Paleontología Mexicana
Volumen 10, núm. 2, 2021, p. 105 – 111

Dinosaurs from the Late Cretaceous of the Ojinaga Basin in Northeastern Chihuahua, Mexico

Dinosaurios del Cretácico Superior de la Cuenca de Ojinaga en el noreste de Chihuahua, México

Rivera-Sylva, Héctor E. [a,*]; Nava-Rodríguez, Rosalba L.[b]; Sánchez-Uribe, Iván E.[b]

[a] Museo del Desierto, Carlos Abedrop Dávila 3745, 25022, Saltillo, Coahuila, Mexico.
[b] Museo del Desierto Chihuahuense, calle 7a sur s/n, 33093, Delicias, Chihuahua, Mexico.

[*] hrivera@museodeldesierto.org

Abstract

The Ojinaga Basin is crucial for understanding the southern province of Laramidia because it contains a unique dinosaur fauna on the North American continent. The Upper Cretaceous Aguja and Javelina formations contain fossil remains of the dinosaur families Hadrosauridae, Ceratopsidae, Nodosauridae, Tyrannosauridae, and Saltasauridae. The latter is the first evidence for a saltasaurid taxon from Mexico identified as *Alamosaurus sanjuanensis*.

***Keywords*:** Tyrannosauridae, Saltasauridae, Nodosauridae, Hadrosauridae, Ceratopsidae, México.

Resumen

La Cuenca de Ojinaga es crucial para nuestro entendimiento de la provincia sureña de Laramidia, debido a que contiene una fauna única de dinosaurios en el continente Norteamericano. Las formaciones Aguja y Javelina del Cretácico Tardío contienen las familias Hadrosauridae, Ceratopsidae, Nodosauridae, Tyrannosauridae, y Saltasauridae. El último es la primera evidencia de un taxon saltasaurino para México identificado como Alamosaurus sanjuanensis.

Palabras clave: *Tyrannosauridae, Saltasauridae, Nodosauridae, Hadrosauridae, Ceratopsidae, México.*

1. Introduction

The Ojinaga Basin is located in northeastern Chihuahua, and encompasses part of the Chihuahuan desert along the Mexico-Texas border to the northeast and with Coahuila to the southeast. In this area, Paleogene volcanic and plutonic rocks have intruded into the Cretaceous and Paleogene sedimentary sequence (Maxwell *et al*., 1967; Schiebout, 1989; Lehman, 1991) conformed by the Pen, Aguja, and Javelina formations. These sediments are exposed locally beneath a cover of young (Pleistocene) gravel and alluvium.

The Upper Cretaceous Aguja and Javelina formations contain a varied, yet poorly studied, dinosaur fauna. Hadrosaurs are an abundant component of this fauna (Davies, 1983), whereas Ceratopsidae, Nodosauridae, and Tyrannosauridae are rare elements, and Saltasauridae are exclusively known from the Javelina Formation (Sankey, 2001; Hunt and Lehman, 2008; Lehman *et al*., 2016). The region has been identified as a southern North American dinosaur biogeographic province, which is differentiated from nearby provinces by distinct rainfall and temperature patterns (Baghai, 1996), with a late Campanian to mid-Maastrichtian paleolatitude of ≈35°N (Robinson-Roberts and Kirschbaum, 1995), and the Western Interior Seaway nearby (Atchley *et al*., 2004).

Historically, few dinosaur remains have been reported in the scientific literature from the Ojinaga Basin (Montellano *et al*., 2000; Weishampel *et al*., 2004; Rivera-Sylva *et al*., 2006), although more abundant specimens are known to exist in private collections and are undescribed (Rivera-

Manuscript received: October 25, 2021.
Manuscript corrected: December 8, 2021.
Manuscript accepted: December 9, 2021.

Sylva and Carpenter, 2014a). The fossil vertebrates documented in this paper were collected from two sites located in the municipality of Manuel Benavides, in the northeastern portion of the State of Chihuahua, Mexico (Figure 1).

Abbreviations. MDCH = Museo del Desierto Chihuahuense, Mexico; TMM = Texas Memorial Museum, Austin, Texas.

2. Material and Methods

The material described here is housed at the Museo del Desierto Chihuahuense. It comprises six teeth from four different dinosaur taxa. The specimens were donated when the museum opened in 2010, and the donor remained anonymous.

The specimens were measured using a digital caliper, and photographed using a Canon EOS Rebel T7 with a Canon lens 18–55mm, macro 0.25m, and an Optika stereoscope microscope.

3. Geological Setting

Two Upper Cretaceous Formations in the Ojinaga Basin yield dinosaur material (Arenal, 1964; Wolleben, 1968), the Aguja and the Javelina formations.

3.1. Aguja Formation

The Aguja Formation is a widespread sedimentary unit in northeast Chihuahua and south Texas reaching between 250 to 400 m thickness. U-Pb zircon geochronologic data have yielded ages of between 72.6 + 1.5 Ma to 76.9 + 1.2 Ma (late Campanian) (Befus *et al*., 2008). Lithostratigraphy and changes in the fossil assemblages imply a gradual change from marine to paralic environments and finally an inland floodplain (Lehman, 1985). The Aguja Formation is divided in two units in the SE of the Ojinaga Basin, the lower shale member, which is entirely marine and correlates with the San Carlos Formation, and the upper shale member equivalent to the middle and inferior part of the El Picacho Formation of the same area. Its lithology consists of sandstone intercalated with clay. The sandstone predominates in the inferior part of the formation, with brown light-yellow color, showing primary structures and fresh water fossils (Cabrera *et al*., 1984). Thin layers of siderite and gypsum are intercalated. The clay is white to gray-green-colored, with layers rich in organic matter and traces of coal. In the upper part of the column fossil wood is abundant and dinosaur bones are frequently found. A variety of well-developed paleosols formed on the inland floodplain of the upper Aguja and overlying Javelina formations, and their stage of development has been linked to sea level fluctuations in the nearby Western Interior Seaway (Atchley *et al*., 2004).

3.2. Javelina Formation

This formation has a reported U-Pb zircon geochronologic age of 69.0 + 0.9 Ma (early Maastrichtian) (Lehman *et al*., 2006), and includes a thickness of about 100 meters throughout the Big Bend region. The unit conformed by mudstone, minor sandstone and conglomerate was deposited in fluvial flood-plain and lacustrine environments at several hundred kilometers distance from the Late Cretaceous shoreline (Maxwell *et al*., 1967; Lehman, 1990). The absence of structureless mudstone reflects lacustrine facies (Maxwell *et al*., 1967). In Chihuahua, the Javelina Formation is adjacent to the Big Bend, but it also crops out in the Manuel Benavides area, in the valley located to the

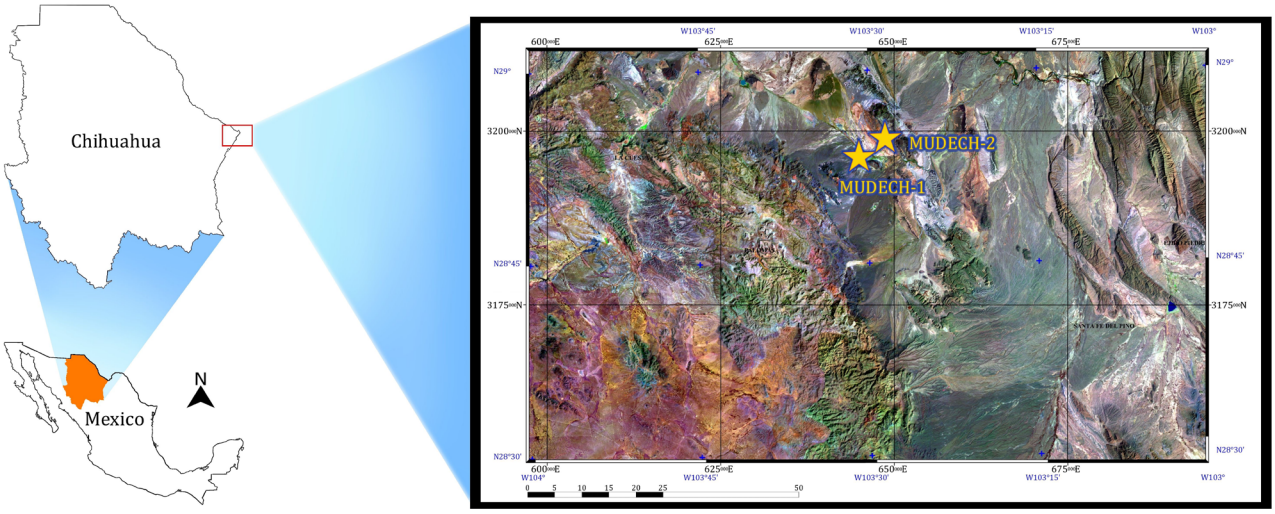

Figure 1. Location of the fossil sites marked by yellow stars.

east of Sierra Santa Elena and in the Sierra Hechiceros. The formation is constituted by 60 m of bentonitic mudstones intercalated with cross stratified sandstones (Cabrera *et tal*., 1984). The unit contains fossilized wood and dinosaur bones. The contact with the underlying Aguja Formation is gradual, while the upper contact is disconformous with volcanic rocks of Paleogene age.

4. Systematic Paleontology

Dinosauria Owen, 1842
Saurischia Seeley, 1888
Theropoda Marsh, 1881
Tyrannosauridae Osborn, 1906
Gen. et sp. indet.

Material. Tooth fragment (MDCH V042; Figure 2 A–D). This element is housed and registered in the Museo del Desierto Chihuahuense, Delicias, Chihuahua, Mexico.

Horizon and Locality. Upper Shale Member of the Aguja Formation (Campanian, Late Cretaceous), locality MUDECH-1, 23 km southeast of the town of Manuel Benavides; municipality of Manuel Benavides, Chihuahua, Mexico. The exact locality information is on file at the Museo del Desierto Chihuahuense, Delicias, Chihuahua.

Description. MDCH V042 (Figure 2 A–D) is a small faintly recurved premaxillary tooth, 20.9 mm high, with an oval cross-section. The mesial carina is lost but the basal carina has the serrations preserved. The longitudinal basal length is 12.2 mm and the basal width 6.6 mm. The crown tip is missing. The tooth cross-section is oval. The denticles are chisel-shaped, with a basal diameter of 0.5 mm in mesiodistal and 0.6 mm in labiolingual direction. The interdenticular space measures 0.2 mm. The serration density is three denticles per mm.

Comments. The serration density is diagnostic for tyrannosaurids (Farlow and Brinkman, 1987; Abler, 1997; Sankey, 2001; Holtz, 2004). This identification is supported by the spatulate outline of the denticles and the tooth morphology in general (Sankey, 2001).

Sauropoda Marsh, 1878
Saltasauridae Wilson and Upchurch, 2003
cf. *Alamosaurus sanjuanensis* Gilmore, 1922

Material. Tooth fragment (MDCH V043; Figure 2 E–H). This element is housed and registered in the Museo del Desierto Chihuahuense, Delicias, Chihuahua, Mexico.

Horizon and Locality. Javelina Formation (Maastrichtian, Late Cretaceous), locality MUDECH-2, 23 km southeast of the town of Manuel Benavides; municipality of Manuel Benavides, Chihuahua, Mexico. The exact locality information is on file at the Museo del Desierto Chihuahuense, Delicias, Chihuahua.

Description. MDCH V043 is a badly weathered peg-like tooth fragment, without the crown tip, and rounded in cross section. It has a tubular pulp cavity with convex lingual and labial sides. The enamel preserved in one section shows faint longitudinal undulations. Measurements of MDCH V043 in millimetres: height = 15.7; diameter = 5.3.

Comments. The tooth is exceedingly similar to those described and figured by Kues *et al*. (1980) for *Alamosaurus sanjuanensis*. Lehman and Coulson (2002) mention some tooth fragments similar to those described by Kues *et al*. (1980) which were recovered with *Alamosaurus sanjuanensis* specimen TMM 43621-1. Since this taxon is the only sauropod known from the Cretaceous Javelina Formation, there is strong circumstantial evidence that the tooth comes from this species. Sullivan and Lucas (2000) also described a sauropod tooth from New Mexico, although Lucas and Sullivan (2000) note their tooth with those described by Kues *et al*. (1980), shows a smooth enamel, suggesting the presence of more than one sauropod taxon for the Maastrichtian of North America. Montellano-Ballesteros (2003) described some titanosaurid vertebrae from Chihuahua but these were posteriorly referred to Hadrosauria by D'Emic *et al*. (2010) based on the morphology as well as the geologic horizon where they were found. Consequently, the specimen described here represents the first evidence for the existence in Mexico of a sauropod conferred to the *Alamosaurus sanjuanensis*.

Ornithsichia Seeley, 1888
Ankylosauria Osborn, 1923
Nodosauridae Marsh, 1890
Gen. et sp. indet.

Material. Isolated tooth crown (MDCH V044; Figure 2, I–J). This element is housed and registered in the Museo del Desierto Chihuahuense, Delicias, Chihuahua, Mexico.

Horizon and Locality. Upper Shale Member of the Aguja Formation (Upper Cretaceous, Campanian), locality MUDECH-1, 23 km southeast of the town of Manuel Benavides, Chihuahua, Mexico. The exact locality information is on file at the Museo del Desierto Chihuahuense, Delicias, Chihuahua.

Description. The specimen consists of an isolated crown without a root. It most closely resembles that of other nodosaurids in its relatively large size, the presence of a complete shelf-like cingulum, and three low denticle count along the posterior cutting edge. The cingulum is irregularly wavy labially. Lingually, it is smooth and concave. Measurements of MDCH V044 in millimetres: height = 8.7; length = 7.4; wide = 3.9.

Comments. *Ankylosaurs* teeth are taxonomically useful to family level only (Vickaryous *et al*., 2004). The crowns of nodosaurid teeth are proportionally large, with few denticles (4–8) along the cutting edge that often merge into a ridge (Coombs, 1990). The base of the crown is swollen and a complete cingulum is present on one or both sides. Therefore, identification of MDCH V044 as a nodosaurid is confident.

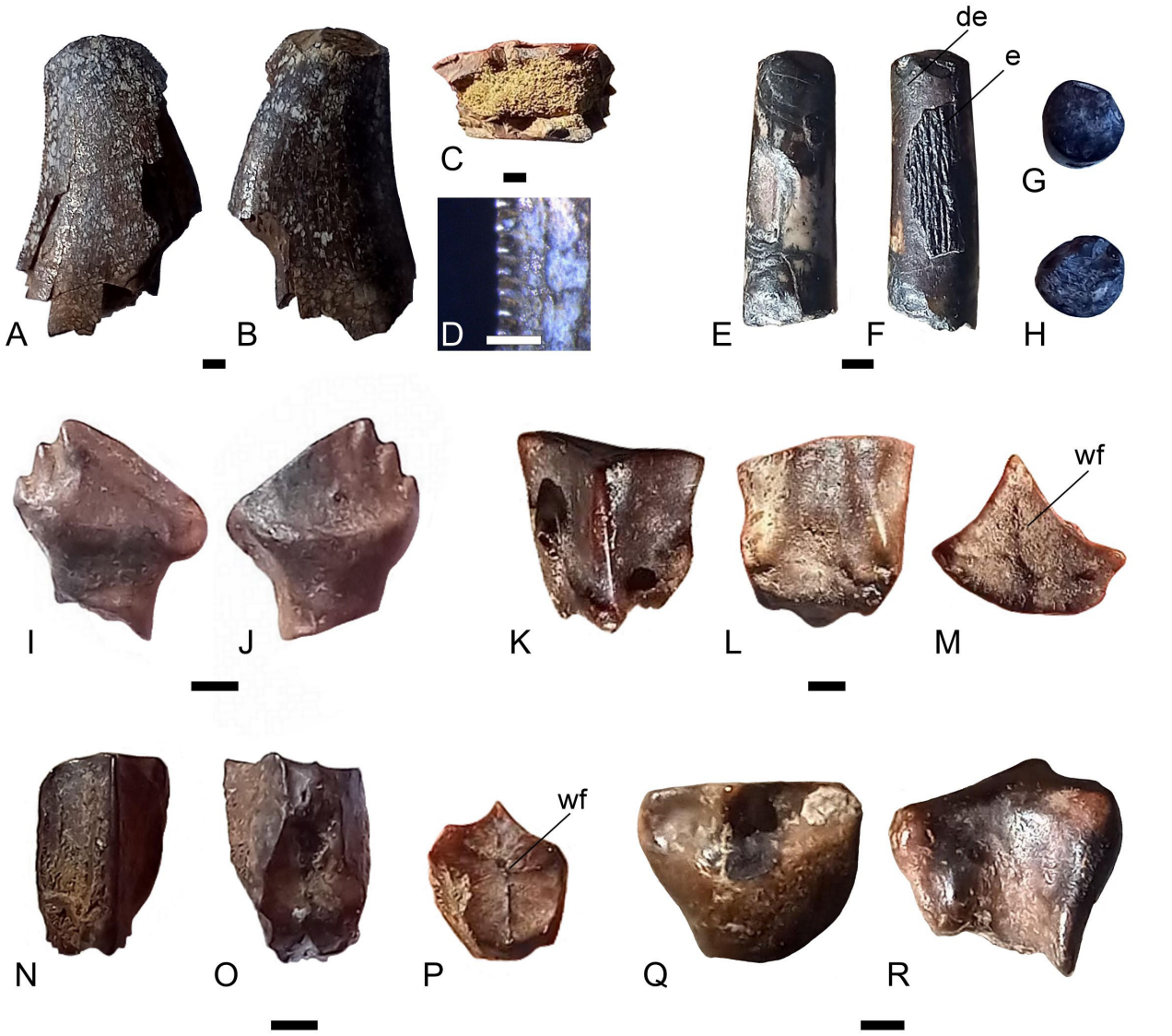

Figure 2. Tyrannosaurid tooth (MDCH V042) in: A) labial, B) lingual, C) basal views, D) close-up of posterior denticles. Saltasaurid tooth (MDCH V043) in: E) labial, F) lingual, G) apical, and H) basal views. Nodosaurid tooth (MDCH V044) in: I) labial, and J) lingual views. Hadrosaurid tooth (MDCH V045) in: K) lingual, L) labial; and M) apical views. Hadrosaurid tooth (MDCH V046) in: N) lingual, O) labial, and P) apical views. Ceratopsian tooth (MDCH V051) in: Q) lingual, and R) apical views. The abbreviations inside of the figure refer to: de= dentine; e= enamel; wf= wear facet. Scale bar = 2 mm. Scale bar for D = 1 mm.

Ornithopoda Marsh, 1881
Hadrosauridae Cope, 1869
Gen. et sp. indet.

Material. Tooth crowns (MDCH V045 / MDCH V046 / MDCH V047 / MDCH V048 / MDCH V049 / MDCH V050; Figure 2 K-P). These elements are housed and registered in the Museo del Desierto Chihuahuense, Delicias, Chihuahua, Mexico.

Horizon and Locality. Upper Shale Member of the Aguja Formation (Campanian, Late Cretaceous), locality MUDECH-1, 23 km southeast of the town of Manuel Benavides; municipality of Manuel Benavides, Chihuahua, Mexico. The exact locality information is on file at the Museo del Desierto Chihuahuense, Delicias, Chihuahua.

Description. All specimens are worn teeth (MDCH V045 / MDCH V046 / MDCH V047 / MDCH V048 / MDCH V049 / MDCH V050) with strong median carina in the middle of the lingual face. The worn apex of both teeth is slightly concave and has radiating dentine deposits. MDCH V046 is a juvenile and more complete teeth. Measurements of MDCH V045 in millimetres: height = 8.3; length = 7.9; wide = 7.8; MDCH V046 in millimetres: height = 7.8; length = 5.2; wide = 5.6; MDCH V047 in millimetres: height = 7.6; length = 8.5; wide = 5.3; MDCH V048 in millimetres:

height = 7.4; length = 5.8; wide = 6.1; MDCH V049 in millimetres: height = 9.8; length = 4.9; wide = 4.6; MDCH V050 in millimetres: height = 9.0; length = 7.5; wide = 4.4.

Comments. These teeth are clearly from hadrosaurs because they have the diagnostic ridge on the outer surface of the tooth (Peng *et al*., 2001). Juvenile hadrosaur teeth with a similar morphology to MDCH V046 are common for the Aguja Formation (Sankey, 2001). In the Aguja Formation, hadrosaur specimens are common elements outnumbering the ceratopsians by about 60% (Lehman, 2007).

Ceratopsia Marsh, 1890
Ceratopsidae Marsh, 1888
Gen. et sp. indet.

Material. Shed tooth (MDCH V051; Figure 2 Q–R). This element is housed and registered in the Museo del Desierto Chihuahuense, Delicias, Chihuahua, Mexico.

Horizon and Locality. Upper Shale Member of the Aguja Formation (Campanian, Late Cretaceous), locality MUDECH-1, 23 km southeast of the town of Manuel Benavides; municipality of Manuel Benavides, Chihuahua, Mexico. The exact locality information is on file at the Museo del Desierto Chihuahuense, Delicias, Chihuahua.

Description. MDCH V051 is enamel lingually, with a strong medial ridge, extremely flat triangular shape, with a median ridge of tooth forming its low tip. It is strongly worn down distally, showing a characteristic cross section of the tooth. Measurements of MDCH V051 in millimetres: height = 7.2; length = 9.8; wide = 5.4.

Comments. The tooth matches those referred to ceratopsian teeth in the Judith River Group of Alberta (Peng, *et al*., 2001), differentiating from those of hadrosaurs in being much longer than wide, in contrast to hadrosaurids where the crown is wider than long (Baszio, 1997). Also, the grinding surface in ceratopsians is flatter than the basin-like condition that is seen in hadrosaurs. Ceratopsian bones are rare in the Aguja Formation but the taxa present are the chasmosaurines *Agujaceratops mariscalensis*, and *A. mavericus* and the centrosaurine *Yehuecauhceratops mudei* (Lehman, 1989; Lehman *et al*., 2016; Rivera-Sylva *et al*., 2017).

5. Discussion

Late Cretaceous vertebrate faunas from southern parts of North America including their composition and assemblage changes are still poorly known compared to northern assemblages. The fossils reported from the Ojinaga Basin significantly increase our knowledge for this area. Vertebrates from the Big Bend and Ojinaga Basin are taxonomically distinct at the species or even genus level from contemporaneous northern faunas (Sankey, 2010), confirming the uniqueness of this southern fauna. The late Campanian Big Bend/Ojinaga Basin dinosaur assemblage was more similar to the late Maastrichtian southern Alberta (Scollard Formation) dinosaur assemblage in the following aspects: *Richardoestesia isosceles* was more abundant than *R. gilmorei*; *Dromaeosaurus* was absent or rare; and pachycephalosaurids were present to common (Sankey, 2001; Sankey *et al*., 2005; Rivera-Sylva and Carpenter, 2014b).

Differences between the southern and northern areas and their vertebrate faunas were primarily due to differences in climate, indicating habit preferences to some taxa, with periodic aridity occurring earlier in the Big Bend/Ojinaga Basin than in the northern areas. The Aguja Formation dinosaur bonebeds probably resulted from periodic droughts, severe enough to cause the marshes to dry up (Davies and Lehman, 1989) and paleocaliche to form soils. Postdrought flooding, possibly even flash floods, would have eroded and transported soil and vertebrate remains, depositing them rapidly within streams and forming conglomeratic beds with appreciable fossil content (Sankey and Gose, 2001).

6. Conclusions

The specimens described here from the Aguja and Javelina formations (late Campanian/ Maastrichtian) in the Ojinaga Basin, Chihuahua, significantly improve our knowledge of the vertebrates from the southern part of Laramidia. This assemblage provides an important glimpse of local paleocommunity structure in the region, as well as an opportunity to make comparisons with other Campanian-Maastrichtian age vertebrate faunas within North America.

Fossil material from the Javelina Formation of Mexico is here referred to *Alamosaurus sanjuanensis* for the first time. This new record of Saltasauridae from Chihuahua is a very important addition to the Late Cretaceous sauropod record of North America. The fossil finds are also of interest in relation to the biogeographic differences between the Late Cretaceous faunas of the northern hemisphere and the southern "*Alamosaurus* fauna", which is a unique terrestrial vertebrate fauna that characterized southern latitudes in North America at the end of the Cretaceous (Lehman, 1987, 2001).

The paucity of Late Cretaceous sauropod faunas in North America makes Mexican sauropod material of great importance to our understanding of the development of the Sauropoda.

Acknowledgments

We are extremely grateful to the anonymous donor of the present dinosaur specimens for making this project possible. We want to thank Adam S. Smith for reviewing an early copy of the manuscript. We extend our thanks to Margarita Alfaro-Ortíz for taking the photographs of the specimens. Special thanks to Rubén Guzmán-Gutiérrez for providing

bibliography which was otherwise difficult to obtain. We thank Daniel Barrera-Guevara for producing the images. Also we would like to thank two unknown reviewers that contribute to the improvement of this paper.

References

Abler, W.L., 1997, Tooth serrations in carnivorous dinosaurs, *in* Padian, K., Currie, P.J. (eds.), Encyclopaedia of Dinosaurs, San Diego, Academic Press, 740–741.

Arenal, R., 1964, Estudio geológico para la localización de yacimientos de carbón en el área Ojinaga-San Carlos, Estado de Chihuahua, México: Asociación Mexicana de Geólogos Petroleros, 16, 121–142.

Atchley, S.C., Nordt, L.C., Dworkin, S.I., 2004, Eustatic control on alluvial sequence stratigraphy: A possible example from the Cretaceous-Tertiary transition of the Tornillo Basin, Big Bend National Park, West Texas, USA: Journal of Sedimentary Research, 74, 391–404. doi:10.1306/102203740391.

Baghai, N., 1996, An analysis of palynomorphs from Upper Cretaceous sedimentary rocks with emphasis on the Aguja Formation, Big Bend National Park, Brewster County, Texas: Austin, University of Texas, Ph.D. dissertation, 495 pp.

Baszio, S., 1997, Systematic palaeontology of isolated dinosaur teeth from the Latest Cretaceous of south Alberta, Canada, in Investigations on Canadian dinosaurs, Courier Forschungsinstitut Senckenberg 196, 33–77.

Befus, K.S., Hanson, R.E., Lehman, T.M., Griffin, W.R., 2008, Cretaceous basaltic phreatomagmatic volcanism in West Texas: Maar complex at Peña Mountain, Big Bend National Park: Journal of Volcanology and Geothermal Research 173, 245–264. doi:10.1016/j.jvolgeores.2008.01.021.

Cabrera, F., Narváez, G., Chávez, J.M., Hernández, R., Alcantara, J., Gómez, F., 1984, Exploración carbonífera en la Cuenca de Ojinaga, Chihuahua: Boletín de la Sociedad Geológica Mexicana 45(3), 3. doi:10.18268/BSGM1984v45n3a3.

Coombs, W.P., Jr., 1990, Teeth and taxonomy in ankylosaurs, *in* Carpenter, K., Currie, P.J. (eds.), Dinosaur Systematics: Approaches and Presepectives: Cambridge, Cambridge University Press, 269–279. doi:10.1017/CBO9780511608377.023.

Cope, E.D., 1869, Synopsis of the extinct Batrachia, Reptilia, and Aves of North America. Transactions of the American Philosophical Society 14, 1–252.

Davies, K.L., 1983, Hadrosaurian dinosaurs of Big Bend National Park, Brewster County, Texas: Austin, University of Texas, Masters Thesis, 235 pp.

Davies, K., Lehman, T.M., 1989, The WPA quarries, *in* Busbey A.B. III, Lehman, T.M. (eds.), Vertebrate Paleontology, Biostratigraphy, and Depositional Environments. Latest Cretaceous and Tertiary, Big Bend Area, Texas:Austin, Texas, Society of Vertebrate Paleontology 49th Annual Meeting, Guidebook, Field Trips 1a, b, and c, p. 32–42.

D'Emic, M., Wilson, J., Thompson, R., 2010, The end of the sauropod dinosaur hiatus in North America: Palaeogeography, Palaeoclimatology, Palaeoecology 297, 486–490. doi: 10.1016/j.palaeo.2010.08.032.

Farlow, J.O., Brinkmann, D.L., 1987, Serration coarseness and patterns of wear of theropod dinosaur teeth: Geological Assotiation of America, Abstracts with Programs 19, 151.

Gilmore, C.W., 1922, A new sauropod dinosaur from the Ojo Alamo Formation of New Mexico: Smithonian Miscelaneous Collection 72(14), 1–9.

Holtz, T.R. Jr., 2004, Tyrannosauroidea, *in* Weishampel, D.B., Dodson, P., Osmólska, H., (eds.), The Dinosauria 2nd Edition: Berkeley, University of California Press, 111–136.

Hunt, R.K., Lehman, T.M., 2008, Attributes of the ceratopsian dinosaur *Torosaurus*, and new material from the Javelina Formation (Maastrichtian) of Texas: Journal of Paleontology 82(6), 1127–1138. doi: 10.1666/06-107.1.

Kues, B.S., Lehman, T.M., Rigby K. Jr., 1980, The teeth of *Alamosaurus sanjuanensis*, a Late Cretaceous sauropod: Journal of Paleontology 54(4), 864–869.

Lehman, T.M., 1985, Stratigraphy, sedimentology, and paleontology of Upper Cretaceous (Campanian-Maastrichtian) sedimentary rocks in Trans-Pecos, Texas: Austin, University of Texas Ph.D. dissertation, 299 pp.

Lehman, T.M., 1987, Late Maastrichitan paleonenvironments and dinosaur biogeography in the western interior of North America: Palaeogeography, Palaeoclimatology, Palaeoecology 60, 189–217. doi: 10.1016/0031-0182(87)90032-0.

Lehman, T.M., 1989, Upper Cretaceous (Maastrichtian) paleosols in Trans-Pecos Texas: Geological Society of America Bulletin 101(2), 188–203. doi:10.1130/0016-7606(1989)101<0188:UCMPIT>2.3.CO;2.

Lehman, T.M., 1991, Sedimentation and tectonism in the Laramide Tornillo Basin of West Texas: Sedimentary Geology 75, 9–28. doi: 10.1016/0037-0738(91)90047-H.

Lehman, T.M., 2001, Late Cretaceous dinosaur provinciality, *in* Carpenter, K., Tanke, D. (eds.), Mesozoic Vertebrate Life: Bloomington, Indiana University Press, 310–328.

Lehman, T.M., 2007, Growth and population age structure in the horned dinosaur *Chasmosaurus*, *in* Carpenter, K. (ed.) Horns and Beaks: Ceratopsian and Ornithopod Dinosaurs: Bloomington, Indiana University Press, 259–317.

Lehman, T.M., Coulson, A.,B., 2002, A juvenile specimen of the sauropod dinosaur *Alamosaurus sanjuanensis* from the Upper Cretaceous of Big Bend National Park, Texas: Journal of Paleontology 76(1), 156–172. doi:10.1666/0022-3360(2002)076<0156:AJSOTS>2.0.CO;2.

Lehman, T.M., Mcdowell, F.W., Connelly, J.N., 2006, First isotopic (U-Pb) age for the Late Cretaceous *Alamosaurus* vertebrate fauna of west Texas, and its significance as a link between two faunal provinces: Journal of Vertebrate Paleontology 26(4), 922–928. doi:10.1671/0272-4634(2006)26[922:FIUAFT]2.0.CO;2.

Lehman, T.M., Wick, S.L., Wagner, J.R., 2016, Hadrosaurian dinosaurs from the Maastrichtian Javelina Formation, Big Bend National Park, Texas: Journal of Paleontology 90(2), 333–356. doi:10.1017/jpa.2016.48.

Lucas, S.G., Sullivan, R.M., 2000, The sauropod dinosaur *Alamosaurus* from the Upper Cretaceous of the San Juan Basin, New Mexico: New Mexico Museum of Natural History and Science Bulletin 17, 147–156.

Marsh, O.C., 1878, Principal characters of American Jurassic dinosaurs. Part I: American Journal of Science, Series 3, 16, 411–416. doi: 10.2475/ajs.s3-16.95.411.

Marsh, O.C., 1881, Principal characters of American Jurassic dinosaurs. Part IV. Spinal cord, pelvis and limbs of *Stegosaurus*: American Journal of Science, Series 3, 21, 167–170. doi:10.2475/ajs.s3-21.122.167.

Marsh, O.C., 1888, A new family of horned dinosaurs from the Cretaceous: American Journal of Science, Series 3, 21, 477–478. doi:10.2475/ajs.s3-36.216.477.

Marsh, O.C., 1890, Description of new dinosaurian reptiles: American Journal of Science, Series 3, 39, 81–86. doi:10.2475/ajs.s3-39.229.81.

Maxwell, R.A., Lonsdale, J.T., Hazzard, R.T., Wilson, J.A., 1967, Geology of Big Bend National Park; Brewster County, Texas. University of Texas Bureau of Economic Geology, Publication 6711, 320 pp. doi:10.26153/tsw/5062.

Montellano-Ballesteros, M., 2003, A titanosaurid sauropod from the Upper Cretaceous of Chihuahua, Mexico: Revista Mexicana de Ciencias Geológicas 20, 160–164.

Montellano, M., Hernández, R., Alvarez, G., Andrade, P., Martin, L., 2000, Discovery of Late Cretaceous vertebrate local faunas in northern Mexico: Journal of Vertebrate Paleontology 20(3), suppl., 58A.

Osborn, H.F., 1906, *Tyrannosaurus*, Upper Cretaceous carnivorous dinosaur (second communication): Bulletin of the American Museum of Natural History 22, 281–296.

Osborn, H.F., 1923, Two Lower Cretaceous dinosaurs of Mongolia: American Museum Novitiates 95, 1–10.

Owen, R., 1842, Report on British fossil reptiles. Part II: Report of the British Association for the Advances of Sciences 1841, 60–204.

Peng, J., Russell, A.P., Brinkman, D.B., 2001, Vertebrate Microsite Assemblage (Exclusive of Mammals) from the Foremost and Oldman Formation of the Judith River Group (Campanian) of Southeastern Alberta: An illustrated Guide: Edmonton, Provincial Museum of Alberta, Natural History Occasional, Paper no. 25. doi:10.5962/bhl.title.115853.

Robinson-Roberts, L., Kirschbaum, M., 1995, Paleogeography of the Late Cretaceous of the western interior of middle North America-Coal distribution and sediment accumulation: U.S. Geological Survey Professional, Paper 1561, 115 p. doi:10.3133/pp1561.

Rivera-Sylva, H.E., Guzmán-Gutiérrez, J.R., Palomino-Sánchez, F.R., 2006, Preliminary report on a vertebrate fossil assemblage from the Late Cretaceous of Chihuahua, Mexico: Hantkeniana 5, 66–68.

Rivera-Sylva, H.E., Carpenter, K., 2014a, The Ornithischian dinosaurs from Mexico, *in* Rivera-Sylva, H.E., Carpenter, K., Frey, E., (eds), Dinosaurs and other reptiles from the Mesozoic from Mexico: Bloomington, Indiana University Press, 156–180.

Rivera-Sylva, H.E., Carpenter, K., 2014b, Mexican Saurischian dinosaurs, *in* Rivera-Sylva, H.E., Carpenter, K., Frey, E., (eds), Dinosaurs and other reptiles from the Mesozoic from Mexico: Bloomington Indiana University Press, 143–155.

Rivera-Sylva, H.E., Frey, E., Stinnesbeck, W., González-González, A.H., Guzmán-Gutiérrez, J.R., 2017, Mexican Ceratopsids: Considerations on their diversity and biogeography: Journal of South American Earth Sciences, 75, 66–73. doi:10.1016/j.jsames.2017.01.008.

Sankey, J.T., 2001, Late Campanian southern dinosaurs, Aguja Formation, Big Bend, Texas: Journal of Paleontology 75, 208–215. doi:10.1666/0022-3360(2001)075<0208:LCSDAF>2.0.CO;2.

Sankey, J.T., 2010, Faunal Composition and Significance of High-Diversity, mixed bonebeds containing *Agujaceratops mariscalensis* and other dinosaurs, Aguja Formation (Upper Cretaceous), Big Bend, Texas, in New Perspectives on Horned Dinosaurs: Bloomington Indiana University Press, 520–537.

Sankey, J.T., Gose, W.A., 2001, Late Cretaceous mammals and magnetostratigraphy, Big Bend, Texas: Louisiana State University Occasional Papers of the Museum of Natural Science 77, 1–16. doi:10.31390/opmns.077.

Sankey, J.T., Standhardt, B.R., Schiebout, J.A., 2005, Theropod teeth from the Upper Cretaceous (Campanian-Maastrichtian), Big Bend National Park, Texas, *in* Carpenter, K. (ed.), The Carnivorous Dinosaurs: Bloomington, Indiana University Press, 127–152.

Schiebout, J.A., 1989, The Paleocene Rocks of Tornillo flat, Big Bend National Park Texas: Evolving Views, *in* Busbey, A.B., Lehman, T.M. (eds.), Vertebrate Paleontology, Biostratigraphy and Depositional Environments, Latest Cretaceous and Tertiary, Big Bend Area, Texas, Society of Vertebrate Paleontology Field Trip Guidebook Number 1, 61–66.

Seeley, H.G., 1888, The classification of the Dinosauria: Report of the British Association for the Advances of Sciences 1887, 698–699.

Sullivan, R.A., Lucas, S.G., 2000, *Alamosaurus* (Dinosauria: Sauropoda) from the Late Campanian of New Mexico and its significance: Journal of Vertebrate Paleontology 20(2), 400–403. doi:10.1671/0272-4634(2000)020[0400:ADSFTL]2.0.CO;2.

Vickaryous, M.K., Maryańska, T., Weishampel, D.B., 2004, Ankylosauria, *in* Weishampel, D.B., Dodson, P., Osmólska, H. (eds.), The Dinosauria Second Edition: Berkeley, University of California Press, 363–392. doi:10.1525/9780520941434-023.

Weishampel, D.B., Barrett, P.M., Coria, R.A., Le Loeuff, J., Xing, X., Xijin, Z., Sahni, A., Gomani, E.M.P., Noto, C.R., 2004, Dinosaur Distribution, *in* Weishampel, D.B., Dodson, P., Osmólska, H. (eds.), The Dinosauria Second Edition: Berkeley, University of California Press, 517–606. doi:10.1525/9780520941434-030.

Wilson, J.A., Upchurch, P., 2003, A revision of *Titanosaurus* Lydekker (Dinosauria: Sauropoda), the first dinosaur genus with a "Gondwanan" distribution: Journal of Systematic Palaeontology 1, 125–160. doi: 10.1017/S1477201903001044.

Wolleben, J.A., 1968, Statistical biostratigraphic correlation and Senonian stratigraphy in west Texas and northeastern Chihuahua, Mexico: Transactions Gulf Coast Association of Geological Societies 18, 166–173.