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PROTOCERATOPS ANDREWSI, A PRE-CERATOPSIAN DINOSAUR FROM MONGOLIA¹

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With an Appendix on the
STRUCTURAL RELATIONS OF THE *PROTOCERATOPS* BEDS

BY CHARLES P. BERKEY

The type of *Protoceratops andrewsi*, new genus, new species, was discovered on September 2, 1922, by Granger and party on the Kwei-wa-ting trail, east of Artsa Bogdo, Mongolia, during a preliminary geological and palaeontological survey conducted by the Third Asiatic Expedition of The American Museum of Natural History. The specimen consists of a skull, lacking the occiput. It was found by Mr. Shackelford in exposures of red shale in a formation which has been provisionally referred to the Cretaceous by Professor Berkey.²

The skull (A. M. N. H. No. 6251) is hornless and far smaller than that of any known ceratopsian or ankylosaur, being only about 160 mm. in length from the anterior end of the premaxilla to the posterior border of the jugal. As seen from above, it is broadly triangular, with a pointed apex and wide lateral crests, the latter composed chiefly of the backward-and-downwardly expanded jugals. The greatest width of the skull across the posterior borders of the jugals is about 190 mm., while the depth of the jugal below the middle of the orbit is 43 mm. The orbits are very large (50 mm. in anteroposterior length), not surmounted by supraorbital bones or horns. The postorbital-squamosal bar is narrow. Parts of the anterior and lateral borders of the supratemporal fenestra as preserved indicate that the fenestra was large and that the occipital roof was very delicate and not produced as far backward as in later Ceratopsia. The squamosal broadly overlapped the enlarged jugal and was produced posterosuperiorly but was not greatly enlarged. The pineal foramen is small or absent. The single preorbital fossæ are far larger than in other predentates. The premaxillæ were very large and

¹Publications of the Asiatic Expeditions of The American Museum of Natural History. Publication No. 6.

²See Appendix, p. 7, below.

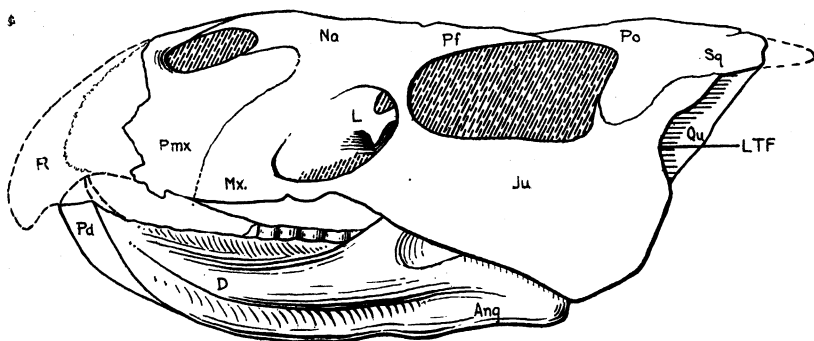


Fig. 1. *Protoceratops andrewsi*, type skull, side view. Position of mandible corrected. $\times \frac{1}{2}$

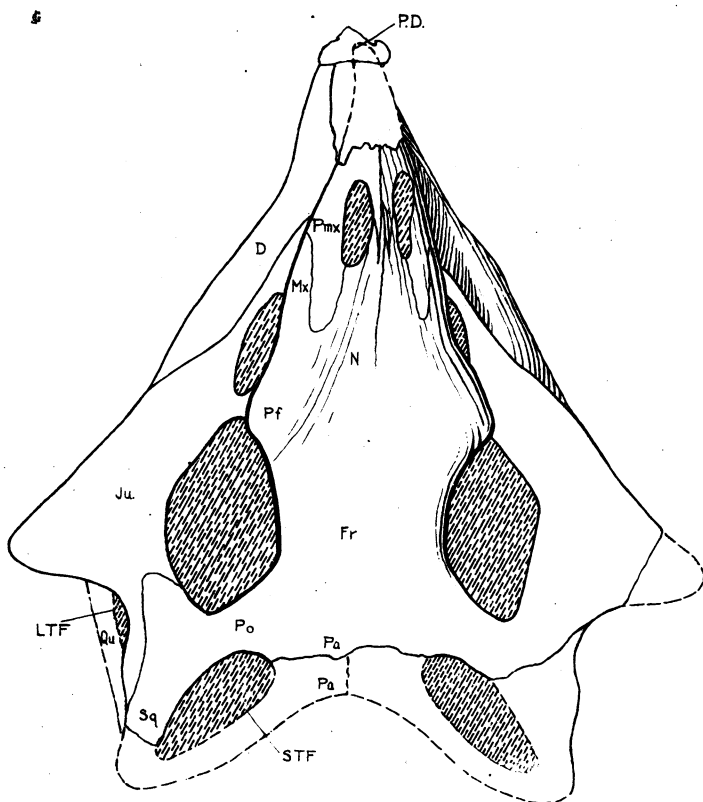


Fig. 2. *Protoceratops andrewsi*, type skull, top view. $\times \frac{1}{2}$

probably supported a large rostral bone, which is broken off; the premaxillæ and nasals approach the ceratopsian type and the same is true of the pterygoids, the internal nares, and the quadrates. The quadratojugal lies on the posterior surface of the quadrate.

The mandible has on each side a straight row of about nine relatively large and long-crowned teeth, worn on their buccal sides and set far inward toward the midline. The remains of the lower molar crowns suggest the three-pointed lower molars of ceratopsians, rather than the spatulate, many-cusped teeth of ankylosaurs and of European *Acanthopholidæ*.¹ The anteroposterior measurement of the four teeth shown in Fig. 1 is 28 mm. The last tooth preserved has its tip about 13 mm. above the alveolus. The first four teeth are represented by their alveoli. The diastema from the first alveolus to the predentary bone was about 14 mm. in length. The strong coronoid process rises from the dentary at a gentle slope. The predentary bone is well developed and has a pair of long inferior processes, one on either side of the midline.

At first sight the specimen suggested the *Procolophonia* in the very large size and backward prolongation of the orbits and in the presence of a lateral crest below and behind the orbit; but reference to that group is excluded, especially by the absence of a large pineal foramen, by the fact that the lateral crest is composed of the jugal instead of the quadratojugal, by the presence of a predentary bone and by the characters of the dentition. *Meiolania*, *Elginia*, the pariasaurs and other reptiles with flaring lateral crests all differ from *Protoceratops* in fundamental characters.

The presence of a predentary bone and the characters of the mandible and dentition positively determine the specimen as an ornithischian (orthopod) dinosaur. Of the Ornithopoda none of the known skulls have expanded lateral crests and there is a general tendency toward dorsoventral flattening of the beak. The squamosal is reduced and widely separate from the jugal, the latter not greatly expanded posteriorly. The Jurassic *Hypsilophodon* has a relatively short and primitive type of skull (Marsh, 1896, Pl. LXXXIV), which might well be the starting-point for the far more specialized conditions of *Protoceratops*.

Of the Stegosauria the most primitive is the Liassic *Scelidosaurus*, a longer skull, the details of which seem to point toward *Stegosaurus*. In the latter the squamosal is small and widely separated from the small jugal, the coronoid process of the dentary is reduced or wanting and

¹For figures of all these see Nopcsa, F. B., 1918, '*Leipsanosaurus*, n. gen. ein neuer Thyreophore aus der Gosau,' Sep. Földtani Közlemény, XLVIII, Taf. III.

the beak is somewhat flattened dorsoventrally. The Acanthopholidæ have small heads and spatulate, many-cusped teeth. The ankylosaurs agree with *Protoceratops*, rather than with *Stegosaurus*, in the characters of the temporal region, but have acquired a heavily armored skull roof and expanded muzzles.

The true Ceratopsia, hitherto unknown below the Upper Cretaceous of America, are all far larger than *Protoceratops*; all of them have horns; the crest is much expanded above and behind the occiput; there are epoccipital and supraorbital bones; and the orbit is small, placed high up and bounded by a wide postorbital bar. The preorbital fossa is reduced to a small slit.

As *Protoceratops* presents the opposite of these characters, it may prove necessary to erect for it a new suborder (Protoceratopsia) but we prefer at present to regard it only as the type of a new and probably primitive family, the **Protoceratopsidæ**, characterized by the lack of horns, the very large size of the orbits, and the narrowness of the post-orbital-squamosal bar.

Protoceratops thus stands far below the Upper Cretaceous ceratopsians and structurally it tends to bridge the long gap between the latter and such primitive Jurassic Ornithopoda as *Hypsilophodon*.

The *Protoceratops* skull tends also to settle the relationships of the ankylosaurs. The latter differ widely from *Stegosaurus* and resemble the Ceratopsia in the temporal region of the skull, in the reduction of the pubis to a vestige and in the outward growth of the dorsal border of the ilium. Abel¹ groups them with the Ceratopsia, and *Protoceratops* may prove to be near the common ancestor of the two groups.

In conclusion, the discovery of *Protoceratops* constitutes one of the foremost items of direct evidence in support of the view advocated especially by Osborn and Matthew, namely that, as the palæontologic record of Asia is more fully explored, it will fill many gaps in our knowledge of the origin, evolution, and migrations of the late Mesozoic and Tertiary faunæ of western North America and Europe.

We therefore take pleasure in dedicating this important type to Mr. Roy C. Andrews in recognition of his splendid qualities as the organizer and leader of the American Museum Third Asiatic Expedition.

¹Abel, O., 1919, 'Die Stämme der Wirbeltiere,' p. 653.

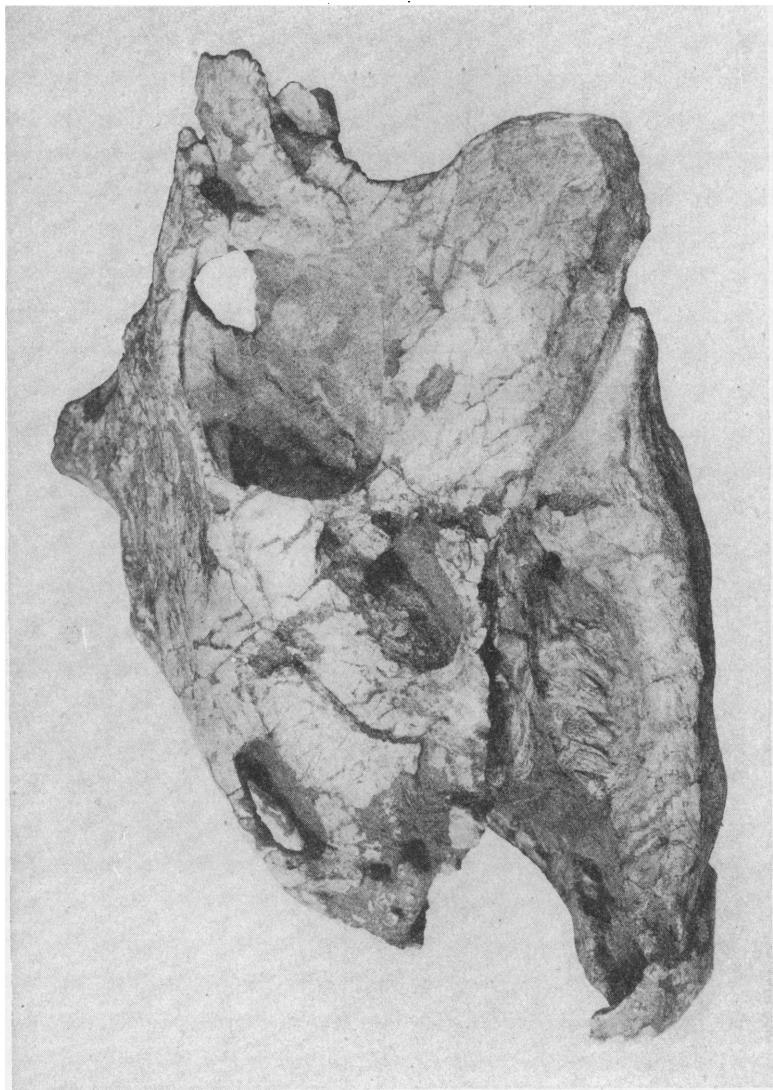


Fig. 3. *Protoceratops andrewsi*, type skull, oblique side view. About two-thirds natural size.

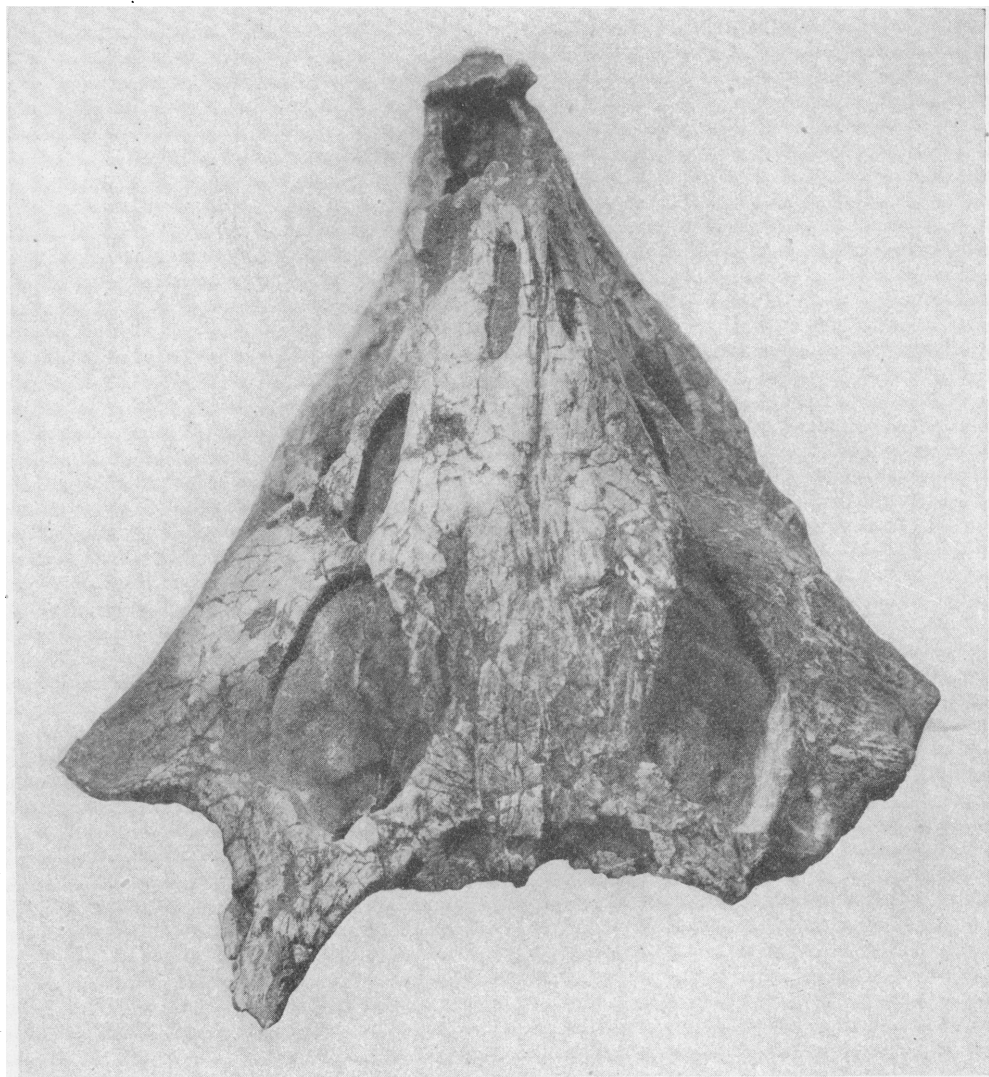


Fig. 4. *Protoceratops andrewsi*, type skull, top view. Two-thirds natural size.

APPENDIX

STRUCTURAL RELATIONS OF THE PROTOCERATOPS BEDS

BY CHARLES P. BERKEY

The type *Protoceratops andrewsi*, described by Professor Gregory, was found on the return journey by Mr. Shackleford in making a rapid inspection of some ground a short distance from the trail while waiting for the rest of the party. A few minutes later all came up and joined in a search of the locality. The finds made in the first few minutes of the stop netted some fine specimens, although none surpassed the first one; and all proved to be so unusual in character that it was decided to spend the remaining two hours of daylight in fossil hunting. The next morning the expedition moved on.

The ground would undoubtedly richly reward a more extended investigation. We touched only one spot and each one of the party carried off a load of specimens, leaving behind in our hurry many others either too fragmentary or too heavy or too much imbedded in the rock for recovery.

The spot is on the north side of the Kwei-wa-ting trail, 50 miles east of Artsa Bogdo. The rocks are red, friable sandstones and shaly sandstones which are very well exposed at this point by erosion. Badland cliffs and remnants, more than 200 feet in total relief, form an escarpment here and mark the beginnings of a considerably dissected country extending for many miles northward and eastward, quite in contrast to the smooth peneplane surface over which the trail had led to this point. In fact, at a distance of less than half a mile the escarpment is not noticeable from the upper plain, although one can see that there is a belt of lower ground off to the side.

Beds of the same series and of apparently the same physical relations were crossed by Morris and Berkey on their side trip with camels from Artsa Bogdo to a large mountain group known as the Gurban Saikhan. Several hundred feet of red, sandy beds were seen on the north margin of the Gurban Saikhan, but where the examination was made the beds were barren. The Kwei-wa-ting trail, where the fossils were found, passes north of the Gurban Saikhan at a distance of 20 or 30 miles out on the open plain.

Although there was no time for local side study of the stratigraphic relations in this vicinity, enough of the geology was determined by this earlier trip to the Gurban Saikhan and by the continuous route-cross-section work kept up by the geologic staff to fix these strata structurally

within certain well-prescribed limits. They lie well above the great Jurassic or post-Jurassic unconformity, which is the most marked structural break in central Mongolia. They also lie beneath an early Tertiary or pre-Tertiary unconformity of much less physical prominence, these strata thus partaking of a deformation that antedates all Tertiary sediments.

They are to be regarded, therefore, as belonging to the same series that has been referred to in our reports as of Cretaceous age, using the term in its large sense to cover everything thus far found between the Jurassic strata on one side and Tertiary beds on the other.

This series doubtless does cover a very wide range. Some of the beds may correlate with the Comanchic of America. In Mongolia the series must for the present be kept flexible enough and broad enough to include the dinosaur-bearing beds of Iren Dabasu (already described in Amer. Mus. Novitates No. 42), the Ondai Sair dinosaur-bearing formation of the Hsanda Gol region, and the dinosaur-bearing Ashile formation of the basins north of Artsa Bogdo.

The relative positions in the time scale of these different local developments are yet to be determined, but they probably can be fixed definitely with the material already collected or to be collected this year. A tabulation of locality formational terms, without insistence on the significance of the order, is as follows:

Cenozoic	Tertiary		
		Unconformity.....	
Later Mesozoic	Cretaceous	Shamo Series	{ Iren Dabasu Formation Ondai Sair Formation Ashile Formation Dja-doch-ta Formation (<i>Protoceratops</i> Beds)
		Great Unconformity	
Earlier Mesozoic	Jurassic		

The beds seen at the Gurban Saikhan, together with these at Dja-doch-ta furnishing the *Protoceratops* remains along the Kwei-wa-ting trail, doubtless are identical with those seen by Chernov, the geologist

of the Kosloff expedition and referred to by him as the Red Khan-Khai beds. Khan-Khai is a well-established term introduced by von Richthofen and has been widely used, apparently rather indiscriminately, for any or all of the later sedimentary beds supposed by the earlier observers to have been formed in the disappearing or evaporating sea. But it is loosely used and undoubtedly has served to cover strata of a large range of age relations. Perhaps it is inadvisable now to attempt any narrower limitation. It is proposed therefore to introduce the term *SHAMO SERIES* for all of the later Mesozoic strata above the Great Unconformity.

