nat. Hist., vol. 3, pt. 3, 1933
[15] Trans. Roy. Soc. Canada, vol. 21, sect. 4, 1927.

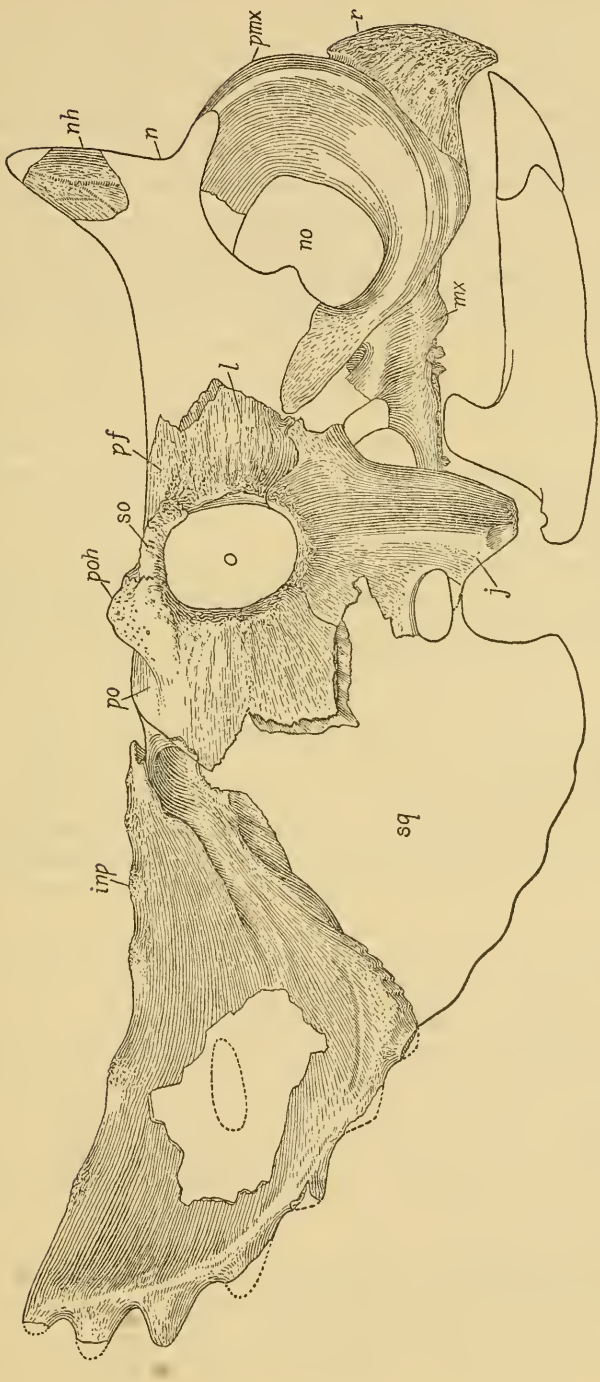

FIGURE 11.—Right lateral view of skull of *Brachyceratops montanensis* (U.S.N.M. No. 14765); *inp*, Interparietal?; *j*, jugal; *l*, lachrymal; *mx*, maxillary; *n*, nasal; *nh*, nasal horncore; *no*, anterior nareal opening; *o*, orbit; *pf*, prefrontal; *pmx*, premaxillary; *po*, postorbital; *poh*, postorbital horncore; *r*, rostral; *sq*, squamosal; *so*, supraorbital. About one-seventh natural size.

cannot believe that the correct answer to this perplexing problem has yet been found. Sternberg, I believe, has correctly determined the limits, and sutural unions of the so-called parietal and frontal bones in the *Styracosaurus* skull, for they are in perfect accord with my original assembly of the scattered elements of the *Brachyceratops* skull and substantiated by the adult specimen under discussion. My objection to accepting the proposed identifications rests entirely on the fact that neither of these bones gives any indication on their ventral surfaces of ever having participated in the formation of the brain case, which they do in all reptilian skulls of which we have knowledge. If it can be shown that they do enter into the formation of the brain case, I will then be willing to accept this latest interpretation.

The presence on one side or the other of most of the lateral elements of the skull now permits of a second restoration of the skull (fig. 11). This reconstruction presents details of some of the structure not given in the first attempt and presents for the first time an illustration of a nearly adult skull of this genus.

Though there is probability of error in assembling the disarticulated elements of a skull, some parts of which were slightly distorted, it is believed this reconstruction gives a fairly accurate representation of the cranium. The more striking growth changes of this specimen as contrasted with the juvenile skull are the development of prominent epoccipital processes along the borders of the frill and the lengthening of the facial region. The latter may be slightly exaggerated in the reconstruction. That fenestra were present in the frill appears to be indicated by the extreme thinness of the bone, although nowhere do the broken borders give any indication of a finished edge. The opening has been tentatively indicated in the drawing.

The left jugal preserved with specimen U.S.N.M. No. 14765 shows for the first time in *Brachyceratops* its exact relationships to the surrounding elements, as this bone was missing in the type specimen. In form it closely resembles the jugal in *Monoclonius*, from which it differs only in minor details. As in *Monoclonius* and *Chasmosaurus* the infratemporal fossa lies principally within the jugal, only its posterior border being formed by the squamosal. Above it forms about one-third of the orbital rim, articulating with the postorbital by a diagonally directed suture at the back of the orbit, and with the lachrymal at the front of the orbit.

Anteriorly the jugal sends forward a short process that is widely notched for union with the superior process of the maxillary. As in *Triceratops* a slender, forward-directed spur is interposed between the lachrymal and maxillary. Posteriorly the lachrymal articulated

with the squamosal, but the damaged condition of this border renders its precise outline somewhat uncertain. The jugal thus forms the external surface of the skull between the orbit and forward of the infratemporal fossa. Its relations to the surrounding elements is well shown in figure 11.

If an epijugal was present in *Brachyceratops* it was extremely small. A small rounded pit on the outer posteroventral border may represent the seat of this missing element (fig. 11).

The lachrymal is a subquadrangular bone that fills the interspace between the jugal below and the prefrontal (frontal of authors) and supraorbital above. Its thickened posterior end contributes to the formation of the anterior border of the orbit for a space of 42 mm. Its lower anterior end is notched and forms the posterior boundary of the preorbital fossa. The upper portion of this end was broadly in contact with the nasal and probably the posterior branch of the premaxillary, a point that cannot be positively determined from this incomplete specimen. Viewed laterally the jugal-lachrymal suture loops downward into the jugal as in *Monoclonius*, instead of continuing straight forward and downward from the orbit as in many ceratopsians.

The supraorbital is a rectangular blocklike bone whose thickened outer border forms the upper anterior portion of the orbital rim between the lachrymal below and the postorbital above. Internally it is wholly in contact with the prefrontal. It is quite evident from this specimen that there is early coalescence of the sutures and that in aged individuals all trace of them would probably be obliterated through fusion. This element was entirely missing in the type, but its presence was indicated by the surrounding sutural borders.

In the right maxillary the unworn crowns of seven young teeth are preserved. Four are near the front of the dental series, probably the second, third, fourth, and fifth. The other three are near the back of the series. These teeth agree in all particulars with the young teeth of the type specimen, which have been described.[16] About the only new information regarding the teeth to be gained from the present specimen is that the anterior teeth are considerably smaller than the posterior ones. The total number of teeth in the maxillary series cannot be positively determined in this specimen, owing to injury of the alveolar borders, but it would seem to be in accord with the original determination of 20.

A median portion of the right half of the nasal horn shows it to be divided into right and left halves as in the type specimen. The internal side is flattened, this surface being sculptured by alternating longitudinal grooves and flat-topped ridges that probably fitted into

[16] Gilmore, C. W., U. S. Geol. Surv. Prof. Paper 103, p. 16, figs. 18–20, 1917.

their counterparts on the opposite side. A portion of the anterior border indicates the horn to have been slightly recurved. The external surface is sculptured by a few longitudinal ramifying vascular grooves.

The left premaxillary is preserved in almost its entirety. It shows the median septum to be more extensive with a resulting diminution in size of the nareal opening through these bones as contrasted with the original restoration of this part of the skull; also the ascending posterior process is longer and thus extends back farther on the side of the face. It closely resembles the premaxillary of *Monoclonius* in being short and deep.

The rostral except for its larger size is in perfect agreement with the rostral of the immature specimens. The outer surfaces are more rugose, a difference naturally expected in an animal of more advanced age.

The left scapula is nearly twice the size of those found with the typical specimens, but it is in accord with them in all respects. The blade is relatively narrower, especially at the center, than in any of the *Monoclonius* scapulae with which it was compared.

The single anterior dorsal vertebral preserved with this specimen agrees in all particulars with those of the type specimen. It shows the same strongly elevated diapophyses with relatively small centrum. The femora are about 580 mm. long, this measurement being uncertain because of the crushing to which both have been subjected. On this account they offer no basis of comparison with those of other members of the Ceratopsia.

In 1933, after reviewing the skeletal characters of the *Brachyceratops* skeleton, Lull[17] remarks: "The relationship of *Brachyceratops* with other genera is obscure." This study of a nearly adult specimen I believe clears up some of that obscurity. It now seems quite apparent that its closest affinities are with the genus *Monoclonius*. The short, deep facial region of the skull; similarities in frill development, especially the short squamosal; small brow horns and large nasal horns; and saddle-shaped crest are all features held in common. A summary of the distinguishing skull features of *Brachyceratops* are as follows: Longitudinal division of the nasal horn; reduced number of teeth in the dental series; epoccipital processes outgrowths of the frill not separate ossifications; greater number of epoccipital processes on the frill; and small fenestra in the frill.

[17] Mem. Peabody Mus. Nat. Hist., vol. 3, pt. 3, p. 102, 1933.

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