This page intentionally left blank.

SMITHSONIAN MISCELLANEOUS COLLECTIONS
VOLUME 72, NUMBER 14

A NEW SAUROPOD DINOSAUR FROM THE OJO ALAMO FORMATION OF NEW MEXICO

(With Two Plates)

BY

CHARLES W. GILMORE

Associate Curator, Division of Paleontology, U. S. National Museum

(Publication 2663)

CITY OF WASHINGTON
PUBLISHED BY THE SMITHSONIAN INSTITUTION
JANUARY 31, 1922

The Lord Baltimore Press
BALTIMORE, MD., U. S. A.

A NEW SAUROPOD DINOSAUR FROM THE OJO ALAMO FORMATION OF NEW MEXICO

By Charles W. Gilmore,
ASSOCIATE CURATOR, DIVISION OF PALEONTOLOGY, UNITED STATES NATIONAL MUSEUM

(With Two Plates)

INTRODUCTION

In a brief note[1] I have recently announced the discovery by Mr. John B. Reeside, Jr., geologist of the United States Geological Survey, of Sauropodous dinosaur remains in the Upper Cretaceous of New Mexico, and it is now proposed to give a more detailed account of the specimens and of their exact geological occurrence than was possible in the preliminary notice.

The remains so far recovered consist of a left scapula and a right ischium, both in a good state of preservation. The great importance of these particular bones lies in the fact that the remains of Sauropodous dinosaurs have not previously been known to occur above the Lower Cretaceous in North America, so that the extension of their geological range into the Upper Cretaceous is of the greatest paleontologic and geologic interest.

It is particularly fortunate that this discovery should have been made by a trained geologist of Mr. Reeside's attainments, and in a section so well established as to preclude the possibility of question as to their late position in the geological column.

That these bones pertain to a member of the Sauropoda is indicated by their immense size and also by their close general resemblance to homologous elements of the typical Sauropoda from the Morrison formation. Marked differences in details, however, more especially in the ischium, in conjunction with the very late geological occurrence, makes it necessary to establish a new genus and species for their reception, for which the name *Alamosaurus sanjuanensis* is proposed.

DESCRIPTION

ALAMOSAURUS, new genus

The characters of this genus are included in the following description of the type species:

---

[1] Science (N. S.), vol. LIV, 1921, p. 274.

ALAMOSAURUS SANJUANENSIS, new species

Plates 1, 2

Type.—Cat. No. 10,486, U. S. N. M., consists of the nearly complete left scapula.

Paratype.—Cat. No. 10,487, U. S. N. M., consists of the nearly complete right ischium.

Type locality.—Barrel Spring Arroyo, one mile south of Ojo Alamo, San Juan County, New Mexico.

Horizon.—Ojo Alamo formation, Upper Cretaceous.

Collector.—J. B. Reeside, Jr., June, 1921.

The scapula and ischium designated as the type and paratype, respectively, were found in the same geological horizon, but some 200 feet distant from one another. While it is quite possible that both may pertain to the same individual, it is thought best to regard them as distinct until their closer relationship can be more positively established.

Scapula.—The scapula is in a good state of preservation except for the loss of a portion of the proximal or articular end (see pl. 1) where it projected above the ground and was weathered away. The suprascapular end is also incomplete, though apparently only the border is missing. In size this bone rivals the largest of the *Camarasaurus* scapulae described by Messrs. Osborn and Mook,[1] since as preserved its greatest length is 155 cm. (60 inches), and it is conservatively estimated that the total length of the complete bone would have been at least 170 cm. (68 inches).

In outline, as shown in plate 1, the blade of the scapula differs from any described form in that there is a gradual widening of the shaft from below upward to the superior end, there being no especial expansion of the anterior border as found in *Camarasaurus,* nor rapid superior expansion of both borders as found in *Diplodocus* and *Haplocanthosaurus.* While this portion of the bone is heavy it is not so massive as in *Camarasaurus,* being much thinner. The superior end is flattened out, though the external surface becomes convex transversely as the middle of the bone is approached. From end to end the bone is curved as in other members of the Sauropoda. Both anterior and posterior borders thin out to sharp edges, this condition continuing downward half its total length. Immediately above the point where the anterior border begins to turn upward to form the prescapular expansion of the lower end the border becomes thick-

[1] Memoirs Amer. Mus. Nat. Hist., new ser., vol. 3, pt. 3, 1921, p. 341, fig. 74.

ened and rounded. The posterior border, however, continues downward as a fairly sharp edge to the downward swing of this border to form the glenoid socket where the bone rapidly thickens transversely.

The spine or ridge on the lower external surface extends from the base of the shaft in an anterior direction to the anterior-superior border, and at right angles to the longitudinal axis of the bone. This ridge is not greatly elevated except that on the side toward the coracoidal border the bone is rapidly and deeply excavated, forming a muscle fossa of great extent. On the upper side of this ridge the surface of the bone slopes off gradually to the border, there being no excavation or superior fossa such as is found in so many Sauropod scapulae.

MEASUREMENTS

	Centimeters
Greatest length of scapula (as preserved)	155
" " " " (estimated)	170
Greatest breadth of superior end	45
Least breadth of shaft	29
Greatest breadth inferior (oblique)	82
Thickness of shaft at center	29

Ischium.—A large bone found in the same horizon but some 200 feet distant from the scapula described above is identified as the right ischium of a Sauropod dinosaur. This bone differs so from other Sauropod ischia that its true nature was determined with difficulty. That it pertains to a member of the Sauropoda is indicated by its large size and also by its general resemblance, though differing markedly from any described form. It is characterized by its extreme shortness, and especially by the lack of the long, slender posterior extension so characteristic of other Sauropod ischia.

The proximal portion is nearly complete, lacking only a small portion of the sharp inner edge of the acetabular border. The distal end, though not perfect, apparently lacks but little of being complete. Likewise the thin inner border below the articulation for the pubis is slightly imperfect. Except for the missing portions mentioned, the bone is in a remarkably fine state of preservation.

The expanded proximal end is unusual, not so much because of its great antero-posterior extent, but on account of the great dorso-ventral diameter, and especially the great length of the pubic articulation which extends distalward more than one-half the total length of the bone. Below the pubic articulation the inner border presents a thin, sharp edge, and the flattened distal portion gradually diminishes in width to the distal end. This end is apparently without distal

expansion, though the incomplete surfaces makes this point slightly uncertain. Neither can it be definitely determined whether the ischia met on the median line, though I am inclined to think they did. The rounded and somewhat thickened posterior border is deeply concave from end to end. The sweep downward from the iliac articulation is especially pronounced. On the posterior external surface at the mid-length of the bone is a raised ridge with roughened surface marking the point of insertion for a strong muscle.

The form and principal features of this bone are well shown in plate 2.

MEASUREMENTS

	Centimeters
Greatest length	81
Greatest width of proximal end	44.5
Greatest width at lower end of pubic articulation	32
Greatest length of pubic articular surface	37.5
Greatest transverse diameter of articular end for ilium	10.5

RELATIONSHIPS

The scapula cannot be closely correlated with any of those of described genera, and the ischium differs so much in its details from those with which it has been compared as to indicate an animal with a considerably different pelvic structure than any of the Sauropoda with which we are acquainted to-day. That both of these bones pertain to the same individual cannot be proven, but that both are Sauropod in aspect seems certain.

In size the scapula approaches *Camarasaurus,* but it differs by the non-expansion of the upper anterior border and the very much thinner blade; from *Diplodocus* it is to be distinguished by its larger size and the direction of the spine in relation to the longitudinal axis. In the present specimen this angle is approximately 90°, whereas in *Diplodocus* and *Amphicoelus* it is acute. The scapulae of *Apatosaurus, Amphicoelus,* and *Brachiosaurus* are more slender and with a much more constricted shaft at their narrowest width. *Haplocanthosaurus* is very much smaller and has a very different outline.

GEOLOGICAL OCCURRENCE

At my request Mr. Reeside prepared the following note on the stratigraphy:

NOTE ON THE STRATIGRAPHY OF SAN JUAN COUNTY, NEW MEXICO, WITH ESPECIAL REFERENCE TO THE OCCURRENCE OF DINOSAURS

The oldest rocks exposed in San Juan County, New Mexico, have been assigned to the McElmo formation of Jurassic or Lower Cretaceous age. The overlying rocks, of Upper Cretaceous and Tertiary age, have been divided into

a number of units named in ascending order as follows: Dakota sandstone, Mancos shale, Point Lookout sandstone, Menefee formation, Cliff House standstone, Lewis shale, Pictured Cliffs sandstone, Fruitland formation, Kirtland shale with included Farmington sandstone member, Ojo Alamo sandstone, Puerco formation, Torrejon formation, and Wasatch formation. The Point Lookout sandstone, Menefee formation, and Cliff House sandstone comprise the Mesaverde formation of the older literature and the Pictured Cliffs sandstone, Fruitland formation, and Kirtland shale, the Laramie formation. The Dakota sandstone contains coal beds and other plant remains and grades into the overlying Mancos shale. The formations from the Mancos shale to the Pictured Cliffs sandstone, inclusive, are marine except parts of the Menefee formation which are brackish and fresh water deposits with coal beds. The lower part of the Fruitland formation contains a transition series of brackish water beds and the upper part and all of the overlying formations are fluviatile deposits. The Mancos shale represents in large part the Benton shale and Niobrara formation of the region east of the Rocky Mountains. Its extreme upper part, however, is the equivalent of the basal part of the Pierre shale. The Mesaverde group, Lewis shale, and Pictured Cliffs sandstone contain invertebrates of Montana age, and the Fruitland and Kirtland formations, plants, invertebrates, and reptiles of Montana age. These beds definitely assignable to the Upper Cretaceous, *i. e.*, from Dakota sandstone to Kirtland shale, inclusive, are a comformable series 5,500 feet thick, of which about 4,000 feet are of Montana age. The age of the Ojo Alamo sandstone is in dispute. It has been assigned by some writers on the basis of its dinosaur fauna to the Montana group and correlated with the Judith River beds. It is separated from the Kirtland shale by a widespread unconformity and has been correlated on that ground by other writers with the Denver and Raton formations of post-Montana age. The Puerco and Torrejon formations contain large mammalian faunas and are usually placed in the Tertiary, though some writers would place them in the Cretaceous. The Wasatch formation is universally accepted as Tertiary.

Dinosaur remains have been found in the Fruitland formation, throughout the Kirtland shale, and in the Ojo Alamo sandstone. The sauropod bones found in June, 1921, came from the lower part of the Ojo Alamo sandstone on Barrel Spring Arroyo, one mile south of Ojo Alamo. A detailed section at this locality is as follows:[1]

Ojo Alamo sandstone:	Feet
Sandstone, conglomeratic; top eroded	15+
Shale, dark greenish gray	7
Sandstone, soft, nearly white, crossbedded; contains gray argillaceous streaks and brown concretions	21
Shale, wine red, with local gray sandstone lenses	5
Sandstone, soft, white, crossbedded; contains brown concretions in the lower part	10
Sandstone, brown, platy, ferruginous	1
Shale, dark bluish gray to purple, sandy	4

[1] See Bauer, C. M., Stratigraphy of a part of the Chaco River Valley. U. S. Geol. Survey Prof. Paper 98, pl. 69 and pl. 70, 1916. This locality is shown as locality 67 on plate 69 and the stratigraphic section as section R on plate 70.

	Feet
Ojo Alamo sandstone:—Continued.	
Sandstone, soft white, conglomeratic; contains brown concretions; horizon of the sauropod and other bones	6
Sandstone, yellow to brown, conglomeratic; contains an abundance of siliceous pebbles as large as 3 inches in diameter	5
Unconformity.	
Kirtland shale:	
Shale, gray to drab, with several wine red layers; scattered dinosaur bones	30
Sandstone with lenses of grit, fine conglomerate, and many clay pellets	10
Shale, gray	20±
Farmington sandstone member: brown indurated sandstone and gray shale	80±
Shale, gray to drab, and sandstone, soft, gray-white	1000±
Fruitland formation:	
Sandstone, shale, and coal.	

Directly associated with the bones of *Alamosaurus* are many other fragmentary and undeterminable dinosaur bones, teeth of carnivorous and Ceratopsian dinosaurs, dermal plates of an armored form, turtle fragments, and crocodile bones. At nearly the same horizon in adjacent localities on Barrel Spring Arroyo there were obtained part of the frill of an undetermined Ceratopsian[1] different from known forms, dermal plates of an armored dinosaur,[2] incomplete vertebrae of a carnivorous dinosaur as large as *Tyrannosaurus*,[3] fragments of a Ceratopsian frill marked with radiating vasicular grooves like those of *Triceratops*, but indeterminable.[4] This horizon is also the source of the maxillary and fragments of a skull collected by Sinclair and Granger and identified by Brown as *Kritosaurus navajovius*.[5]

From the uppermost part of the Kirtland shale near this locality have been collected specimens that are closely related to species known to be of Montana age: *Kritosaurus navajovius* Brown, skull and

---

[1] Gilmore, C. W., Reptilian faunas of the Torrejon, Puerco, and underlying Upper Cretaceous formations of San Juan County, New Mexico: U. S. Geol. Survey Prof. Paper 119, p. 65, 1919.

[2] Idem, p. 65, pl. 26, fig. 2.

[3] Idem, p. 67.

[4] Gilmore, Vertebrate faunas of the Ojo Alamo, Kirtland, and Fruitland formations: U. S. Geol. Survey Prof. Paper 98, p. 287, 1916.

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

other bones[1]; *Monoclonius* sp., horn core and fragments of frill[2]; armored dinosaur suggesting a Belly River genus,[3] humerus; a carnivorous form suggesting *Dryptosaurus* or *Dynamosaurus,* dentary[4]; undeterminable fragments of other trachodont, ceratopsian, and carnivorous dinosaurs; turtle and crocodile bones.

In 1910 the late Dr. S. W. Williston[5] reported the discovery of a Sauropod coracoid in the Trinity Sand of Oklahoma, Lower Cretaceous in age, which, in so far as western North America is concerned, represented the latest occurrence of Sauropod dinosaurs, up to the time of the present discovery. In the eastern United States, Sauropod dinosaurs (*Astrodon, Pleurocoelus*) have been known as occurring in the Arundel (Potomac) formation since Marsh first described them in 1888, but for a long time the Arundel was correlated with the Morrison formation (Atlantosaurus beds) of the west, but more recently, largely on paleobotanical evidence, it has been referred to the Lower Cretaceous. A recent restudy of the Arundel vertebrates[6] appears to indicate a higher position in the Lower Cretaceous than has previously been given them. It is also of interest that the Maryland Sauropoda are found associated with the remains of other dinosaurs having undoubted Upper Cretaceous affinities, as is the case with the bones now under discussion.

It thus appears that these specimens, found under conditions which allow no question of doubt to be raised, furnish the first indisputable evidence of the occurrence of Sauropodous dinosaurs in the Upper Cretaceous of North America.

REPORTED DISCOVERIES OF SAUROPOD REMAINS IN UPPER CRETACEOUS DEPOSITS

There have been a considerable number of reported occurrences of Sauropod dinosaur remains in Upper Cretaceous deposits in various parts of the world. Those recorded are from India, southern France, South America, Madagascar, German East Africa, and Egypt. These

---

[1] Brown, Barnum, The Cretaceous Ojo Alamo beds of New Mexico, with description of the new dinosaur genus Kritosaurus: Am. Mus. Nat. Hist. Bull., vol. 28, p. 269, 1910.

Gilmore, C. W., Vertebrate faunas of the Ojo Alamo, Kirtland, and Fruitland formations, U. S. Geol. Surv. Prof. Paper No. 98, pp. 283-284, fig. 28; p. 285, 1916.

[2] Brown, Barnum, idem, p. 278.

[3] Gilmore, C. W., idem, p. 287.

[4] Gilmore, C. W., idem, p. 288, pl. 73, fig. 1.

[5] See Larkin, Pierce, Journ. Geol., vol. 18, No. 1, 1910, p. 93.

[6] Gilmore, C. W., Proc. U. S. Nat. Mus., vol. 59, 1921, pp. 581-594, pls. 110-114.

finds, however, have been called into question for one cause or another, so that as the evidence stands to-day, their exact status is very unsatisfactory.

Below I shall briefly review these various discoveries, although no attempt will be made to critically re-examine the evidence, however desirable that may be. I feel that in this problem I should defer to those having a wider knowledge of geological structures, and especially to those who have available extensive collections of Sauropodous dinosaur materials with which to make the necessary comparisons.

Taken in chronological order these reported finds are as follows:

1. Apparently the first Sauropod remains to be described from the Middle Cretaceous or above were those found in the Lamenta beds, probably Cenomanian, near Jabalpur, India. These specimens were described by Falconer[1] in 1862, without name, and it was 1877 before their Sauropod nature was recognized by Lydekker,[2] who redescribed them under the name *Titanosaurus indicus,* the type being a post-median caudal vertebra.

2. In 1893, Lydekker[3] described various dinosaur bones from the Guaranitic beds of Patagonia, referring them to the Sauropod genera *Titanosaurus* and *Argyrosaurus.* These identifications were based upon numerous vertebral centra, limb and foot bones, fragmentary parts of the sacrum, pelvis, etc. The limb bones appear to have been in a splendid state of preservation and are certainly sauropod in aspect, though this assignment is seriously questioned by Nopcsa as I shall show later. Hatcher[4] observes that the Guaranitic beds "are referred to the Upper Cretaceous both upon stratigraphic and paleontologic evidences. Just where they should be placed in that series cannot be determined until we know more of the Dinosaurs contained in them. At present it seems not improbable that they will prove to be the equivalent of the Laramie of North America, as they have long been considered by Dr. Ameghino and others."

3. In 1899 Depéret[5] recognized the Sauropod genus *Titanosaurus* as occurring in the Danian of the Montague Noire of southern France. This determination was based upon a femur, an identification to which, as in the former case, Nopcsa makes serious objection as to its validity. He says:[6] "I wish briefly to draw attention to the fact that the Upper Cretaceous *Titanosaurus,* as known from the

---

[1] Paleontological Memoirs, vol. 1, 1868, p. 418, pl. 34, figs. 3, 4, 5.
[2] Rec. Geol. Surv. India, vol. 10, 1877, pp. 38-41.
[3] Anales Museo de La Plata, vol. 2, pt. 1, 1893, pp. 1-12, pls. 1-5.
[4] Amer. Journ. Sci., vol. 9, 4th ser., 1900, pp. 94, 95.
[5] Bull. Soc. Geol. France, 3d ser., vol. 27, 1899, p. 692.
[6] Geol. Mag., n. s., Dec. 5, 1910, p. 261.

Montague Noire in France and from the Cretaceous formation of Argentina, and perhaps also from East Africa, has nothing to do with the Sauropoda, but belongs to the Trachodontid Orthopoda, as proved by the abundant Transylvanian material at my disposal." He then goes on to point out that these dinosaurs referred to *Titanosaurus* are generically identical with *Telmatosaurus,* a heavily built Trachodontid animal from Transylvania, of which the structure is largely known from undescribed material, the name *Titanosaurus* being applicable only to the English Wealden Sauropod described in 1887.[1]

4. In 1907, Thevenin[2] described certain fossils from Madagascar that were referred to the Sauropod genera *Bothriospondylus* and *Titanosaurus.* These are Cenomanian in age.

5. In 1907, Dr. E. Frass made the interesting discovery of Sauropod dinosaurs in southern German East Africa. These were at first thought to be of Upper Cretaceous origin, but since it now appears to be universally recognized that these animals are from the Lower Cretaceous and Upper Jurassic, they may be dismissed from further consideration in the present connection.[3]

6. Dr. W. D. Matthew, in a recent letter, informs me that Strömer has some fine Sauropod material as yet undescribed, "with that extraordinary *Spinosaurus*[4] from the Upper Cretaceous of Baharich Oasis, Egypt." According to Strömer these are Cenomanian-Albian in age.

From this brief review of the reported finds of Sauropod remains of Cenomanian age or above, it will be seen that much doubt exists either as to their proper identification or to their exact geological position. In the light of this more recent discovery, under conditions that permit hardly a question of doubt to be raised as to either identity or stratigraphic position, it would appear very probable that a critical re-examination of the evidence would show the original determination of some of these finds to be valid in all respects. That Sauropod dinosaurs continued to exist until after the Cenomanian, and even into the Danian, there is every reason to believe.

---

[1] In this Nopcsa is mistaken for the name would certainly be applicable to the genotype which is the specimen from India described by Lydekker in 1877 and again reviewed in the Quarterly Journal of the Geological Society of London, p. 156, in connection with the Wealden Sauropod cited by Nopcsa. It is also of interest to note that Seeley, in the same article, p. 160, regarded the specimens from India as being insufficient for purposes of identification, or to enable the relations of the animal to be determined.

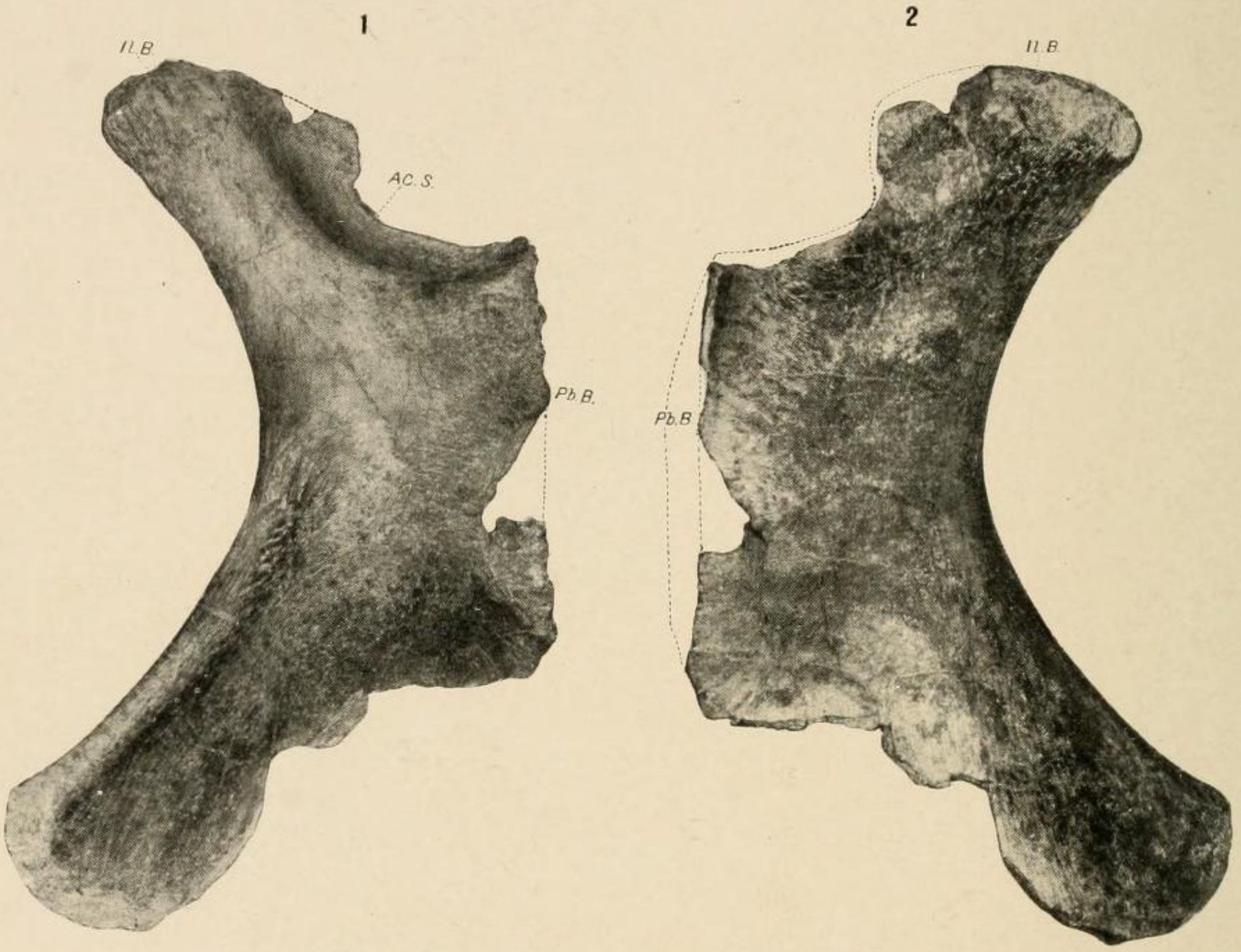
[2] Annales de Paleontologie, 1907.

[3] See Schuchert, Bull. Geol. Soc. America, vol. 29, No. 2, 1918, p. 264, for citations of articles and discussion of the age of the Tendagura series.

[4] Abh. Bayer. Akad. Wiss., Nov., 1915.

LEFT SCAPULA OF ALAMOSAURUS SANJUANENSIS

Type. About one-tenth natural size



RIGHT ISCHIUM OF ALAMOSAURUS SANJUANENSIS

Paratype. About one-tenth natural size. 1. External view. 2. Internal view

The following text is generated from uncorrected OCR.

[Begin Page: Text]

SMITHSONIAN MISCELLANEOUS COLLECTIONS

VOLUME 72, NUMBER 14

A NEW SAUROPOD DINOSAUR FROM THE OJO ALAMO FORMATION OF NEW MEXICO

(With Two Plates)

BY

CHARLES W. GILMORE

Associate Curator, Division of Paleontology, U. S. National Museum

(Publication 2663)

CITY OF WASHINGTON

PUBLISHED BY THE SMITHSONIAN INSTITUTION

JANUARY 31, 1922

[Begin Page: Text]

BALTIMORE, MD., U. S. A.

[Begin Page: Text]

A NEW SAUROPOD DINOSAUR FROM THE OJO ALAMO FORMATION OF NEW MEXICO

By Charles W. Gilmore,

associate curator, division of paleontology, united states national museum

(With Two Plates)

INTRODUCTION

In a brief note ^ I have recently announced the discovery by Mr. John B. Reeside, Jr., geologist of the United States Geological Survey, of Sauropodous dinosaur remains in the Upper Cretaceous of New Mexico, and it is now proposed to give a more detailed account of the specimens and of their exact geological occurrence than was possible in the preliminary notice.

The remains so far recovered consist of a left scapula and a right ischium, both in a good state of preservation. The great importance

of these particular bones lies in the fact that the remains of Sauropodous dinosaurs have not previously been known to occur above the Lower Cretaceous in North America, so that the extension of their geological range into the L^pper Cretaceous is of the greatest paleontologic and geologic interest.

It is particularly fortunate that this discovery should have been made by a trained geologist of Mr. Reeside's attainments, and in a section so well established as to preclude the possibility of question as to their late position in the geological column.

That these bones pertain to a member of the Sauropoda is indicated by their immense size and also by their close general resemblance to homologous elements of the typical Sauropoda from the Morrison formation. Marked differences in details, however, more especially in the ischium, in conjunction with the very late geological occurrence, makes it necessary to establish a new genus and species for their reception, for which the name Alauwsaurus sanjuancnsis is proposed.

DESCRIPTION

ALAMOSAURUS, new genus

The characters of this genus are included in the following description of the type species :

^Science (N. S.), vol. LIV, 1921, p. 274.

ALAMOSAURUS SANJUANENSIS, new species

Plates I, 2

Type. — Cat. No. 10,486, U. S. N. M., consists of the nearly complete left scapula.

Paratypc. — Cat. No. 10,487, U. S. N. M., consists of the nearly complete right ischium.

Type locality. — Barrel Spring Arroyo, one mile south of Ojo Alamo, San Juan County, New Mexico.

Horizon. — Ojo Alamo formation, Upper Cretaceous.

Collector. — J. B. Reeside, Jr., June, 1921.

The scapula and ischium designated as the type and paratype, respectively, were found in the same geological horizon, but some 200 feet distant from one another. While it is quite possible that both may pertain to the same individual, it is thought best to regard them as distinct until their closer relationship can be more positively established.

Scapula. — The scapula is in a good state of preservation except for the loss of a portion of the proximal or articular end (see pi. i) where it projected above the ground and was weathered away. The suprascapular end is also incomplete, though apparently only the border is missing. In size this bone rivals the largest of the Camarasaurus scapulae described by Messrs. Osborn and Mook,^ since as preserved its greatest length is 155 cm. (60 inches), and it is conservatively estimated that the total length of the complete bone would have been at least 170 cm. (68 inches).

In outline, as shown in plate i, the blade of the scapula dififers from any described form in that there is a gradual widening of the shaft from below upward to the superior end, there being no especial expansion of the anterior border as found in Camarasaurus, nor rapid superior expansion of both borders as found in Diplodocus and Haplocanthosauriis. While this portion of the bone is heavy it is not so massive as in Camarasaurus, being much thinner. The superior end is flattened out, though the external surface becomes convex transversely as the middle of the bone is approached. From end to end the bone is curved as in other members of the Sauropoda. Both anterior and posterior borders thin out to sharp edges, this condition continuing downward half its total length. Immediately above the point where the anterior border begins to turn upward to form the prescapular expansion of the lower end the border becomes thick-

* Memoirs Amer. Mus. Nat. Hist., new sen, vol. 3, pt. 3, 1921, p. 3^1, fig. 74.

[Begin Page: Page 3]

ened and rounded. The posterior border, however, continues downward as a fairly sharp edge to the downward swing of this border to form the glenoid socket where the bone rapidly thickens transversely. The spine or ridge on the lower external surface extends from the base of the shaft' in an anterior direction to the anterior-superior border, and at right angles to the longitudinal axis of the bone. This ridge is not greatly elevated except that on the side toward the coracoidal border the bone is rapidly and deeply excavated, forming a muscle fossa of great extent. On the upper side of this ridge the surface of the bone slopes off gradually to the border, there being no excavation or superior fossa such as is found in so many Sauropod scapulae.

Measurements ^ ^.

	Centimeters
Greatest length of scapula (as preserved)	155
" " " " (estimated)	170
Greatest breadth of superior end	45

Least breadth of shaft 29

Greatest breadth inferior (oblique) 82

Thickness of shaft at center 29

Ischium. — A large bone found in the same horizon but sortie 200 feet distant from the scapula described above is identified as the right ischium of a Sauropod dinosaur. This bone differs so from other Sauropod ischia that its true nature was determined with difficulty. That it pertains to a member of the Sauropoda is indicated by its large size and also by its general resemblance, though dift'ering markedly from any described form. It is characterized by its extreme shortness, and especially by the lack of the long, slender posterior extension so characteristic of other Sauropod ischia.

The proximal portion is nearly complete, lacking only a small portion of the sharp inner edge of the acetabular border. The distal end, though not perfect, apparently lacks but little of being complete. Likewise the thin inner border below the articulation for the pubis is slightly imperfect. Except for the missing portions mentioned, the bone is in a remarkably fine state of preservation.

The expanded proximal end is unusual, not so much because of its great antero-posterior extent, but on account of the great dorso-ventral diameter, and especially the great length of the pubic articulation which extends distalward more than one-half the total length of the bone. Below the pubic articulation the inner border presents a thin, sharp edge, and the flattened distal portion gradually diminishes

in width to the distal end. This end is apparently without distal

[Begin Page: Page 4]

expansion, though the incomplete surfaces makes this point sHghtly uncertain. Neither can it he definitely determined whether the ischia met on the median line, though I am inclined to think they did. The rounded and somewhat thickened posterior border is deeply concave from end to end. The sweep downward from the iliac articulation is especially pronounced. On the posterior external surface at the mid-length of the bone is a raised ridge with roughened surface marking the point of insertion for a strong muscle.

The form and principal features of this bone are well shown in plate 2.

Measurements ' centimeters

Greatest length 8i

Greatest width of proximal end 44.5

Greatest width at lower end of pubic articulation 32

Greatest length of pubic articular surface 37.5

Greatest transverse diameter of articular end for ilium 10.5

RELATIONSHIPS

The scapula cannot be closely correlated with any of those of described genera, and the ischium differs so much in its details from those with which it has been compared as to indicate an animal with a considerably different pelvic structure than any of the Sauropoda with which we are acquainted to-day. That both of these bones pertain to the same individual cannot be proven, but that both are Sauropod in aspect seems certain.

In size the scapula approaches Camarasanrns, but it differs by the non-icxpansion of the upper anterior border and the very much thinner blade; from Diplodocns it is to be distinguished by its larger size and the direction of the spine in relation to the longitudinal axis. In the present specimen this angle is approximately 90°, whereas in Diplodocns and Aiiiphicocliis it is acute. The scapulae of Apatosanrus, AmpJiicocIns, and BracJiiosaunis are more slender and with a much more constricted shaft at their narrowest width. Haplocanthosauriis is very much smaller and has a very different outline.

GEOLOGICAL OCCURRENCE

At my request Mr. Reeside prepared the following note on the stratigraphy :

NOTE ON THE STRATIGRAPHY OF SAN JUAN COUNTY, NEW MEXICO,

WITH ESPECIAL REFERENCE TO THE OCCURRENCE OF DINOSAURS

The oldest rocks exposed in San Juan County, New Mexico, have been assigned to the McElmo formation of Jurassic or Lower Cretaceous age. The overlying rocks, of L^pper Cretaceous and Tertiary age, have been divided into

[Begin Page: Page 5]

a number of units named in ascending order as follows : Dakota sandstone, Mancos shale, Point Lookout sandstone, Menefee formation, Cliff House standstone, Lewis shale, Pictured Cliffs sandstone, Fruitland formation, Kirtland shale with included Farmington sandstone member, Ojo Alamo sandstone, Puerco formation, Torrejon formation, and Wasatch formation. The Point Lookout sandstone, Menefee formation, and Cliff House sandstone comprise the Mesaverde formation of the older literature and the Pictured Cliffs sandstone, Fruitland formation, and Kirtland shale, the Laramie formation. The Dakota sandstone contains coal beds and other plant remains and grades into the overlying Mancos shale. The formations from the Mancos shale to the Pictured Cliff's sandstone, inclusive, are marine except parts of the Menefee formation which arc brackish and fresh water deposits with coal beds. The lower part of the Fruitland formation contains a transition series of brackish water beds and the upper part and all of the overlying formations are fluviatile

deposits. The Mancos shale represents in large part the Benton shale and Niobrara formation of the region east of the Rocky Mountains. Its extreme upper part, however, is the equivalent of the basal part of the Pierre shale. The Mesaverde group, Lewis shale, and Pictured Cliffs sandstone contain invertebrates of Montana age, and the Fruitland and Kirtland formations, plants, invertebrates, and reptiles of Montana age. These beds definitelj'^ assignable to the Upper Cretaceous, /. c, from Dakota sandstone to Kirtland shale, inclusive, are a comformable series 5,500 feet thick, of which about 4,000 feet are of Montana age. The age of the Ojo Alamo sandstone is in dispute. It has been assigned by some writers on the basis of its dinosaur fauna to the Montana group and correlated with the Judith River beds. It is separated from the Kirtland shale by a widespread luiconformity and has been correlated on that ground by other writers with the Denver and Raton formations of post-Montana age. The Puerco and Torrejon formations contain large mammalian faunas and are usually placed in the Tertiary, though some writers would place them in the Cretaceous. The Wasatch formation is universally accepted as Tertiary.

Dinosaur remains have been found in the Fruitland formation, throughout the Kirtland shale, and in the Ojo Alamo sandstone. The sauropod bones found in June, 1921, came from the lower part of the Ojo Alamo sandstone on Barrel Spring Arroyo, one mile south of Ojo Alamo. A detailed section at this locality is as follows : ^

Ojo Alamo sandstone: Feet

Sandstone, conglomeratic ; top eroded I5-|-

Shale, dark greenish gray 7

Sandstone, soft, nearly white, crossbedded ; contains gray argilla-

ceous streaks and brown concretions 21

Shale, wine red, with local gray sandstone lenses 5

Sandstone, soft, white, crossbedded ; contains brown concretions in

the lower part 10

Sandstone, brown, platy, ferruginous i

Shale, dark bluish gray to purple, sandy 4

^ See Bauer, C. M., Stratigraphy of a part of the Chaco River Valley. U. S. Geol. Survey Prof. Paper 98, pi. 69 and pi. 70, 1916. This locality is shown as locality 67 on plate 69 and the stratigraphic section as section R on plate 70.

[Begin Page: Page 6]

Ojo Alamo sandstone: — Continued. p^^j

Sandstone, soft white, conglomeratic ; contains brown concretions ;

horizon of the sauropod and other bones 6

Sandstone, yellow to brown, conglomeratic ; contains an abimdance

of siliceous pebbles as large as 3 inches in diameter 5

Unconformity.

Kirtland shale :

Shale, gray to drab, with several wine red layers ; scattered dinosaur

bones 30

Sandstone with lenses of grit, fine conglomerate, and many clay

pellets 10

Shale, gray 20±

Farmington sandstone member : brown indurated sandstone and

gray shale 8o±

Shale, gray to drab, and sandstone, soft, gray-white iooo±

Fruitland formation :

Sandstone, shale, and coal.

Directly associated with the bones of Alamosanrus are many other fragmentary and undeterminable dinosaur bones, teeth of carnivorous and Ceratopsian dinosaurs, dermal plates of an armored form, turtle fragments, and crocodile bones. At nearly the same horizon in adjacent localities on Barrel Spring Arroyo there were obtained part of the frill of an undetermined Ceratopsian ' different from known forms, dermal plates of an armored dinosaur," incomplete vertebrae of a carnivorous dinosaur as large as Tyrannosaurus,^ fragments of a Ceratopsian frill marked with radiating vasicular grooves like those of Triceratops, but indeterminable.* This horizon is also the source of the maxillary and fragments of a skull collected by Sinclair and Granger and identified by Brown as Kritosaurus naziaj ovhi s .^

From the uppermost part of the Kirtland shale near this locality have been collected specimens that are closely related to species known to be of Montana age : Kritosaurus navajovius Brown, skull and

^ Gilmore, C. W., Reptilian faunas of the Torrejon, Puerco, and underlying Upper Cretaceous formations of San Juan County, New Mexico : U. S. Geol. Survey Prof. Paper 119, p. 65, 1919.

^ Idem, p. 65, pi. 26, fig. 2.

" Idem, p. 67.

* Gilmore, Vertebrate faunas of the Ojo Alamo, Kirtland, and Fruitland formations : U. S. Geol. Survey Prof. Paper 98, p. 287, 1916.

° Sinclair, W. J., and Granger, Walter, Paleocene deposits of the San Juan Basin, New Mexico : Am. Mus. Nat. Hist. Bull., vol. 33, p. 303, 1914.

[Begin Page: Page 7]

other bones ^; Monoclonius sp., horn core and fragments of f rilP ; armored dinosaur suggesting a Belly River genus/ humerus ; a carnivorous form suggesting Dryptosaiirus or Dynamosaurus, dentary * ; undeterminable fragments of other trachodont, ceratopsian, and carnivorous dinosaurs ; turtle and crocodile bones.

In 1910 the late Dr. S. W. Williston ° reported the discovery of a Sauropod coracoid in the Trinity Sand of Oklahoma, Lower Cretaceous in age, which, in so far as western North America is concerned, represented the latest occurrence of Sauropod dinosaurs, up to the time of the present discovery. In the eastern United States, Sauropod dinosaurs {Astrodon, Plcurocoelns) have been known as occurring in the Arundel (Potomac) formation since Marsh first described them in 1888, but for a long time the Arundel was correlated with the Morrison formation (Atlantosaurus beds) of the west, but more recently, largely on paleobotanical evidence, it has been referred to the Lower Cretaceous. A recent restudy of the Arundel vertebrates ° appears to indicate a higher position in the Lower Cretaceous than has previously been given them. It is also of interest that the Maryland Sauropoda are found associated with the remains of other dino-

saurs having undoubted Upper Cretaceous affinities, as is the case with the bones now under discussion.

It thus appears that these specimens, found under conditions which allow no question of doubt to be raised, furnish the first indisputable evidence of the occurrence of Sauropodous dinosaurs in the Upper Cretaceous of North America.

REPORTED DISCOVERIES OF SAUROPOD REMAINS IN UPPER CRETACEOUS DEPOSITS

There have been a considerable number of reported occurrences of Sauropod dinosaur remains in Upper Cretaceous deposits in various parts of the world. Those recorded are from India, southern France, South America, Madagascar, German East Africa, and Egypt. These

^ Brown, Barnum, The Cretaceous Ojo Alamo beds of New Mexico, with description of the new dinosaur genus Kritosaurus : Am. Mus. Nat. Hist. Bull., vol. 28, p. 269, 1910.

Gilmore, C. W., Vertebrate faunas of the Ojo Alamo, Kirtland, and Fruitland formations, U. S. Geol. Surv. Prof. Paper No. 98, pp. 283-284, fig. 28; p. 285, 1916.

^ Brown, Barnum, idem, p. 278.

^ Gilmore, C. W., idem, p. 287.

* Gilmore, C. W., idem, p. 288, pi. y^^ fig. i.

^ See Larkin, Pierce, Journ. Geol., vol. 18, No. i, 1910, p. 93.

^ Gilmore, C. W., Proc. U. S. Nat. Mus., vol. 59, 1921, pp. 581-594, pis. 110-114.

[Begin Page: Page 8]

finds, however, have been called into question for one cause or another, so that as the evidence stands to-day, their exact status is very unsatisfactory.

Below I shall briefly review these various discoveries, although no attempt will be made to critically re-examine the evidence, however desirable that may be. I feel that in this problem I should defer to those having a wider knowledge of geological structures, and especially to those who have available extensive collections of Sauropodous dinosaur materials with which to make the necessary comparisons.

Taken in chronological order these reported finds are as follows:

1. Apparently the first Sauropod remains to be described from the Middle Cretaceous or above were those found in the Lamenta beds, probably Cenomanian, near Jabalpur, India. These specimens were described by Falconer ^ in 1862, without name, and it was 1877 before

their Sauropod nature was recognized by Lydekker," who redescribed them under the name Tifanosaurus indicus, the type being a post-median caudal vertebra.

2. In 1893, Lydekker "^ described various dinosaur bones from the Guaranitic beds of Patagonia, referring them to the Sauropod genera Titanosaitrus and Argyrosaurus. These identifications were based upon numerous vertebral centra, limb and foot bones, fragmentary parts of the sacrum, pelvis, etc. The limb bones appear to have been in a splendid state of preservation and are certainly sauropod in aspect, though this assignment is seriously questioned by Nopcsa as I shall show later. Hatcher * observes that the Guaranitic beds " are referred to the Upper Cretaceous both upon stratigraphic and paleontologic evidences. Just where they should be placed in that series cannot be determined until we know more of the Dinosaurs contained in them. At present it seems not improbable that they will prove to be the equivalent of the Laramie of North America, as they have long been considered by Dr. Ameghino and others."

3. In 1899 Deperet° recognized the Sauropod genus Titanosaunis as occurring in the Danian of the Montague Noire of southern France. This determination was based upon a femur, an identification to which, as in the former case, Nopcsa makes serious objection as to its validity. He says : " "I wish briefly to draw attention to the fact that the LIpper Cretaceous Tifanosaurus, as known from the

' Paleontological Memoirs, vol. i, 1868, p. 418, pi. 34, figs. 3, 4, 5.

' Rec. Geol. Surv. India, vol. 10, 1877, PP- 38-41.

' Anales Museo de La Plata, vol. 2, pt. i, 1893, pp. 1-12, pis. 1-5.

* Amer. Journ. Sci., vol. 9, 4tli ser., 1900, pp. 94, 95.

^ Bull. Soc. Geol. France, 3d ser., vol. 27, 1899, p. 692.

"Geol. Mag., n. s., Dec. 5, 1910, p. 261.

[Begin Page: Page 9]

JMontague Noire in France and from the Cretaceous formation of Argentina, and perhaps also from East Africa, has nothing to do with the Sauropoda, but belongs to the Trachodontid Orthopoda, as proved by the abundant Transylvanian material at my disposal." He then goes on to point out that these dinosaurs referred to Titanosaurus are generically identical with Telmatosaurus, a heavily built Tracho-dontid animal from Transylvania, of which the structure is largely known from undescribed material, the name Titanosaurus being applicable only to the English Wealden Sauropod described in 1887."

4. In 1907, Thevenin " described certain fossils from Madagascar that were referred to the Sauropod genera B othriospondylus and Titanosaurus. These are Cenomanian in age.

5. In 1907, Dr. E. PVass made the interesting discovery of Sauropod dinosaurs in southern German East Africa. These were at first thought to be of Upper Cretaceous origin, but since it now appears to be universally recognized that these animals are from the Lower Cretaceous and Upper Jurassic, they may be dismissed from further consideration in the present connection."

6. Dr. W. D. Matthew, in a recent letter, informs me that Stromer has some fine Sauropod material as yet undescribed, " with that extraordinary Spinosaurus^ from the Upper Cretaceous of Baharich Oasis, Egypt." According" to Stromer these are Cenomanian-Albian in age.

From this brief review of the reported finds of Sauropod remains of Cenomanian age or above, it will be seen that much doubt exists either as to their proper identification or to their exact geological position. In the light of this more recent discovery, under conditions that permit hardly a question of doubt to be raised as to either identity or stratigraphic position, it would appear very probable that a critical re-examination of the evidence would show the original determination of some of these finds to be valid in all respects. That Sauropod dinosaurs continued to exist until after the Cenomanian, and even into the Danian, there is every reason to believe.

^ In this Nopcsa is mistaken for the name would certainly be applicable to the genotype which is the specimen from India described by Lydekker in 1877 and again reviewed in the Quarterly Journal of the Geological Society of London, p. 156, in connection with the Wealden Sauropod cited by Nopcsa.

It is also of interest to note that Seeley, in the same article, p. 160, regarded the specimens from India as being insufficient for purposes of identification, or to enable the relations of the animal to be determined.

^ Annales de Paleontologie, 1907.

' See Schuchert, Bull. Geol. Soc. America, vol. 29, No. 2, 1918, p. 264, for citations of articles and discussion of the age of the Tendagura series.

* Abh. Bayer. Akad. Wiss., Nov., 1915.

[Begin Page: Text]

[Begin Page: Text]

Gl»-

LEFT SCAPULA OF ALAMOSAURUS SANJUANENSIS

Type. About one-tenth natural size

[Begin Page: Text]

SMITHSONIAN MISCELUANEOUS COLLECTIONS

VOL. 72, NO 14, PI. 2

RIGHT ISCHIUM OF ALAMOSAURUS SANJUANENSIS

Paratype. About one-tenth natural size. 1. External view. 2. Internal view