



The Discovery, Local Distribution, and Curation of the Giant Azhdarchid Pterosaurs from Big Bend National Park

Authors: Brown, Matthew A., Sagebiel, J. Chris, and Andres, Brian

Source: Journal of Vertebrate Paleontology, 41(sp1) : 2-20

Published By: The Society of Vertebrate Paleontology

URL: <https://doi.org/10.1080/02724634.2019.1780599>


BioOne Complete (complete.BioOne.org) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at www.bioone.org/terms-of-use.

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

THE DISCOVERY, LOCAL DISTRIBUTION, AND CURATION OF THE GIANT AZHDARCHID PTEROSAURS FROM BIG BEND NATIONAL PARK

MATTHEW A. BROWN, ^{*},¹ J. CHRIS SAGEBIEL,¹ and BRIAN ANDRES ²

¹Texas Vertebrate Paleontology Collections, The University of Texas at Austin, Austin, Texas 78758, U.S.A., matthewbrown@utexas.edu; sagebiel@austin.utexas.edu;

²Department of Animal & Plant Sciences, University of Sheffield, Sheffield S10 2TN, U.K., brian.andres@aya.yale.edu

ABSTRACT—Field crews from The University of Texas at Austin first identified pterosaur remains from the Upper Cretaceous Javelina Formation of Big Bend National Park in 1971 and continued excavation of these animals for decades. The announcement of the giant *Quetzalcoatlus northropi* in 1975 by graduate student Douglas Lawson drew worldwide attention, and fossil preparators William Amaral and Robert Rainey discovered several key localities in a region informally called Pterodactyl Ridge that have been thoroughly collected and documented. The Pterodactyl Ridge sites produced hundreds of bones from surface collection and quarries through 1986, but later surface collection yielded poorer results. The majority of these elements represent an animal substantially smaller than *Q. northropi*, *Quetzalcoatlus lawsoni* Andres and Langston, 2021—historically referred to as *Quetzalcoatlus* sp. These and subsequent field expeditions from several institutions have reported occurrences of pterosaurs from both the Aguja and Javelina formations, but this study limits only the Javelina Formation material to pterosaurs. *Quetzalcoatlus northropi* is known within Big Bend National Park only from stream channel facies, and the smaller *Q. lawsoni* from the upper abandoned channel-lake facies at Pterodactyl Ridge. The lower abandoned channel-lake facies strata of Pterodactyl Ridge produce a third genus and species, *Wellnhopterus brevirostris* Andres and Langston, 2021. In addition, a smaller azhdarchid is found in the overbank floodplain facies.

Citation for this article: Brown, M. A., J. C. Sagebiel, and B. Andres. 2021. The discovery, local distribution, and curation of the giant azhdarchid pterosaurs from Big Bend National Park; pp. 2–20 in K. Padian and M.A. Brown (eds.), The Late Cretaceous pterosaur *Quetzalcoatlus* Lawson 1975 (Pterodactyloidea: Azhdarchoidea). Society of Vertebrate Paleontology Memoir 19. Journal of Vertebrate Paleontology 41(2, Supplement). DOI: 10.1080/02724634.2019.1780599.

INTRODUCTION

From the time the giant azhdarchid pterosaur *Quetzalcoatlus northropi* Lawson, 1975b, was discovered in 1971, it has confounded belief. Found in an area already known for 12-m-long crocodilians and 30-m-long sauropods, its 10-m wingspan showed not only that it was as large as some of its other archosaur contemporaries but also that it could fly. Questions about how these improbable animals got off the ground, sustained flight, walked, fed, and grew have captivated researchers and global audiences for decades. Upon its debut, *Quetzalcoatlus northropi* graced the cover of Science (Lawson, 1975a), was featured in Time, and in 1981 made the cover of Scientific American (Langston, 1981). The public profile of *Quetzalcoatlus northropi* is evidenced by its presence on the postage stamps of more than 24 countries, including Spain, Togo, Grenada, Cuba, and the Maldives, and by coins struck by the Royal Canadian Mint (a \$10.00 silver proof coin and the \$0.25 coin that features a glow-in-the-

dark skeleton). *Quetzalcoatlus* has featured in starring roles in television and IMAX documentaries, in children's books, as toys in the Jurassic Park franchise and Dino-Riders action figure line, and even in Sunday comic strips such as Calvin and Hobbes (Fig. 1). Casts of the *Q. northropi* holotype specimen are available for sale and have been mounted in museum exhibitions around the world.

As widely recognized as *Quetzalcoatlus* is in the public sphere, the availability of scientific information about it is paradoxically limited outside the repository in Austin, Texas. Up to now, the specimens have not been comprehensively described in the literature, tantalizing and frustrating a research community that has eagerly anticipated full publication of the material for more than 40 years. Only brief published glimpses have been available, from the terse description and naming of the holotype (Lawson, 1975a, 1975b) to the recognition of a new but unnamed species, *Quetzalcoatlus* sp. (Langston, 1981; Kellner and Langston, 1996). The present volume aims to redress these deficiencies. The following overview of the collection and curatorial history of the Big Bend National Park pterosaurs is drawn largely from field notebooks, locality and quarry maps, photographs, and correspondence archived at the Texas Vertebrate Paleontology Collections at The University of Texas at Austin. This publication is intended to summarize the original documentary source material and serve as an orientation to the pterosaur specimens collected from Big Bend National Park between 1970 and 2002. It should be noted

*Corresponding author.

© 2021 Matthew A. Brown, J. Chris Sagebiel, and Brian Andres.

This is an Open Access article distributed under the terms of the Creative Commons Attribution-NonCommercial-NoDerivatives License (<http://creativecommons.org/licenses/by-nc-nd/4.0/>), which permits non-commercial re-use, distribution, and reproduction in any medium, provided the original work is properly cited, and is not altered, transformed, or built upon in any way.



FIGURE 1. **A**, comic strip depicting *Quetzalcoatlus northropi* as a meal for *Tyrannosaurus rex*, Calvin and Hobbes © 1990 Watterson. Reprinted with permission of Andrews McMeel Syndication. All rights reserved. **B**, postage stamps featuring *Q. northropi* from Grenada, Maldives, Grenadines of St. Vincent, and Mozambique. **C**, *Quetzalcoatlus* coins from the Royal Canadian Mint and the Department of Mayotte, France.

that the names *Quetzalcoatlus lawsoni* and *Wellnhopterus brevirostris* are used in this paper, but they are named in Andres and Langston (2021) and should be cited as such. Any names or nomenclatural acts in this paper are

disclaimed for nomenclatural purposes (Article 8.3 of the International Code of Zoological Nomenclature; International Commission on Zoological Nomenclature [ICZN], 1999).

MATERIALS AND METHODS

Texas Vertebrate Paleontology Collections Numbering Conventions

All Big Bend National Park specimens were collected under National Park Service permit numbers 73-TX-004, 74-TX-004, 75-TX-012, 78-TX-091, 81-TX-303, 85-BIBE-1(P), 88-BIBE-1(P), 91-BIBE-1(P), 94-BIBE-1(P), BIBE-97-33, BIBE-99-19, and BIBE-2002-SCI-0012 and are repositied in the Texas Vertebrate Paleontology Collections at The University of Texas at Austin (TMM). For the sake of accurate identification, the institutional locality and catalog numbers represent the ultimate record and supersede locality names and field specimen and site names and numbers (Appendix 1). Locality numbers take the format of TMM #####, for example, the *Quetzalcoatlus northropi* holotype locality is TMM 41450. Catalog numbers take the format of TMM #####-#. Thus, the holotype specimen of *Q. northropi* is TMM 41450-3. In some instances, individual elements from a single individual are tracked in the collections with a decimal unit following the specimen number. For example, the left humerus of the holotype of *Q. northropi* is TMM 41450-3.1. Field numbers are used in the collecting history narrative of this paper as primary descriptors because they represent the finest level of granularity applied by Wann Langston’s crews throughout several decades of field work in Big Bend National Park (BIBE). They are also the primary reference that ties fossils to TMM localities within Langston’s notebooks. Sometimes field numbers have a one-to-one relationship with the final

TABLE 1. Pterosaur producing localities in Big Bend National Park organized by taxonomic identification and indicating field numbers of which they are comprised.

Locality Number	Field Numbers
Pterosauria indeterminate	
TMM 41839	WL 371
TMM 42538	TL 95-7
TMM 45616	TL 95-5
TMM 45888	TL 95-7
<i>Quetzalcoatlus northropi</i>	
TMM 41450	DL 5
TMM 44036	TL 97-4
<i>Quetzalcoatlus</i> cf. <i>northropi</i>	
TMM 41047	TL 02-03
TMM 41398	DL 1
TMM 42889	WL 422
<i>Quetzalcoatlus lawsoni</i>	
TMM 41544	WL 367
TMM 41545	WL 368
TMM 41546	WL 369
TMM 41547	WL 372
TMM 41954	WL 392, WL A, WL 458, WL 470, WL 471
TMM 41961	WL 368
TMM 42138	WL B, WL 439
TMM 42157	WL A
TMM 42161	WL C
TMM 42180	WL D, WL 419, WL 420, WL 429, WL 438, WL 478
TMM 42246	WL 433, WL 434, WL 482
TMM 42259	WL 421
TMM 42272	WL 423
TMM 42297	WL 456
TMM 42422	WL 467
TMM 42462	WL 435
TMM 42521	WL C
TMM 44037	TL 93-2
TMM 44048	Unknown
TMM 45977	None
TMM 45997	WL 489
<i>Wellnhopterus brevirostris</i>	
TMM 42489	WL 474

institutional locality number: for instance, all specimens from locality number TMM 41544 correspond to field number WL 367. In others, several field numbers were later condensed into one locality number (e.g., TMM 41954; see Table 1). Like catalog numbers, field numbers sometimes followed the convention of appending a decimal number to identify discrete collected items. For example, the hypothetical WL #.1 could refer to an individual bone, a field jacket, elements collected together in articulation, or a bag of surface-collected fragments. All specimens have been issued National Park Service (NPS) catalog numbers, which take the form BIBE #####. For example, the left humerus of the holotype of *Q. northropi* is BIBE 49947. All elements collected by Langston have a unique BIBE catalog number and are contained within the accession records NPS BIBE-1661 and NPS BIBE-1662. BIBE numbers for specimens collected by Lehman are pending. Colloquial site names are not to be used as identifiers, because there has been considerable inconsistency or ambiguity in their application over the years. For example, TMM 41544 (WL 367) is referred to colloquially as Pterosaur Site I and the Amaral Quarry (also Amaral Site or Amaral Locality). Langston’s field notes consistently identify the Amaral Quarry as WL 367, but Kellner and Langston (1996) describe the Amaral Site as the source for all the *Quetzalcoatlus lawsoni* specimens. This region is also broadly referred to as Pterodactyl Ridge (but also sometimes ‘Pterosaur Ridge’ in Langston’s field notes), and on field maps as Pterosaur Site, which overlaps entirely with the *Q. lawsoni*-producing localities, but there are also pterosaur localities at Pterodactyl Ridge that contain taxa other than *Q. lawsoni*. However, no definitions exist in field notes, collections, or manuscripts that characterize the boundaries or contents of ‘named’ units; thus these ‘named’ units should not be used to identify localities. Pterodactyl Ridge is used in this paper only as a nickname for the geographic feature at which a dense concentration of localities is located; its usage does not denote a locality name. Two generations of locality maps were produced and are reproduced here for clarity and completeness. The most accurate map showing localities was generated by Tom Lehman and Wann Langston (Fig. 2B). However, until 2017, when the original plane table map was found in unlabeled boxes in Langston’s records, the only map on file in the collections records was a United States Geological Survey (USGS) topographic map with field numbers marked in pencil (Fig. 3A), and these were the coordinates listed in the museum catalog. Lehman and Langston early suspected that many of these sites were marked incorrectly, and this interpretation was borne out by subsequent surveys. Langston’s field notes and photographs are repositied in the Texas Vertebrate Paleontology Archives in the Wann Langston Papers, Series II: Field Notes 1936–1999, Boxes VPA001/19 and VPA001/20. Douglas Lawson’s field notes are summarized by Langston in Langston’s field notebooks. Thomas Lehman and Timothy Rowe’s field notes are housed in VPA009. Locality maps are repositied in the Texas Vertebrate Paleontology Collections Locality Files. Precise locality data are available to qualified researchers upon request, subject to the provisions of the Paleontological Resources Preservation Act of 2009 and National Park Service regulations. Institutional Abbreviations—BIBE, Big Bend National Park, Texas, U.S.A.; LSUMNS, Louisiana State University Museum of Natural Science, Baton Rouge, Louisiana, U.S.A.; TMM, Texas Vertebrate Paleontology Collections, The University of Texas at Austin, Austin, Texas, U.S.A. Field Number Abbreviations—DL, Douglas Lawson; TL, Thomas Lehman; WL, Wann Langston, Jr. Laboratory Methods Most specimens collected by Langston’s field crews were prepared at The University of Texas at Austin (UT); specimens

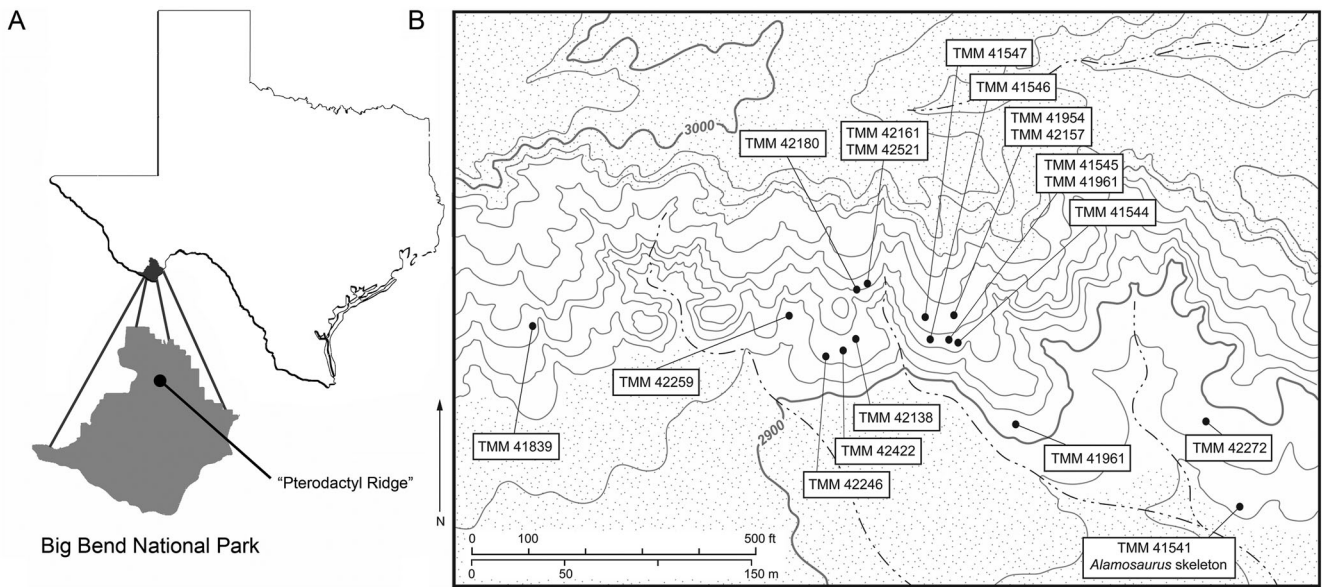


FIGURE 2. **A**, location of Big Bend National Park relative to the state of Texas, U.S.A., and general location of the 'Pterodactyl Ridge' area. **B**, map of major 'Pterodactyl Ridge' localities as plotted in 1980. Locality map courtesy of Thomas Lehman.

collected during the 1974 field season were sent to the University of California Museum of Paleontology. Formal preparation records do not exist for TMM specimens prior to 2009, but contemporary correspondence, photographs, and materials receipts shed light on standard laboratory practices in use at the time. Langston's field notes describe the use of hammers, chisels, picks, shovels, and gasoline-powered rock saws. Hand tools such as hammers and chisels were commonly used for matrix removal in the Austin laboratories (Brown, 2013:fig. 4b). One photograph (Fig. 4C) shows Earl Yarmer using a Chicago Pneumatic (Chicago Pneumatic Tool Company) air scribe to remove matrix from a Pterodactyl Ridge field jacket. These tools had stainless and carbide steel tips designed and fabricated in the University of Texas at Austin machine shop. Materials likely applied to consolidate, adhere, and fill fossils in this collection are Coecal dental plaster and other gypsum plasters, unknown grades of Glyptal (General Electric) and Gelva (Henkel Adhesives) adhesives, and Duco Cement (ITW Consumer). Weathered and broken surfaces of many of the bones have been sculpted; in most cases, a gypsum product has been applied directly to the bone. The posterior skull of TMM 41961-1 was chemically prepared with a 5% solution of formic acid (Kellner and Langston, 1996).

Histologically sampled specimens are known to include TMM 41544-2, TMM 41544-11, TMM 42180-17, TMM 42180-25, TMM 44036-1, TMM 44037-1, TMM 44037-2, TMM 41450-3.3, TMM 41544-23, TMM 41954-1, TMM 41954-90, TMM 41954-91, TMM 42180-7, TMM 42180-22, and TMM 42180-23. Additional unidentified slides exist within this collection and are being traced to source specimens as part of an ongoing project.

Field Collecting

A Century of Big Bend Paleontology—Geologists and paleontologists have collected Cretaceous fossils from the area in and around the modern boundaries of Big Bend National Park for more than a century. Udden (1907) published Samuel Williston's identification of hadrosaur, ceratopsian, theropod, turtle, and crocodilian bones collected during a geological survey, and a memo in the American Museum of Natural History (AMNH) archives

places Barnum Brown in the area in 1908 (B. Brown memorandum, 1940; AMNH archives). Brown (1917) later reported ceratopsian material from the same Rattlesnake Beds (now Aguja Formation) where Udden collected; Brown returned to this region with R. T. Bird in August 1940 (Colbert and Bird, 1954). The University of Oklahoma, American Museum of Natural History, University of Texas at El Paso, Texas Tech University, Dallas Museum of Natural History, and Texas Memorial Museum have all made substantial field collections in the region, and the presence of paleontological resources constituted "a portion of the justification for the establishment of the area as a national park" (Letter, A.E. Demaray to B. Brown, September 5, 1940:1; AMNH archives).

The individual most closely associated with Cretaceous research at Big Bend National Park is Wann Langston, Jr., who joined his first expedition as a 17-year-old volunteer on a University of Oklahoma trip into the region in June 1938 (Bell et al., 2013), and again in 1940 (Czaplewski et al., 1994). Langston later led a Texas Tech collecting trip in 1949 and returned to the park again in 1963 when he moved to a curatorial position at the Texas Memorial Museum from the National Museum of Canada. TMM field crews had been conducting permitted field work in the park since 1952, following geology professor John Wilson's 1950 discovery of Eocene mammal fossils in beds mapped as Late Cretaceous outcrop (Wilson, 1967). Langston developed a diverse field program in Big Bend and visited the park almost every year until 1999, training graduate students and collecting hundreds of specimens for the Texas Memorial Museum (Fig. 3).

Pterosaur Discovery—Field work undertaken by graduate student Douglas Lawson for his master's degree project entitled 'Paleoecology of the Javelina Formation, Big Bend National Park, Brewster County, Texas' (Lawson, 1972) resulted in the discovery of the fragments of fossil bone that would launch several decades of pterosaur excavation at the park. Lawson visited Big Bend with Langston in March 1970 before starting graduate school at The University of Texas at Austin and on the last day of the trip discovered a tyrannosaur maxilla while climbing a hill to leave the field. He later identified this as the first *Tyrannosaurus rex* Osborn, 1905, material known from Texas

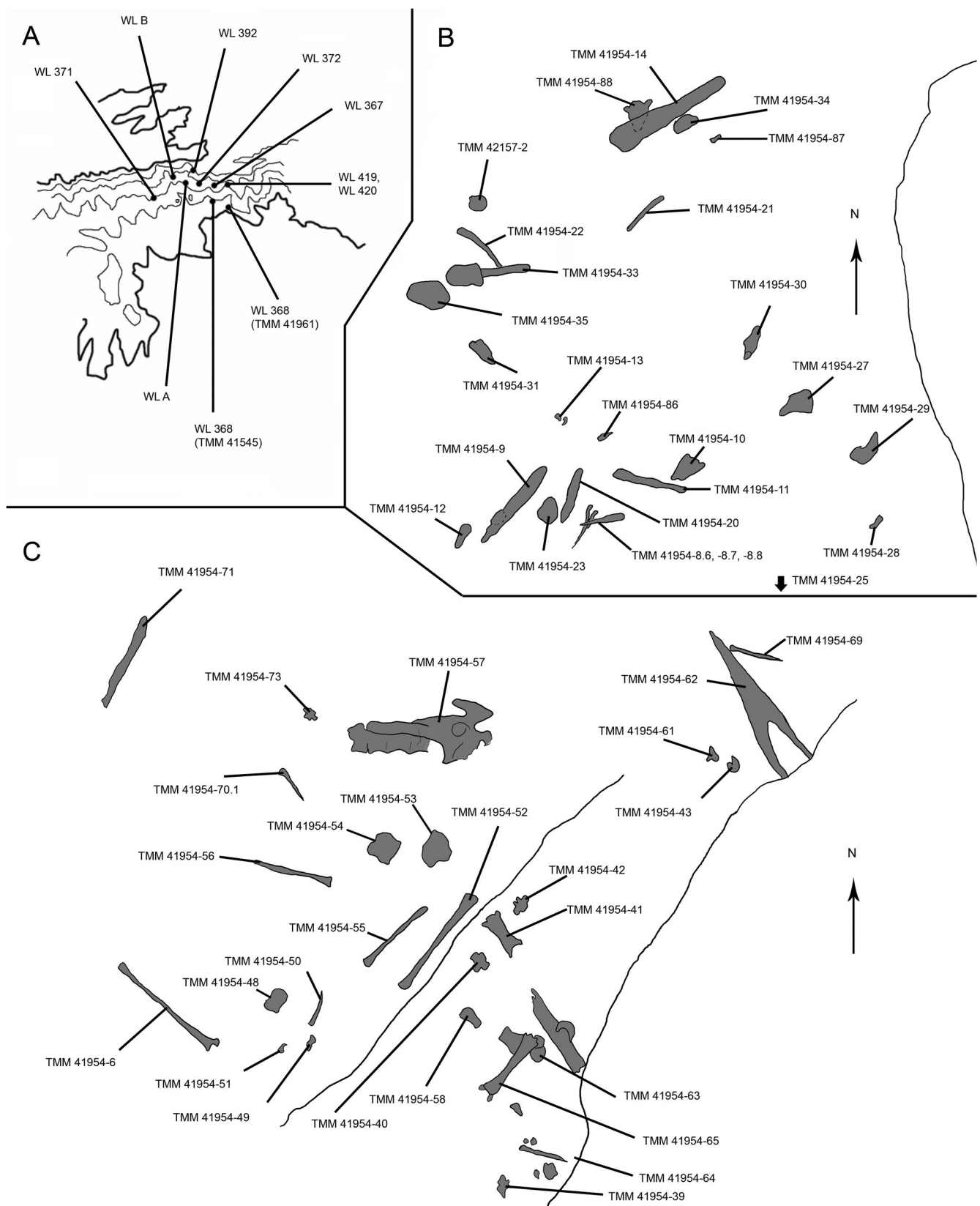


FIGURE 3. **A**, first generalized locality map of Pterodactyl Ridge showing the 10 field numbers plotted on Wann Langston's field maps. This map is known to be slightly inaccurate, but represents all the pterosaur localities as they were originally plotted by Langston, but does not include all of the pterosaur localities. **B**, quarry map for field number WL A of locality TMM 41954 showing TMM specimen numbers; **C**, quarry map for field number WL 471 of locality TMM 41954 showing TMM specimen numbers.



FIGURE 4. Field and laboratory photographs. **A**, Wann Langston in the field in 1986, collecting the skull of TMM 42489-2. **B**, Arthur Busbey (left) and Langston (right) in 1976 collecting at TMM 41544. **C**, Earl Yarmer preparing a Pterodactyl Ridge field jacket, from locality TMM 41961 in 1976. **D**, field crew working at TMM 41450 in 1976. **E**, Earl Yarmer (left) and Bob Rainey (right) collecting TMM 41954 in 1986.

(Lawson, 1976). Langston and Lawson returned to the park for 8 days of collecting in January 1971, in temperatures ranging between -6 and 0°C . On the second day in the field, Lawson found the proximal end of a sauropod humerus, the first attributable to *Alamosaurus sanjuanensis* Gilmore, 1922, as well as fragments of the first pterosaur material known from the park from site DL 1 (TMM 41398-3) and DL 3 (TMM 41398-4).

Lawson discovered the holotype of *Quetzalcoatlus northropi* during 1971 in an arroyo in the Dawson Creek section (locality TMM 41450) in the western edge of the park (Lawson, 1972). This began with some pieces of float that led him to a 3-foot-long in situ bone, from which he took a foot-long sample (Langston, 1978). He showed this sample to Langston upon returning to Austin, and they identified it as a pterosaur based on its extreme hollowness and comparison with pterosaur bones in other collections (Langston, 1978). Langston joined Lawson again in the field in November 1971, and his field notes of November 22 reflect the disbelief that accompanies most encounters with such an enormous flying reptile:

“Finally we examined the presumed pterosaur specimen.

[emphasis original] I still cannot be sure what it is. Some bones are very large for any pterosaur I know, but they are thinner-walled than anything but a pterosaur. The rock is a fairly hard yellow-white sandstone that will be difficult to dig. There is a steep cliff above. It is not a job for this year! Lawson picked up and wrapped in paper all the fragments that had weathered out since last summer, but he made no attempt to excavate anything. The specimen is D.L. 5” (Langston Field Notes, November 22, 1971:69–71).

This material comprised a giant left radius and ulna, proximal and distal syncarpals, and the proximal end of a wing metacarpal (metacarpal IV; Lawson, 1972). Crews monitored and continued to collect from this locality over the following decades. Some bones from the site were originally cataloged as TMM 41501-1 but were amended to TMM 41450-3 in July 1975.

A Texas Memorial Museum field crew composed of Langston and fossil preparators Bob Rainey, Earl Yarmer, and Bill Amaral returned to Big Bend in February 1973 to excavate an *Alamosaurus* quarry, WL 366 (TMM 41541). Presaging a career as a legendary field worker, the young Amaral was restlessly on the trail of more fossils. “As if he hadn’t enough to do with the dinosaur Amaral spends his lunch time prospecting nearby. Today he brought back a number of surface fragments of the now familiar Javelina pterosaur bone. None of the scraps suggest anything so large as Lawson’s *Pteranodon gigas*” (Langston Field Notes, March, 2, 1973:91). Over the following week, Amaral discovered several pieces of surface float during what Langston called ‘noontime jaunts’ and on March 14 located in situ bone at WL 367 (TMM 41544; called at the time Pterosaur Site I). WL 368 (TMM 41545; Pterosaur Site II) and WL 369 (TMM 41546; Pterosaur Site III) were established at the same time; WL 368 comprised a complete carpal and was located above WL 367, and WL 369 float was distributed across the west side of the ridge (Fig. 3A). WL 372 (TMM 41547), an accumulation of float and a complete in situ ‘finger’ bone, was also identified ca. 15 m northwest of WL 367. Field number WL 368 was mistakenly reused in 1974 to identify locality TMM 41961, and herein WL 368 is always accompanied by locality number to differentiate the two. Surface float from all sites was collected along with two small field jackets. Because much of the float represented freshly broken specimens that could be fit back together, the prospect was saved for a future date when screening and an appropriate excavation could be arranged. The crew returned to Austin for 10 days to retrieve a dump truck and two pickup trucks needed to transport the sauropod field jackets, and on March 27 they returned to the *Quetzalcoatlus*

northropi locality to look for additional material. Surface float was collected and was later reattached to specimens already in the collections, and ‘a long, slender, delicate bone’ was excavated and found to be in articulation with another large element, which remained in the ground until the next field season.

In April 1974, Langston returned to the park with Lawson (now a University of California, Berkeley, doctoral student) and UT graduate student Marc Gallup. On the 3rd, they drove with Ranger George Howorth to TMM 41450 and discovered more float that had weathered out into the flats. Over the next several days, they excavated the humerus in two large pieces, broken at midshaft. After removing the humerus, Langston felt confident that no more bone was present at the site due to the very close articulation of already excavated elements, and the absence of immediate bone in close proximity, and closed the quarry for the year. Crews returned several times in subsequent years, but no further substantial material was found.

On April 6, the crew moved back to ‘Amaral’s Pterosaur Site’ WL 367, where that morning Lawson and Gallup uncovered a cervical vertebra ca. 500 mm in length. Several additional bones were recovered, as well as an accumulation of black, waxy, needle-like structures in close association to the bone. Acknowledged to likely be plant fossils, the hope was raised that they represented a filamentous integument. The structures were later identified as conifer needles. Also uncovered were presumed paired lower jaws (TMM 41544-22), one of which was heavily fragmented by an unfortunately placed rock pick.

The second WL 368 locality (TMM 41961) was discovered by Langston on April 6 when “on the way down the hill [from 367] following a route taken several times last year and today, I almost stepped on what appears to be an associated pterosaur skeleton” (Langston Field Notes, April 6, 1974:11). Langston went on to investigate this find while Lawson and Gallup collected the exposed bones at WL 367 and covered the quarry for the season, and they tentatively identified a femur, folded wing, vertebrae, and additional long bones before running out of time and covering WL 368 with a protective field jacket to be collected the following year. On April 8, the crew departed the park, and Lawson took all the fossils collected this season back to Berkeley for preparation and study.

Lawson announced the discovery of the Big Bend pterosaur material in March (Lawson, 1975a), figuring elements TMM 41450-3.1, TMM 41544-9, and TMM 41544-15, and established TMM 41450-3 as the holotype of *Q. northropi* in May (Lawson, 1975b). Bones of the smaller animal discovered by Amaral historically have been referred to as *Quetzalcoatlus* sp. (Kellner and Langston, 1996; but see Andres and Langston, 2021). Langston returned with Lawson and Yarmer to the area now known as Pterodactyl Ridge in April 1975, collected the jacket at WL 368, surface-collected the hill, and found evidence of bone weathering out of WL 367 that warranted investigation in subsequent years.

March 1976 saw Langston and Lawson return with Bob Rainey and new graduate student Art Busbey in tow. After several days of prospecting for dinosaurs, Rainey and Busbey opened the quarry at WL 367 (TMM 41544; referred to by Langston at this point as the ‘Amaral Quarry’ and similar) and worked it from March 19 to 22, 1976, collecting field numbers WL 367.12 to WL 367.21. On March 22, 1976, Langston revisited WL 371 (TMM 41839), identified by Amaral and Rainey in 1971 from which a sauropod femur (TMM 41839-1) and pterosaur limb (TMM 41839-2) had been collected. They collected WL 371.2 and WL 371.3, then returned on March 25, 1976, to collect WL 371.4 through WL 371.6 (TMM 41839-3.1, 3.2, 3.6, and 3.7), as well as coprolites (WL 371.8) with the hope that they would prove pterosaurian.

Langston returned again to Big Bend in May 1977, but later lost the original field notes from this brief trip. His reconstructed notes

are recorded in his 1979–1981 field notebook, based on his recollections and specimen catalog records in collections. The field party consisted of Langston, Rainey, Yarmer, and UT graduate student Ann Elder. Previous expeditions had surface-collected bone-filled concretions weathering out above the existing Pterodactyl Ridge localities, and on this trip Rainey finally located the productive horizon, WL 392 (TMM 41954), a few feet from WL 372. Eight specimens were collected (TMM 41954-1 to TMM 41954-8), and the site was reburied for future excavation.

During the 1979 field season, Langston did not have the aforementioned missing field notes, so for that season he switched to an alphabetical field numbering system to avoid numerical duplication. Localities on this trip were identified as WL A through WL D. With the previously assigned number unavailable at the time, WL 392 also became WL A (TMM 41954), and work began again at Pterodactyl Ridge by Langston, Rainey, and Yarmer on March 11. While clearing overburden at this site, more conifer needles, a palm frond, and gastropods were uncovered, and quarry mapping was implemented for the first time (Fig. 3B). Twenty-nine mostly unidentifiable elements were collected, wrapped in paper and one small plaster block (WL A.1-29). Langston discovered WL B (TMM 42138) on the next ridge over, from which 10 specimens would be collected (Fig. 5A), and while investigating Langston's new site, Rainey found WL C (TMM 42161), a jaw and several associated bones (Fig. 5B), and soon after WL D (TMM 42180). Langston was extremely pleased to have uncovered an elusive element (TMM 42138-1.2) in WL B: "at last, after 5 years of searching, there is a humerus attached ... This wing will go far to answering the morphological and proportionality problems that have had us on high center for the last five years!" (Langston Field Notes, March 16, 1979:15).

Between May 5 and 19, 1980, Langston, Rainey, and Yarmer returned with students Thomas Lehman, Glenn Storrs, and Kyle Davies and reopened WL D. Rainey and Yarmer cleared a 10 ft × 20 ft quarry floor, finding only a cervical vertebra and a metatarsal on the first day. Rainey, Yarmer, and Storrs continued to work the quarry, while Langston, Lehman, and Davies prospected, identifying several new localities. Yarmer also recovered the deltopectoral crest (WL 424) of a humerus that was accidentally discarded in a WL B talus pile the previous year. During this season, sites WL 419 to WL 443 were collected. On May 13, Lehman and Davies began a plane table map of the localities from the Panther Junction Road, and on May 16 Lehman, Storrs, and Langston completed mapping of the quarries. These data are the basis of Figure 2B. In March of 1981, Rainey and Yarmer spent a week prospecting through the Pterodactyl Ridge region with meager results, and Langston began to feel that the localities might be played out. A return trip to the ridge in May 1982 yielded the same limited success. Rainey and Yarmer also revisited the *Q. northropi* holotype locality and dug further into the site of the 1974 humerus excavation but did not find any more of this specimen.

Rainey, Yarmer, and Busbey returned to Pterodactyl Ridge in January 1983 to collect bones that Langston found weathering out 6 m from WL B in November 1982 and discovered another 20 bones over 3 days. This locality was numbered WL 467 (TMM 42422), and a quarry map by Busbey is appended to Langston's field notebook (Fig. 5C). Langston, Yarmer, and Francis Zimmer returned to WL 467 in May and collected specimens remaining from the previous season, prior to opening the quarry further. Specimens WL 467.1 to WL 467.34 were collected from this site, and rib fragments (the first, as WL 467.35) were surface-collected from the valley floor below. The quarry was filled in on May 25, 1983. WL 467 (TMM 42422) was revisited in May 1985, resulting in the collection of a few more elements and the discovery of WL 470 (TMM 41954-66), considered an extension of WL A, and the discovery of WL 471, which is mapped in field notes (Fig. 3C). A March 22–29, 1986, excavation

resulted in the collection of a total of 28 elements from WL 471 and the discovery by Rainey of WL 474 (TMM 42489). Located ca. 380 m northeast of the Pterodactyl Ridge localities, WL 474 comprises a partial skull, jaws, and five articulated cervical vertebrae (Fig. 5D). "We came to the end of the snout sooner than expected. This specimen is very different from the previous snouts and jaws in that it is much deeper and shorter (if it is complete, which is uncertain). Further inspection of the neck suggests that the atlas-axis may also be present. If so this is a very important find because it means that the first five out of seven cervicals are intact" (Langston Field Notes, March 27, 1986:36–37). Incidentally, the bill for lodging at the K-Bar Ranch for this field season was \$190.

Trips by Langston to Pterodactyl Ridge in March 1987, March 1989, April 1991, May 1992, and May 1996 yielded mostly fragmentary or isolated material, with little evidence of new specimens eroding out, like WL 489 (TMM 45997), two elements of a distal wing collected by Langston and Rainey in May 1996. In 1991, a crew reopened WL 471 and extended the quarry ca. 3 m from the last occurrence of bone, without result. In this year, a visit to the *Q. northropi* holotype locality showed that weathering had erased all traces of excavation. Thomas Lehman continued field work in the area and surface-collected TL 93-2 (TMM 44037-1), TL 93-2 (TMM 44037-2), TL 95-5 (TMM 45616-2 and TMM 45616-3), TL 95-7 (TMM 45888), TL 97-4 (TMM 44036-1), and TL 02-03 (TMM 41047-1). Langston's last collecting trip to Big Bend National Park was in November 1999, but his final projects there were focused on the excavation of two extraordinary skulls of the giant crocodilian *Deinosuchus*.

GEOGRAPHIC DISTRIBUTION OF BIG BEND PTEROSAUR MATERIAL

Pterosaurs have been reported from 10 areas in the Aguja and Javelina formations of Big Bend National Park and neighboring region (colloquially known as Canoe Syncline, Clark's Pterosaur Site, Dawson Creek, Dawson Creek NW, Denny's Pterosaur Site, Grapevine Hogback, McKinney Hills, Pterodactyl Ridge, Rattlesnake Mountain, and the Terlingua Micro Site). However, a survey of this material reveals that only the Javelina Formation specimens can be referred to pterosaurs, only the stream channel facies specimens can be referred to *Quetzalcoatlus northropi*, and only specimens from the upper 27 m of the abandoned channel-lake facies at Pterodactyl Ridge can be referred to *Quetzalcoatlus lawsoni* Andres and Langston, 2021, previously termed *Quetzalcoatlus* sp. (Andres and Langston, 2021). Another pterosaur, *Wellnhopterus brevirostris* Andres and Langston, 2021, can be found in the abandoned channel-lake facies much lower in the section at Pterodactyl Ridge.

Quetzalcoatlus northropi is known from only six specimens, but it is found throughout BIBE at varying stratigraphic levels, whereas the second *Quetzalcoatlus* species is known from over 200 specimens, but it is only found in one area in a discrete stratigraphic interval. Another locality at Pterodactyl Ridge distinct from the other pterosaur sites, TMM 41839, is one of two places to preserve pterosaurs in the overbank floodplain facies. It preserves a tiny azhdarchid pterosaur that is unfortunately too poorly preserved to diagnose or classify further. The remaining material at three other localities can only be referred to the Pterosauria, but to no specific group within pterosaurs, and so are considered Pterosauria indeterminate here. This information adds to and updates the review of Texas pterosaurs by Andres and Myers (2013).

Aguja Formation Non-pterosaur Material

Previously identified pterosaurs from the Aguja Formation in Big Bend National Park are considered here not to be pterosaurs, or at least cannot be confirmed to be pterosaurs. These consist of

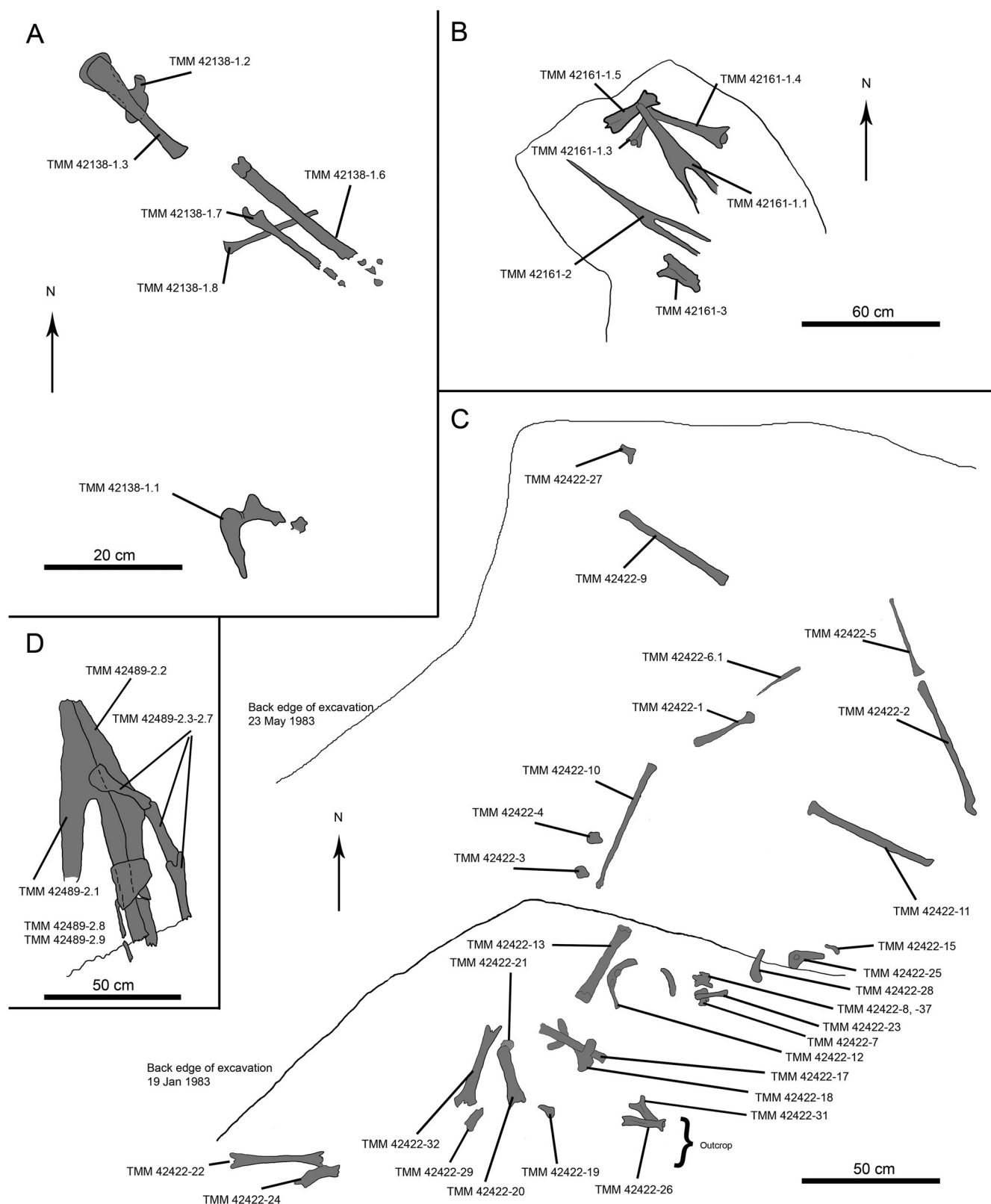


FIGURE 5. **A**, quarry map for field number WL B of locality TMM 42138. **B**, quarry map for field number WL C of TMM 42161. **C**, quarry map for WL 467 of locality TMM 42422. **D**, quarry map for field number WL 474 of TMM 42489.

six specimens from three localities, of which only three specimens have been reported in the literature. Montgomery and Clark (2016) report rare fragments of pterosaur from the Aguja

Formation at the Gaddis site (TMM 45920) just outside the park, but these have not been described and are mentioned here only for the sake of completeness.

TMM 42335—The putative pterosaur specimens from this locality consist of a coelurosaur femur (TMM 42335-7), as well as 26 (TMM 42335-48) and 14 (TMM 42335-77) bone fragments collected in 1982 and 1993, respectively. They have thick cortical bone and solid medullary cavities, unlike the thin cortices and hollow medullae of pterosaur bones. No morphology indicative of pterosaurs can be recognized; therefore, this material is not referable to the Pterosauria. These specimens have not been published in the literature, and their referral to the Pterosauria comes from field identifications and the collection database.

TMM 43057—Colloquially known as the Terlingua Micro Sites, these have produced a wealth of Aguja Formation vertebrates from the western edge of Big Bend National Park. Rowe et al. (1992) reported several crushed and incomplete bones that indicated the presence of pterosaurs but were too fragmentary for more specific identification. No specimen numbers were provided, but a search of the collections and catalog revealed two specimens identified as pterosaurs from the Terlingua Micro No. 1 locality in 1987: TMM 43057-13 and TMM 43057-151.

TMM 43057-13 consists of nine bone fragments labeled as ‘Unidentifiable’ that likely correspond to the Rowe et al. (1992) report. These fragments are identified here as shards of cortical bone and a chelonian neural osteoderm. The cortical bone appears to have flaked off the medullary bone, is rather thick for pterosaurs, and for the most part lacks the fine buttressing and delicate struts that support the trabeculae of some pterosaur long bones (Currie and Russell, 1982). One fragment has some light sculpturing that might correspond to the spacing of trabecular bases on a pterosaur long bone shaft, but these are not numerous or well developed enough to be confirmed as pterosaurian.

The other possible TMM 43057 pterosaur (TMM 43057-151) was reported in Andres and Myers (2013) as a wing phalanx and is labeled as a left first wing phalanx in the collection. At the time, only a photograph of the specimen could be found. When the specimen was located, it was discovered that the putative proximal articulation for the wing metacarpal had been filled in with plaster painted to be the same color as the bone. It is otherwise unprepared. Ignoring the reconstructed portion, the specimen only superficially resembles a pterosaur first wing phalanx and has morphology not found in any pterosaur. In addition, the shaft appears to lack the large medullary cavity of pterosaurs.

LSUMNS V17827—Specimens of a pterosaur were reported to be collected in January 2007 by Gasaway et al. (2007) in the Aguja Formation on the western boundary of Big Bend National Park, although Sankey (2010) mentions only a single pterosaur specimen. J. Sankey (pers. comm.) in Andres and Myers (2013) identified the specimen as Louisiana State University Museum of Natural Science (LSUMNS) V17827 and stated that it was tentatively referred to the Pterosauria and that it was not a diagnostic or identifiable element. Andres and Myers (2013) considered it only a possible pterosaur specimen. This is another fragment of cortical bone that is missing its medullary bone. The specimen also has a rather thick cortex and lacks internal trabecular structure and therefore is not referred to the Pterosauria.

Javelina Formation Pterosauria Indeterminate

Eight specimens from the following localities in Big Bend can be identified as pterosaurs, but their relationships within the Pterosauria cannot be resolved. They may be material of *Quetzalcoatlus*, but that is not the only pterosaur in the park and their fragmentary nature precludes determining their relationships to its species. None of these specimens have been reported in the literature.

TMM 41839—This is one of two localities to preserve pterosaur specimens in the overbank floodplain facies (Lehman, 2021), but

the only one with identifiable elements. It preserves the greatest range of pterosaur sizes, including the only small pterosaurs, and it is the source for the worst-preserved pterosaur specimens of any locality in the park. Seven specimens are known from this locality: TMM 41839-2, 3, 7, and 8 are limb bones from small pterosaurs, whereas TMM 41839-10 to TMM 41839-12 are metatarsals from giant pterosaurs. The only other floodplain specimen (TMM 42538-1) is a shaft fragment from a medium-sized pterosaur. The floodplain facies records sediment accumulation during flooding (Lehman, 2021), and so it most likely preserves the range of pterosaur sizes present at the time that were entrained in flooding events.

TMM 41839-2 was originally identified as a long bone. It is actually the articulated right distal wing metacarpal and first wing phalanx from a small pterosaur, which has been obscured by displacive mineralization and rectilinear cracking at the joint. This poor preservation obscures the extensor tendon process of the first wing phalanx, the fusion of which would help determine whether this is a small adult pterosaur or the small juvenile of a larger adult.

TMM 41839-3 contains fragments of the femora, left tibiotarsus, and the left first three wing phalanges that were originally identified as foot bones. This is the most complete specimen of the small pterosaurs from the floodplain facies. Although very poorly preserved, a couple of characters permit its classification. The femora bear a proximal pneumatic foramen found in the *Ornithocheiroidea* sensu Kellner (2003), and the left third wing phalanx has a τ -shaped cross-section found in the Azhdarchidae. Like the other specimens from this locality, the preservation is not sufficient to determine whether this is a juvenile of a larger species or a small adult. Either way, it is one of the smallest and worst-preserved azhdarchid pterosaurs.

TMM 41839-7 and TMM 41839-8 consist of a couple of bone shafts with significant displacive mineralization and rectilinear cracking. They are identified here as right and left first wing phalanx shafts. They are from a small pterosaur, but their ontogenetic age and relationship to TMM 41839-2 and TMM 41839-3 are unknown.

TMM 41839-10 to TMM 41839-12 are portions of the left metatarsals I–III from a giant pterosaur collected as float. Considering that these are nonoverlapping elements from the left foot, it is not unlikely that they belonged to the same individual. It is also possible that they belong to *Q. northropi*. These are the largest reported pterosaur metatarsals, and *Q. northropi* is the largest reported pterosaur. However, size is all they share. They lack overlapping elements and are found in different depositional environments (i.e., overbank floodplain versus stream channel facies). Whether TMM 41839-10 to TMM 41839-12 are referable to *Q. northropi* depends on whether it is more likely that there was more than one giant pterosaur in the Javelina Formation or that an individual of *Q. northropi* was entrained in a flood event and deposited in the floodplain facies. There is not enough information to determine which is the most defensible; therefore, TMM 41839-10 to TMM 41839-12 are considered Pterosauria indeterminate.

TMM 42538 and TMM 45888—The easternmost and arguably most isolated of the pterosaur localities, they contain the other floodplain facies specimen, TMM 42538-1, a fragment of a limb shaft that has a cross-section that resembles a femur, and a stream channel facies specimen, TMM 45888-2. This stream channel specimen consists of 24 pterosaur fragments in nodules found as float on a thin carbonate pebble conglomerate bed at the base of a hill capped by a dark brown sandstone (Lehman, pers. comm.). They include the anterior end of a cervical vertebra (TMM 45888-2.1) and a left distal syncarpal (TMM 45888-2.2). These are the only non-giant pterosaur elements found on beds identified as stream channel deposits (Lehman, 2021). The other stream channel pterosaur specimens are referred to

Q. northropi, and so it is a possibility that these are small individuals of that giant species. However, there are problems with both this and its alternative interpretations.

TMM 45888-2 was collected as float, and so its provenance is unknown. It may have originated from eroded abandoned channel-lake deposits, which have similarly sized pterosaur specimens at Pterodactyl Ridge. Abandoned channel-lake facies are spatially associated in all instances with underlying stream channel deposits, and they are found within the upper part of most stream channel deposits, albeit most often as thin sequences (Lehman, 2021). Indeed, a channel-lake facies overlies this specimen stratigraphically at this locality (Lehman, 2021:fig. 2, section 8). TMM 45888-2 also appears to have weathered out some time ago: the elements are almost all fragments of bone that have been protected by nodules, and the two identifiable elements have lost all of their cortical bone. This is problematic because the fusion of the syncarpal could indicate whether this is a juvenile of a larger species. These beds are also similar to the unit C subfacies of the abandoned channel-lake deposits with their thinness, reworked carbonate nodule conglomerate, and a capping sandstone that weathers to a dark reddish brown color (as compared with the tan to light olive gray sandstones of the stream channel facies) (Lehman, 2021).

All but one of the putative abandoned channel-lake pterosaur sites are found at Pterodactyl Ridge, and Pterodactyl Ridge is unusual in recording a prolonged period of lake development (Lehman, 2021). The other less extensive abandoned channel-lake deposit, TMM 45616, has comparable-sized elements and almost identical preservation to TMM 45888-2. Less extensive channel lakes may preserve pterosaur specimens differently than at Pterodactyl Ridge. In the end, it cannot be determined what facies TMM 45888-2 came from, and its elements are too poorly preserved to compare with the other Big Bend pterosaur material. The size and shape of the cervical (TMM 45888-2.1) are similar to those of azhdarchid vertebrae, but it is conservatively identified here as Pterosauria indeterminate.

TMM 45616—The solitary abandoned channel-lake facies pterosaur site outside Pterodactyl Ridge includes two specimens: 66 shaft fragments (TMM 45616-2) and 42 shaft fragments in carbonate nodules (TMM 45616-3). Some of the elements resemble fragments of wing phalanges, but none of them can be identified with any degree of precision. These specimens are similar in size to *Q. lawsoni* at Pterodactyl Ridge and are found in the same stratigraphic level and facies. However, *W. brevirostris* is also reported in this facies at Pterodactyl Ridge (albeit lower in the section), and so occurrence in abandoned channel-lake deposits is not sufficient to refer this specimen to *Quetzalcoatlus*.

Quetzalcoatlus northropi

TMM 41450—The holotype of *Q. northropi*, TMM 41450-3, was discovered a few kilometers west of Maverick Ranger Station near the western boundary of Big Bend National Park. It consists of a partial left wing including the humerus, the radius, the ulna, proximal and distal syncarpals, parts of metacarpals III and IV, manual phalanx fragments, portions of the first three wing phalanges, and about a thousand fragments of unknown position that were collected by dry screening at the site. This is both the largest pterosaur specimen in the park and the largest known flying animal. Unlike the 93.9% of the Big Bend pterosaur specimens found in abandoned channel-lake deposits ($n = 216$) or even the 3.5% found in overbank floodplain deposits ($n = 8$), this is one of the scant 2.6% of pterosaur specimens ($n = 6$) found in the stream channel deposits of Big Bend National Park (Lehman, 2021). More unusual is the fact that the stream channel specimens are the six largest pterosaurs in the park by a considerable margin. Two of the other five stream channel pterosaurs, TMM 41398-4 and TMM 44036-1, overlap elements with the holotype, but only the latter shares

autapomorphies with the holotype and can be referred to the same species. Another two of these five specimens, TMM 41398-3 and TMM 41047-1, directly overlap elements only with each other and likely belong to the same species. The last specimen, TMM 42889-1, is not directly comparable to the other stream channel facies pterosaurs, but it can be compared with the other Big Bend pterosaur species and is distinct from them and all other pterosaur species. The distribution of *Q. northropi* is identified here as the stream channel facies of the Javelina and Black Peak formations, with TMM 41450-3 and TMM 44036-1 referred to the species and the others identified as *Quetzalcoatlus* cf. *northropi* (Andres and Langston, 2021).

TMM 44036—TMM 44036-1 is the proximal end of a left ulna and shaft fragment. This specimen is directly comparable to the holotype of *Q. northropi* and can be referred to the species based on diagnostic apomorphies. This is also the only pterosaur specimen in the Black Peaks Formation. It extends the range of *Quetzalcoatlus*, and pterosaurs in general, to within centimeters of the K-Pg boundary. Although directly referable to *Q. northropi*, it is about 75% the size of the holotype, halfway between the two *Quetzalcoatlus* species. Based on osteology, TMM 44036-1 does not appear to be an adult, which may account for this size difference. Fortunately, histological sections exist of this specimen and the holotype ulna, and so this hypothesis can be directly tested.

TMM 41398—The first pterosaurs discovered in Big Bend National Park by Lawson, TMM 41398-3 and TMM 41398-4, are limb bones from the north-central region of the park. Barnum Brown collected several sauropod bones from this area in the 1940s, as did Lawson and Langston in the early 1970s. TMM 41398-4 is another stream channel pterosaur sized between the *Quetzalcoatlus* species. It consists of an expanded proximal end missing the articulation preserved in matrix, a shaft fragment, and a natural mold of the shaft fragment identified as a right first wing phalanx. It has a triangular cross-section like that of *Q. northropi*, and it also shares a shaft in which the transition from an anteriorly deeper triangle to a posteriorly deeper triangle occurs farther down the shaft and so likely belongs to this species. It is about 65% the size of the first phalanx of the holotype of *Q. northropi*, but the extensor tendon process of the proximal articulation is not preserved, so we cannot assess the degree of its fusion that might have suggested whether this specimen was an adult (Frey and Martill, 1998).

TMM 41398-3 was alternatively identified in collections records as a pterosaur limb bone or long bone. It has a bifurcated end that would only correspond to the neck and greater trochanter of the proximal end of a left pterosaur femur. Unfortunately, both processes have been broken off near their bases. Despite this incompleteness, it shares a number of autapomorphies with TMM 41047-1, the largest pterosaur femur known. These two specimens likely belong to the same species and are distinct from all other species, including *Q. lawsoni*. It is most defensible that the giant species represented by femora in the Big Bend stream channel facies is the same as the giant species represented by wing elements in the Big Bend stream channel facies, *Q. northropi*, but they lack overlapping preservation and so cannot unequivocally be referred to the same species. TMM 41398-3 is another one of these intermediate-sized pterosaurs, roughly 140% the size of the small *Quetzalcoatlus* and 70% the size of TMM 41047-1.

TMM 41047—The giant femur TMM 41047-1 is missing its distal half except for two shaft fragments and the medial half of the distal end. Even without considering the missing portions, this is the largest pterosaur femur reported. It is also comparable to the size that phylogenetically would be predicted for *Q. northropi*. This specimen nearly overlaps stratigraphically with *Q. lawsoni*, implying that *Q. lawsoni* is not part of an

anagenetic lineage leading to *Q. northropi*. With a collection date of November 2002, it also has the distinction of being the last known pterosaur specimen officially collected in Big Bend.

TMM 42889—The vast majority of specimens and sediments at Pterodactyl Ridge come from abandoned channel-lake deposits. However, the other two facies that preserve pterosaurs are also present: TMM 41839 is from the overbank floodplain facies, and TMM 42889-1 is from the stream channel facies (Lehman, 2021). TMM 42889-1 is a middle-series cervical vertebra that is complete except for the prezygapophyses. It was identified as a fifth cervical based on its length; it is longer than every *Q. lawsoni* cervical except one unusually elongate specimen. However, it is distinct from the fifth cervicals of *Q. lawsoni* and all other azhdarchids. The specimen is either a fourth or sixth cervical, in which case it would be of the size phylogenetically predicted for *Q. northropi* or between the two species in size, respectively. Conservatively, TMM 42889-1 is more similar to the sixth cervical of *Q. lawsoni* and so is identified as a sixth cervical of *Quetzalcoatlus* cf. *northropi* here.

Quetzalcoatlus lawsoni

Pterodactyl Ridge Material—Three hundred and five elements from 214 specimens are found in the abandoned channel-lake facies of the upper part of the Javelina Formation. They are included in the TMM locality numbers 41544, 41545, 41546, 41547, 41954, 41961, 42138, 42157, 42161, 42180, 42246, 42259, 42272, 42297, 42422, 42462, 42521, 44037, and 45997 (see Table 1 and Appendix 1; Andres and Langston, 2020). These constitute a distinct diagnosable natural group found in one area over a narrow (~27 m) stratigraphic range and are therefore erected as a new species, referred to *Quetzalcoatlus* (Andres and Langston, 2021). This is the greatest number of specimens referred to a single species in the Pterosauria. It is also the only large sample of three-dimensional preservation in the Pterosauria. Much of the morphological description in this volume is presented because it is unknown in other pterosaurs. *Quetzalcoatlus* and the rest of the Pterosauria lived in a three-dimensional environment, and to understand how they functioned in that environment, they should be understood as three-dimensional organisms.

Wellnhoferus brevirostris

TMM 42489—Although *W. brevirostris* (TMM 42489-2) and *Q. lawsoni* both come from the abandoned channel-lake deposits of Pterodactyl Ridge, they are diagnosable species found at different stratigraphic levels. TMM 42489-2 was previously figured by Wellnhofer (1991:144) and referred to *Q. sp.*, as well as by Kellner and Langston (1996), but cited by both as TMM 42489-1. TMM 42489-2 consists of an anterior skull and cervicals IV–VIII. This is a distinct species that has a skull significantly larger and a cervical series significantly smaller than does *Q. lawsoni*.

CONCLUSIONS

The extensive documentation of the Big Bend National Park pterosaur localities by Langston and his field crews allows for precise reconstruction of the occurrences of the material collected. Detailed field notes and consistent record-keeping conventions maintained across several decades of research and professionally archived in the repository allow us to determine that at least three lineages of pterosaurs of various sizes and presumed ecological roles coexisted until the very end of the Cretaceous. It is not yet clear whether the fact that these taxa are found in different paleoenvironments suggests ecological partitioning, preservational bias, or merely chance. Further

exploratory work in the Javelina Formation coupled with the same kind of diligent and thorough record-keeping may help to answer these questions.

ACKNOWLEDGMENTS

This project was based on the detailed records produced by W. Langston and field crews working for the TMM. Specimens were discovered and collected by W. Amaral, A. Busbey, K. Davies, A. Elder, M. Gallup, W. Langston, D. Lawson, T. Lehman, J. Pittman, R. Rainey, T. Rowe, G. Storrs, E. Yarmer, and F. Zimmer. Specimens were prepared by W. Langston, D. Lawson, R. Rainey, and E. Yarmer. S. Werning provided information on histological samples, and J. Schiebout (Louisiana State University Museum of Natural Science) provided photographs and information about LSUMNS V17827. J. Lively, A. Marsh, T. Lehman, E. Yarmer, and S. May provided valuable comments on early drafts of the manuscript. The authors thank R. Irmis and K. Padian for discussion and guidance, as well as reviewers J. Sankey and J. Schiebout. The project was supported with financial and logistical assistance from Big Bend National Park, the Western Archeological Conservation Center, and The University of Texas at Austin Geology Foundation.

ORCID

Matthew A. Brown  <http://orcid.org/0000-0002-2713-1161>
Brian Andres  <http://orcid.org/0000-0002-9958-0134>

LITERATURE CITED

- Andres, B., and W. Langston. 2021. Morphology and taxonomy of *Quetzalcoatlus* (Pterodactyloidea: Azhdarchoidea); pp. 46–202 in K. Padian and M. A. Brown (eds.), *The Late Cretaceous pterosaur Quetzalcoatlus Lawson 1975* (Pterodactyloidea: Azhdarchoidea). Society of Vertebrate Paleontology Memoir 19. Journal of Vertebrate Paleontology 41(2, Supplement).
- Andres, B., and T. S. Myers. 2013. Lone Star Pterosaurs. *Earth and Environmental Science Transactions of the Royal Society of Edinburgh* 103:383–398.
- Bell, C. J., M. A. Brown, M. R. Dawson, and E. L. Lundelius. 2013. Wann Langston, Jr.—a life amongst bones. *Earth and Environmental Science Transactions of the Royal Society of Edinburgh* 103:1–16.
- Brown, B. 1917. A complete skeleton of the horned dinosaur *Monoclonius*, and description of a second skeleton showing skin impressions. *Bulletin of the American Museum of Natural History* 37:281–306.
- Brown, M. A. 2013. The development of “modern” laboratory methods: a century of progress. *Earth and Environmental Science Transactions of the Royal Society of Edinburgh* 103:205–216.
- Colbert, N., and R. T. Bird. 1954. A gigantic crocodile from the Upper Cretaceous beds of Texas. *American Museum Novitates* 1688:1–22.
- Currie, P. J., and D. A. Russell. 1982. A giant pterosaur (Reptilia: Archosauria) from the Judith River (Oldman) Formation of Alberta. *Canadian Journal of Earth Sciences* 19:894–897.
- Czaplewski, N., R. Cifelli, and W. Langston Jr. 1994. Catalog of type and figured fossil vertebrates. Oklahoma Museum of Natural History. Oklahoma Geological Survey Special Publication 94:1–35.
- Frey, E., and D. M. Martill. 1998. Late ontogenetic fusion of the processus tendinis extensoris in Cretaceous pterosaurs from Brazil. *Neues Jahrbuch für Geologie und Paläontologie, Monatshefte* 10:587–594.
- Gasaway, S., J. Sankey, N. Ortiz, and V. Meredith. 2007. Paleogeology of a *Chasmosaurus mariscalensis* bonebed, Late Cretaceous (late Campanian), Big Bend National Park, Texas. *Journal of Vertebrate Paleontology* 27(3, Supplement):79A.
- Gilmore, C. W. 1922. A new sauropod dinosaur from the Ojo Alamo Formation of New Mexico. *Smithsonian Miscellaneous Collections* 72:1–9.
- International Commission on Zoological Nomenclature (ICZN). 1999. *International Code of Zoological Nomenclature*, fourth edition.

- International Trust for Zoological Nomenclature, London, xxix + 306 pp.
- Kellner, A. W. A. 2003. Pterosaur phylogeny and comments on the evolutionary history of the group, p. 105–137. In E. Buffetaut and J.-M. Mazin (eds.), *Evolution and Palaeobiology of Pterosaurs*. Vol. 217. The Geological Society of London.
- Kellner, A. W. A., and W. Langston. 1996. Cranial remains of *Quetzalcoatlus* (Pterosauria, Azhdarchidae) from Late Cretaceous sediments of Big Bend National Park, Texas. *Journal of Vertebrate Paleontology* 16:222–231.
- Langston Jr., W. 1978. The great pterosaur. *Discovery* 2:20–23.
- Langston Jr., W. 1981. Pterosaurs. *Scientific American* 244:122–136.
- Lawson, D. A. 1972. Paleogeology of the Tornillo Formation, Big Bend National Park, Brewster County, Texas. M.A. thesis, The University of Texas at Austin, Austin, Texas, 182 pp.
- Lawson, D. A. 1975a. Pterosaur from the latest Cretaceous of West Texas. Discovery of the largest flying creature. *Science* 187:947–948.
- Lawson, D. A. 1975b. Could pterosaurs fly? *Science* 188:676–678.
- Lawson, D. A. 1976. *Tyrannosaurus* and *Torosaurus*: Maestrichtian dinosaurs from Trans-Pecos, Texas. *Journal of Paleontology* 50:158–164.
- Lehman, T. M. 2021. Habitat of the giant pterosaur *Quetzalcoatlus* Lawson 1975 (Pterodactyloidea: Azhdarchoidea): a paleoenvironmental reconstruction of the Javelina Formation (Upper Cretaceous), Big Bend National Park, Texas. pp. 21–45 in Padian, K. and M.A. Brown (eds.), *The Late Cretaceous pterosaur Quetzalcoatlus* Lawson 1975 (Pterodactyloidea: Azhdarchoidea). Society of Vertebrate Paleontology Memoir 19. *Journal of Vertebrate Paleontology* 41(2, Supplement).
- Montgomery, H., and S. Clark. 2016. Paleogeology of the Gaddis site in the Upper Cretaceous Aguja Formation, Terlingua, Texas. *Palaios* 31:347–357.
- Rowe, T., R. L. Cifelli, T. M. Lehman, and A. Weil. 1992. The Campanian Terlingua local fauna, with a summary of other vertebrates from the Aguja Formation, Trans-Pecos Texas. *Journal of Vertebrate Paleontology* 12:472–493.
- 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; pp. 520–537 in M. Ryan, B. Chinnery-Allgeier, and D. Eberth (eds.), *New Perspectives on Horned Dinosaurs: The Royal Tyrrell Museum Ceratopsian Symposium*. Indiana University Press, Bloomington, Indiana.
- Udden, J. A. 1907. A Sketch of the Geology of the Chisos Country, Brewster County, Texas. *University of Texas Bulletin* 93. Austin, Texas, USA, 101 pp.
- Wellnhofer, P. 1991. *The Illustrated Encyclopedia of Pterosaurs*. Salamander Books, London, 192 pp.
- Wilson, J. A. 1967. Early Tertiary mammals; pp. 157–170 in R. A. Maxwell, J. T. Lonsdale, R. T. Hazzard, and J. A. Wilson (eds.), *Geology of Big Bend National Park, Brewster County, Texas*. The University of Texas, Bureau of Economic Geology Publication No. 6711. Austin, Texas, USA.

Submitted November 25, 2017; accepted May 1, 2020.

Memoir Editor: Randall Irmis.

APPENDIX 1. Database summary of the complete catalog of Big Bend National Park (BIBE) pterosaurs curated in the Texas Vertebrate Paleontology Collections (TMM) of The University of Texas at Austin. Organized numerically by TMM catalog number. NPS, National Park Service.

Texas catalog no.	NPS catalog no.	Field no.	Taxon determination	Object description
TMM 41047-1		TL 02-03	<i>Quetzalcoatlus northropi</i>	Femur left (4 pieces)
TMM 41398-3	BIBE 49963	DL-1	<i>Quetzalcoatlus northropi</i>	Femur left, proximal third (1)
TMM 41398-4	BIBE 49964	DL-3	<i>Quetzalcoatlus northropi</i>	First phalanx manual digit IV right (1)
TMM 41450-3.1	BIBE 49947	DL-5	<i>Quetzalcoatlus northropi</i>	Humerus left (1)
TMM 41450-3.2	BIBE 49948	DL-5	<i>Quetzalcoatlus northropi</i>	Radius left (1)
TMM 41450-3.3	BIBE 49949	DL-5	<i>Quetzalcoatlus northropi</i>	Ulna left (2 pieces)
TMM 41450-3.4	BIBE 49950	DL-5	<i>Quetzalcoatlus northropi</i>	Proximal carpal left (1)
TMM 41450-3.5	BIBE 49951	DL-5	<i>Quetzalcoatlus northropi</i>	Distal carpal, proximal portion (1)
TMM 41450-3.6	BIBE 49955	DL-5	<i>Quetzalcoatlus northropi</i>	First phalanx manual digit III left (2)
TMM 41450-3.7	BIBE 49956	DL-5	<i>Quetzalcoatlus northropi</i>	Metacarpal II left, proximal portion (1)
TMM 41450-3.8	BIBE 49957	DL-5	<i>Quetzalcoatlus northropi</i>	Metacarpal III left, proximal portion (1)
TMM 41450-3.9	BIBE 49952	DL-5	<i>Quetzalcoatlus northropi</i>	Metacarpal IV left (4 pieces)
TMM 41450-3.10	BIBE 49953	DL-5	<i>Quetzalcoatlus northropi</i>	First phalanx manual digit IV left, shaft (4 pieces)
TMM 41450-3.11	BIBE 49954	DL-5	<i>Quetzalcoatlus northropi</i>	Second phalanx manual digit IV left (1)
TMM 41450-3.12	BIBE 49958	DL-5	<i>Quetzalcoatlus northropi</i>	First phalanx manual digit II left, proximal half (1)
TMM 41450-3.13	BIBE 49959	DL-5	<i>Quetzalcoatlus northropi</i>	Ungual phalanx manual digit II left (1)
TMM 41450-3.14	BIBE 49960	DL-5	<i>Quetzalcoatlus northropi</i>	Third phalanx manual digit IV left (1)
TMM 41450-3.15	BIBE 49961	DL-5	<i>Quetzalcoatlus northropi</i>	Second phalanx manual digit III (1)
TMM 41450-3.16	BIBE 49961	DL-5	<i>Quetzalcoatlus northropi</i>	Ungula phalanx manual digit III (1)
TMM 41450-3.17	BIBE 49961	DL-5	<i>Quetzalcoatlus northropi</i>	Phalanx manual digit fragments (5)
TMM 41450-4	BIBE 49962	DL-5	<i>Quetzalcoatlus northropi</i>	Unidentified bone with associated fragments (1000+)
TMM 41544-1	BIBE 49610	WL 367.3	<i>Quetzalcoatlus lawsoni</i>	Unidentified bone (20+ pieces)
TMM 41544-2	BIBE 49611	WL 367	<i>Quetzalcoatlus lawsoni</i>	Femur right (1)
TMM 41544-3	BIBE 49612	WL 367	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit IV right (1)
TMM 41544-4.1	BIBE 49613	WL 367.10	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra V (1)
TMM 41544-4.2	BIBE 49613	WL 367.10	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VI anterior end (1) plus shaft (1)
TMM 41544-5	BIBE 49614	WL 367	<i>Quetzalcoatlus lawsoni</i>	Ungual phalanx manual digit (1)
TMM 41544-6	BIBE 49615	WL 367	<i>Quetzalcoatlus lawsoni</i>	Ungual phalanx manual digit III right, proximal (1)
TMM 41544-7	BIBE 49616	WL 367	<i>Quetzalcoatlus lawsoni</i>	Second phalanx digit III right (1)
TMM 41544-8	BIBE 49617	WL 367.3	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra IV (1)
TMM 41544-9	BIBE 49618	WL 367.3	<i>Quetzalcoatlus lawsoni</i>	Humerus left, proximal (1)
TMM 41544-10	BIBE 49619	WL 367.3	<i>Quetzalcoatlus lawsoni</i>	Humerus right, distal (1)
TMM 41544-11	BIBE 49620	WL 367.3	<i>Quetzalcoatlus lawsoni</i>	Ulna right, fragment (3 pieces)
TMM 41544-12	BIBE 49621	WL 367	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VI, posterior fragment (1)
TMM 41544-14	BIBE 49623	WL 367	<i>Quetzalcoatlus lawsoni</i>	Unidentified bone, shaft fragment (1)
TMM 41544-15	BIBE 49624	WL 367.8	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra V (1)
TMM 41544-16	BIBE 49625	WL 367.9	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra III (1)
TMM 41544-17	BIBE 49626	WL 367.10	<i>Quetzalcoatlus lawsoni</i>	Femur right, shaft (1)
TMM 41544-18		WL 367.4	<i>Quetzalcoatlus lawsoni</i>	Phalanx (1)
TMM 41544-19	BIBE 49628	WL 367	<i>Quetzalcoatlus lawsoni</i>	Distal syncarpal right (1)
TMM 41544-20	BIBE 49629	WL 367.11	<i>Quetzalcoatlus lawsoni</i>	Second phalanx manual digit IV left (2 pieces)
TMM 41544-21	BIBE 49630	WL 367.4	<i>Quetzalcoatlus lawsoni</i>	Third phalanx manual digit IV left (1)
TMM 41544-22	BIBE 49631	WL 367.7	<i>Quetzalcoatlus lawsoni</i>	Mandible (1)
TMM 41544-23	BIBE 49632	WL 367.16	<i>Quetzalcoatlus lawsoni</i>	Second phalanx manual digit IV (10+)
TMM 41544-24	BIBE 49633	WL 367.20	<i>Quetzalcoatlus lawsoni</i>	Ulna left, without proximal end (2 pieces)
TMM 41544-25	BIBE 49634	WL 367.12	<i>Quetzalcoatlus lawsoni</i>	Scapulacoracoid right (1)
TMM 41544-26	BIBE 49635	WL 367.12	<i>Quetzalcoatlus lawsoni</i>	Scapulacoracoid left (1)
TMM 41544-27	BIBE 49636	WL 367.6	<i>Quetzalcoatlus lawsoni</i>	Femur right, without proximal end (1)
TMM 41544-28	BIBE 49637	WL 367.19	<i>Quetzalcoatlus lawsoni</i>	Radius right, without proximal end (1)
TMM 41544-29	BIBE 49638	WL 367.18	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit IV right (2 pieces)
TMM 41544-30	BIBE 49639	WL 367.21	<i>Quetzalcoatlus lawsoni</i>	Metatarsal IV left (1)
TMM 41544-31	BIBE 49640	WL 367.14	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit III left (1)
TMM 41544-32	BIBE 49641	WL 367.13	<i>Quetzalcoatlus lawsoni</i>	Unidentified bone, fragment (50+)
TMM 41544-34.1		WL 367.14	<i>Quetzalcoatlus lawsoni</i>	Lateral distal tarsal right (1)
TMM 41544-34.2		WL 367.14	<i>Quetzalcoatlus lawsoni</i>	Medial distal tarsal right (1)
TMM 41545-1	BIBE 49643	WL 368 41545	<i>Quetzalcoatlus lawsoni</i>	Proximal syncarpal right (1), ?Mate to 42157-2
TMM 41546-1	BIBE 49644	WL 369	<i>Quetzalcoatlus lawsoni</i>	Cervical V, left postzygapophysis (1), and frags
TMM 41546-2	BIBE 49645	WL 369	<i>Quetzalcoatlus lawsoni</i>	Cervical III (1)
TMM 41546-3.1	BIBE 49879	WL 369	<i>Quetzalcoatlus lawsoni</i>	Metacarpal IV left, distal end (1)
TMM 41546-3.2	BIBE 49880	WL 369	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit IV left, proximal end (1)
TMM 41546-4	BIBE 49881	WL 369	<i>Quetzalcoatlus lawsoni</i>	Occipital condyle? (1)
TMM 41546-5	BIBE 49882	WL 369	<i>Quetzalcoatlus lawsoni</i>	Humerus? Right, proximal portion (1)
TMM 41546-6	BIBE 49883	WL 369	<i>Quetzalcoatlus lawsoni</i>	Humerus? Left, proximal portion (10 pieces)
TMM 41546-7	BIBE 49884	WL 369	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra III, prezygapophysis right (1)
TMM 41546-8	BIBE 49885	WL 369	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VI, centrum posterior condyle (1)

(Continued)

Continued.

Texas catalog no.	NPS catalog no.	Field no.	Taxon determination	Object description
TMM 41547-1	BIBE 49646	WL 372	<i>Quetzalcoatlus lawsoni</i>	Second phalanx manual digit IV (1)
TMM 41547-2	BIBE 49647	WL 372	<i>Quetzalcoatlus lawsoni</i>	Limb bone, shaft fragment (1 in 4 pieces)
TMM 41547-3	BIBE 49647	WL 372	<i>Quetzalcoatlus lawsoni</i>	Third phalanx manual digit IV right (1)
TMM 41839-2.1	BIBE 49649	WL 371.1	Pterosauria	Metacarpal IV right, distal end (1)
TMM 41839-2.2	BIBE 49649	WL 371.1	Pterosauria	First phalanx manual digit IV right? (3)
TMM 41839-3.1	BIBE 49650	WL 371	Azhdarchidae	Femur left, proximal end (1)
TMM 41839-3.2	BIBE 49650	WL 371	Azhdarchidae	Femur right, without proximal or distal ends (4)
TMM 41839-3.3	BIBE 49650	WL 371	Azhdarchidae	Tibiotarsus left, proximal and distal ends (2)
TMM 41839-3.4	BIBE 49650	WL 371	Azhdarchidae	First phalanx manual digit IV left (5)
TMM 41839-3.5	BIBE 49650	WL 371	Azhdarchidae	Second phalanx manual digit IV left, shaft (1)
TMM 41839-3.6	BIBE 49650	WL 371	Azhdarchidae	Third phalanx manual digit IV left, shaft (1)
TMM 41839-3.7	BIBE 49650	WL 371	Azhdarchidae	Second phalanx manual digit IV left (1)
TMM 41839-5	BIBE 49652	WL 371.8	Pterosauria	Concretion or coprolite (9)
TMM 41839-7	BIBE 49654	WL 371	Pterosauria	First phalanx manual digit IV right, shaft (2)
TMM 41839-8	BIBE 49655	WL 371	Pterosauria	First phalanx manual digit IV left, shaft (1)
TMM 41839-10	BIBE 49889	WL 371	Pterosauria	Metatarsal II left, without distal end (1)
TMM 41839-11	BIBE 49890	WL 371	Pterosauria	Metatarsal III left, without distal end (1)
TMM 41839-12	BIBE 49891	WL 371	Pterosauria	Metatarsal I left, shaft (1)
TMM 41954-1	BIBE 49657	WL 392.1	<i>Quetzalcoatlus lawsoni</i>	Unidentified bone (1), fragments (40+)
TMM 41954-2	BIBE 49658	WL 392.2	<i>Quetzalcoatlus lawsoni</i>	Metacarpal IV, shaft (1)
TMM 41954-3	BIBE 49659	WL 392.3	<i>Quetzalcoatlus lawsoni</i>	Long bone, fragment (2 pieces)
TMM 41954-4	BIBE 49660	WL 392.4	<i>Quetzalcoatlus lawsoni</i>	Ulna left, proximal end (1)
TMM 41954-5.1	BIBE 49661	WL 392.5	<i>Quetzalcoatlus lawsoni</i>	Skull, rostral portion (1)
TMM 41954-5.2	BIBE 49661	WL 392.5	<i>Quetzalcoatlus lawsoni</i>	Mandible (1)
TMM 41954-5.3	BIBE 49661	WL 392.5	<i>Quetzalcoatlus lawsoni</i>	Long bone (2)
TMM 41954-6	BIBE 49662	WL 392.6	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit IV right, proximal (1)
TMM 41954-7	BIBE 49663	WL 392.7	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra V (1)
TMM 41954-8.1	BIBE 49664	WL 392.8	<i>Quetzalcoatlus lawsoni</i>	Metatarsal I left (1)
TMM 41954-8.2	BIBE 49738	WL 392.8	<i>Quetzalcoatlus lawsoni</i>	Metatarsal II left (1)
TMM 41954-8.3	BIBE 49739	WL 392.8	<i>Quetzalcoatlus lawsoni</i>	Metatarsal III left (1)
TMM 41954-8.4	BIBE 49739	WL 392.8	<i>Quetzalcoatlus lawsoni</i>	Metatarsal IV left (1)
TMM 41954-8.5	BIBE 49739	WL 392.8	<i>Quetzalcoatlus lawsoni</i>	Lateral distal tarsal left (1)
TMM 41954-8.6	BIBE 49739	WL 392.8	<i>Quetzalcoatlus lawsoni</i>	Metacarpal I right (1)
TMM 41954-8.7	BIBE 49739	WL 392.8	<i>Quetzalcoatlus lawsoni</i>	Metacarpal II right (1)
TMM 41954-8.8	BIBE 49739	WL 392.8	<i>Quetzalcoatlus lawsoni</i>	Metacarpal III right (1)
TMM 41954-9	BIBE 49665	WL A26	<i>Quetzalcoatlus lawsoni</i>	Metacarpal IV right, shaft (1)
TMM 41954-10	BIBE 49666	WL A20	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra IV, posterior third (1)
TMM 41954-11	BIBE 49667	WL A21	<i>Quetzalcoatlus lawsoni</i>	Second phalanx manual digit IV left (1)
TMM 41954-12	BIBE 49668	WL A24	<i>Quetzalcoatlus lawsoni</i>	Metacarpal IV right, distal shaft (1)
TMM 41954-13	BIBE 49669	WL A14	<i>Quetzalcoatlus lawsoni</i>	Ungual phalanx pedal digit (1)
TMM 41954-14	BIBE 49670	WL A12	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit IV left (1)
TMM 41954-20	BIBE 49676	WL A29	<i>Quetzalcoatlus lawsoni</i>	Radius left, proximal (1)
TMM 41954-21	BIBE 49677	WL A18	<i>Quetzalcoatlus lawsoni</i>	Pteroid left (1)
TMM 41954-22	BIBE 49678	WL A22	<i>Quetzalcoatlus lawsoni</i>	Pteroid right (1)
TMM 41954-23	BIBE 49679	WL A17	<i>Quetzalcoatlus lawsoni</i>	Unidentified bone (27 fragments)
TMM 41954-24	BIBE 49680	WL A22	Pterosauria	Unidentified bone, fragmentary (1)
TMM 41954-25	BIBE 49681	WL A10	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit III (1)
TMM 41954-26	BIBE 49682	WL A	<i>Quetzalcoatlus lawsoni</i>	Humerus right, proximal (1)
TMM 41954-27	BIBE 49683	WL A8	<i>Quetzalcoatlus lawsoni</i>	Humerus left, proximal (1)
TMM 41954-28	BIBE 49684	WL A6	<i>Quetzalcoatlus lawsoni</i>	Lateral distal tarsal left (1)
TMM 41954-29	BIBE 49685	WL A7	<i>Quetzalcoatlus lawsoni</i>	Coracoid left (1)
TMM 41954-30	BIBE 49686	WL A9	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VI, anterior fragment (1)
TMM 41954-31	BIBE 49687	WL A28	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra V, right prezygapophysis (1)
TMM 41954-32	BIBE 49688	WL A19	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit II left (1)
TMM 41954-33	BIBE 49689	WL A23	<i>Quetzalcoatlus lawsoni</i>	Radius left, distal (1)
TMM 41954-34	BIBE 49690	WL A15	<i>Quetzalcoatlus lawsoni</i>	Proximal carpal left (1)
TMM 41954-35	BIBE 49691	WL A25	<i>Quetzalcoatlus lawsoni</i>	Long bone, midshaft fragment (1)
TMM 41954-36	BIBE 49692	WL A	<i>Quetzalcoatlus lawsoni</i>	Ulna left, proximal (1)
TMM 41954-37	BIBE 49693	WL 458	<i>Quetzalcoatlus lawsoni</i>	Metatarsal V right (1)
TMM 41954-39	BIBE 49694	WL 471.4	<i>Quetzalcoatlus lawsoni</i>	Atlantoaxis vertebra (1)
TMM 41954-40	BIBE 49696	WL 471.9	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra IX (1)
TMM 41954-41	BIBE 49697	WL 471.10	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VII (2 pieces)
TMM 41954-42	BIBE 49698	WL 471.11	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VIII (1)
TMM 41954-43	BIBE 49699	WL 471.1	<i>Quetzalcoatlus lawsoni</i>	Distal carpal right (1)
TMM 41954-48	BIBE 49700	WL 471.19	<i>Quetzalcoatlus lawsoni</i>	Proximal syncarpal right (1)
TMM 41954-49	BIBE 49701	WL 471.16	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit III left (1)
TMM 41954-50.1	BIBE 49702	WL 471.17	<i>Quetzalcoatlus lawsoni</i>	Metacarpal II right, distal half (1)
TMM 41954-50.2	BIBE 49845	WL 471.17	<i>Quetzalcoatlus lawsoni</i>	Metacarpal III right, distal half (1)
TMM 41954-51	BIBE 49703	WL 471.18	<i>Quetzalcoatlus lawsoni</i>	Ungual phalanx manual digit I right (1)
TMM 41954-52	BIBE 49704	WL 471.12	<i>Quetzalcoatlus lawsoni</i>	Radius right (1)
TMM 41954-53	BIBE 49705	WL 471.13	<i>Quetzalcoatlus lawsoni</i>	Long bone, shaft fragment (5+ in matrix block)

(Continued)

Continued.

Texas catalog no.	NPS catalog no.	Field no.	Taxon determination	Object description
TMM 41954-54	BIBE 49706	WL 471.14	<i>Quetzalcoatlus lawsoni</i>	Second phalanx manual digit IV right (1)
TMM 41954-55	BIBE 49707	WL 471.15	<i>Quetzalcoatlus lawsoni</i>	Ulna right, distal (1)
TMM 41954-56	BIBE 49708	WL 471.23	<i>Quetzalcoatlus lawsoni</i>	Metacarpal III right, distal half (1)
TMM 41954-57	BIBE 49709	WL 471.24	<i>Quetzalcoatlus lawsoni</i>	Pelvis and synsacrum, left half (1)
TMM 41954-58	BIBE 49710	WL 471.3	<i>Quetzalcoatlus lawsoni</i>	Prepubis left (1)
TMM 41954-59.1	BIBE 49711	WL 471.5	<i>Quetzalcoatlus lawsoni</i>	Carpal sesamoid (1)
TMM 41954-59.2	BIBE 49711	WL 471.5	<i>Quetzalcoatlus lawsoni</i>	Femur right, distal end (1)
TMM 41954-59.3	BIBE 49711	WL 471.5	<i>Quetzalcoatlus lawsoni</i>	Distal tarsal (1)
TMM 41954-60.1	BIBE 49712	WL 471.6	<i>Quetzalcoatlus lawsoni</i>	Notarium (1)
TMM 41954-60.2	BIBE 49712	WL 471.6	<i>Quetzalcoatlus lawsoni</i>	Second notarium rib left (1)
TMM 41954-60.3	BIBE 49712	WL 471.6	<i>Quetzalcoatlus lawsoni</i>	First notarium rib right (1)
TMM 41954-61	BIBE 49713	WL 471.2	<i>Quetzalcoatlus lawsoni</i>	Medial carpal right (1)
TMM 41954-62	BIBE 49714	WL 471.7	<i>Quetzalcoatlus lawsoni</i>	Skull, rostral (1)
TMM 41954-63	BIBE 49715	WL 471.6	<i>Quetzalcoatlus lawsoni</i>	Humerus right, proximal half (1)
TMM 41954-64.1	BIBE 49716	WL 471.5	<i>Quetzalcoatlus lawsoni</i>	Metatarsal I right (1)
TMM 41954-64.2	BIBE 49717	WL 471.5	<i>Quetzalcoatlus lawsoni</i>	Metatarsal II right (1)
TMM 41954-64.3	BIBE 49718	WL 471.5	<i>Quetzalcoatlus lawsoni</i>	Lateral distal tarsal right (1)
TMM 41954-64.4	BIBE 49718	WL 471.5	<i>Quetzalcoatlus lawsoni</i>	Medial distal tarsal left (1)
TMM 41954-64.5	BIBE 49718	WL 471.5	<i>Quetzalcoatlus lawsoni</i>	Metatarsal V left, proximal end (1)
TMM 41954-64.6	BIBE 49718	WL 471.5	<i>Quetzalcoatlus lawsoni</i>	Phalanx pedal digit V (1)
TMM 41954-65	BIBE 49719	WL 471.6	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VI (1)
TMM 41954-66	BIBE 49720	WL 470	<i>Quetzalcoatlus lawsoni</i>	Metacarpal IV, shaft (4 pieces)
TMM 41954-67	BIBE 49721	WL 471	<i>Quetzalcoatlus lawsoni</i>	Ulna right, distal (3 pieces)
TMM 41954-68	BIBE 49722	WL 471.5	<i>Quetzalcoatlus lawsoni</i>	Ungual phalanx manual digit III right (1)
TMM 41954-69	BIBE 49723	WL 471.8	<i>Quetzalcoatlus lawsoni</i>	Pteroid right (1)
TMM 41954-70.1	BIBE 49724	WL 471.25	<i>Quetzalcoatlus lawsoni</i>	Third phalanx manual digit IV right (1)
TMM 41954-70.2	BIBE 49743	WL 471.25	<i>Quetzalcoatlus lawsoni</i>	Fourth phalanx manual digit IV right, proximal (1)
TMM 41954-71	BIBE 49725	WL 471.27	<i>Quetzalcoatlus lawsoni</i>	Metacarpal IV right (3 pieces)
TMM 41954-72	BIBE 49726	WL 471.21	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit III right, proximal (1)
TMM 41954-73	BIBE 49727	WL 471.26	<i>Quetzalcoatlus lawsoni</i>	Dorsal vertebra I (1)
TMM 41954-74	BIBE 49728	WL 471.21	<i>Quetzalcoatlus lawsoni</i>	Proximal carpal right (1)
TMM 41954-76	BIBE 49730	WL A22	<i>Quetzalcoatlus lawsoni</i>	Notarium rib (1), in matrix block
TMM 41954-78	BIBE 49732	WL A14	<i>Quetzalcoatlus lawsoni</i>	Ungual phalanx pedal digit IV (1)
TMM 41954-79	BIBE 49627	WL 392.7	<i>Quetzalcoatlus lawsoni</i>	Tibiotarsus right, distal end (1)
TMM 41954-80	BIBE 49734	WL 471	<i>Quetzalcoatlus lawsoni</i>	Distal syncarpal right (1)
TMM 41954-81	BIBE 49735	WL 471	<i>Quetzalcoatlus lawsoni</i>	Humerus right, head (1)
TMM 41954-82	BIBE 49736	WL 471.6	<i>Quetzalcoatlus lawsoni</i>	Metacarpal IV, shaft (1)
TMM 41954-83	BIBE 49737	WL 471.6	<i>Quetzalcoatlus lawsoni</i>	Femur right, shaft (1)
TMM 41954-84	BIBE 49740	WL 392.8	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit IV, shaft (1)
TMM 41954-85	BIBE 49741	WL 392.8	<i>Quetzalcoatlus lawsoni</i>	Radius right, proximal portion (1)
TMM 41954-86	BIBE 49742	WL A16	<i>Quetzalcoatlus lawsoni</i>	Third phalanx manual digit IV left (1)
TMM 41954-87	BIBE 49744	WL 471.25	<i>Quetzalcoatlus lawsoni</i>	Second phalanx pedal digit (1)
TMM 41954-88	BIBE 49745	WL 471	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra IV, posterior end (1)
TMM 41954-89	BIBE 49746	WL 471	<i>Quetzalcoatlus lawsoni</i>	Lateral distal tarsal right (1)
TMM 41954-90	BIBE 49747	WL 392.1	<i>Quetzalcoatlus lawsoni</i>	Unidentified bone, fragment in concretion
TMM 41954-91	BIBE 49748	WL 392.1	<i>Quetzalcoatlus lawsoni</i>	Unidentified bone, fragment in concretion (1)
TMM 41961-1.1	BIBE 49849	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Skull, cranial portion (1)
TMM 41961-1.2	BIBE 49850	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Mandible, without rostral portion (1)
TMM 41961-1.3	BIBE 49851	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Metacarpal IV left, without proximal end (1)
TMM 41961-1.4	BIBE 49852	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit IV left (1)
TMM 41961-1.5	BIBE 49853	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Second phalanx manual digit IV left (1)
TMM 41961-1.6	BIBE 49854	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Third phalanx manual digit IV left (1)
TMM 41961-1.7	BIBE 49855	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Fourth phalanx manual digit IV left (1)
TMM 41961-1.8	BIBE 49856	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Ulna left, distal end (1)
TMM 41961-1.9	BIBE 49857	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Proximal syncarpal right (1)
TMM 41961-1.10	BIBE 49858	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Distal syncarpal right (1)
TMM 41961-1.11	BIBE 49859	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Pteroid right (1)
TMM 41961-1.12	BIBE 49860	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Pteroid left (3)
TMM 41961-1.13	BIBE 49861	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Metacarpal IV right, proximal half (1)
TMM 41961-1.14	BIBE 49862	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Medial carpal right (1)
TMM 41961-1.15	BIBE 49863	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit IV right (1)
TMM 41961-1.16	BIBE 49864	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Second phalanx manual digit IV right (1)
TMM 41961-1.17	BIBE 49865	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Third phalanx manual digit IV right (1)
TMM 41961-1.18	BIBE 49866	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Second phalanx manual digit III (1)
TMM 41961-1.19	BIBE 49867	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Third phalanx manual digit III (1)
TMM 41961-1.20	BIBE 49868	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Ungual phalanx manual digit II (1)
TMM 41961-1.21	BIBE 49869	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Ungual phalanx manual digit II (1)
TMM 41961-1.22	BIBE 49870	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Femur left, without proximal end (1)
TMM 41961-1.23	BIBE 49871	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Tibiotarsus left (1)
TMM 41961-1.24	BIBE 49872	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Femur right, shaft (1)
TMM 41961-1.25	BIBE 49873	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Tibiotarsus right (2)
TMM 41961-1.26	BIBE 49874	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Metatarsal II right (2)
TMM 41961-1.27	BIBE 49875	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Metatarsal I left, shaft (1)

(Continued)

Continued.

Texas catalog no.	NPS catalog no.	Field no.	Taxon determination	Object description
TMM 41961-1.28	BIBE 49876	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra V, without anterior portion (1)
TMM 41961-1.29	BIBE 49877	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VI, anterior half (2)
TMM 41961-1.30	BIBE 49878	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VII, anterior half (1)
TMM 41961-1.31	BIBE 49878	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	First phalanx pedal digit I, distal end (1)
TMM 41961-2	BIBE 49878	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit IV left (1)
TMM 41961-4	BIBE 49878	WL 368 41961	<i>Quetzalcoatlus lawsoni</i>	Long bone, midshaft (2)
TMM 42138-1.1	BIBE 49756	WL-B	<i>Quetzalcoatlus lawsoni</i>	Scapulacoracoid right (1)
TMM 42138-1.2	BIBE 49757	WL-B	<i>Quetzalcoatlus lawsoni</i>	Humerus right (1)
TMM 42138-1.3	BIBE 49758	WL-B	<i>Quetzalcoatlus lawsoni</i>	Ulna right (1)
TMM 42138-1.4	BIBE 49759	WL-B	<i>Quetzalcoatlus lawsoni</i>	Radius right, distal end (1)
TMM 42138-1.5	BIBE 49760	WL-B	<i>Quetzalcoatlus lawsoni</i>	Sternum, anterior end (1)
TMM 42138-1.6	BIBE 49761	WL-B	<i>Quetzalcoatlus lawsoni</i>	Metacarpal IV right (1)
TMM 42138-1.7	BIBE 49762	WL-B	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit IV right (1)
TMM 42138-1.8	BIBE 49763	WL-B	<i>Quetzalcoatlus lawsoni</i>	Second phalanx manual digit IV right (1)
TMM 42138-1.9	BIBE 49764	WL-B	<i>Quetzalcoatlus lawsoni</i>	Ungual phalanx manual digit II (1)
TMM 42138-1.10	BIBE 49765	WL-B	<i>Quetzalcoatlus lawsoni</i>	Fourth phalanx manual digit IV right (1)
TMM 42138-2.1	BIBE 49767	WL 439	<i>Quetzalcoatlus lawsoni</i>	Tibiotarsus left, without proximal end (1)
TMM 42138-2.2	BIBE 49768	WL 439	<i>Quetzalcoatlus lawsoni</i>	Metatarsal V left (1)
TMM 42138-2.3	BIBE 49769	WL 439	<i>Quetzalcoatlus lawsoni</i>	Lateral distal tarsal right (1)
TMM 42138-2.4	BIBE 49770	WL 439	<i>Quetzalcoatlus lawsoni</i>	Medial distal tarsal right (1)
TMM 42138-2.5	BIBE 49771	WL 439	<i>Quetzalcoatlus lawsoni</i>	Second pedal phalanx digit II left (1)
TMM 42138-2.6	BIBE 49772	WL 439	<i>Quetzalcoatlus lawsoni</i>	Third pedal phalanx digit III left (1)
TMM 42138-2.7	BIBE 49773	WL 439	<i>Quetzalcoatlus lawsoni</i>	Fourth pedal phalanx digit IV left (1)
TMM 42138-2.8	BIBE 49774	WL 439	<i>Quetzalcoatlus lawsoni</i>	Ungual pedal phalanx digit II left (1)
TMM 42138-2.8	BIBE 49774	WL 439	<i>Quetzalcoatlus lawsoni</i>	Fourth pedal phalanx digit III left (1)
TMM 42138-3	BIBE 49775	WL 436	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit II (1)
TMM 42138-4	BIBE 49776	WL 479	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit III left (1)
TMM 42157-2	BIBE 49778	WL A13	<i>Quetzalcoatlus lawsoni</i>	Distal syncarpal right (1)
TMM 42161-1.1	BIBE 49779	WL C3	<i>Quetzalcoatlus lawsoni</i>	Skull, cranial portion (1)
TMM 42161-1.2	BIBE 49780	WL C3	Pterosauria	Long bone, shaft (1)
TMM 42161-1.3	BIBE 49781	WL C3	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra III (1)
TMM 42161-1.4	BIBE 49782	WL C3	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra V (1)
TMM 42161-1.5	BIBE 49783	WL C3	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VII (1)
TMM 42161-2	BIBE 49784	WL C2	<i>Quetzalcoatlus lawsoni</i>	Mandible (1)
TMM 42161-3	BIBE 49785	WL C1	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VI, anterior two-thirds (1)
TMM 42180-1	BIBE 49786	WL D1	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra III (1)
TMM 42180-2	BIBE 49787	WL D2	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra V (1), dorsoventrally crushed
TMM 42180-3	BIBE 49788	WL D3	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VII, anterior end (1)
TMM 42180-4	BIBE 49789	WL D4	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit IV left, proximal end (1)
TMM 42180-5	BIBE 49790	WL D5	<i>Quetzalcoatlus lawsoni</i>	Atlantoaxis, without neural arch portion (1)
TMM 42180-6	BIBE 49791	WL 429	<i>Quetzalcoatlus lawsoni</i>	Distal syncarpal left (1)
TMM 42180-7	BIBE 49792	WL D6	<i>Quetzalcoatlus lawsoni</i>	Long bone, fragment (45 pieces)
TMM 42180-8	BIBE 49793	WL D6	<i>Quetzalcoatlus lawsoni</i>	Proximal syncarpal right (1)
TMM 42180-9	BIBE 49794	WL D6	<i>Quetzalcoatlus lawsoni</i>	Scapulacoracoid right, glenoid portion (1)
TMM 42180-10	BIBE 49795	WL 429	<i>Quetzalcoatlus lawsoni</i>	Scapulacoracoid left, dorsal portion with glenoid (1)
TMM 42180-11	BIBE 49796	WL D6	<i>Quetzalcoatlus lawsoni</i>	Humerus right, deltopectoral crest (1)
TMM 42180-12	BIBE 49797	WL 429	<i>Quetzalcoatlus lawsoni</i>	Sternum, anterior end (1)
TMM 42180-13	BIBE 49798	WL 429	<i>Quetzalcoatlus lawsoni</i>	Long bone, shaft (9 pieces)
TMM 42180-14.1	BIBE 49799	WL D6	<i>Quetzalcoatlus lawsoni</i>	Humerus left, without deltopectoral crest (1)
TMM 42180-14.2	BIBE 49800	WL D6	<i>Quetzalcoatlus lawsoni</i>	Radius left, without distal end (1)
TMM 42180-14.3	BIBE 49801	WL D6	<i>Quetzalcoatlus lawsoni</i>	Ulna left, without distal end (1)
TMM 42180-14.4	BIBE 49802	WL D6	<i>Quetzalcoatlus lawsoni</i>	Medial carpal left (1)
TMM 42180-14.5	BIBE 49803	WL D6	<i>Quetzalcoatlus lawsoni</i>	Metacarpal IV left, without proximal end (1)
TMM 42180-14.6	BIBE 49804	WL D6	<i>Quetzalcoatlus lawsoni</i>	Metacarpal IV right, without distal end (1)
TMM 42180-14.7	BIBE 49805	WL D6	<i>Quetzalcoatlus lawsoni</i>	Lateral distal tarsal left (1)
TMM 42180-14.8	BIBE 49806	WL D6	<i>Quetzalcoatlus lawsoni</i>	Metatarsal IV left, proximal end (1)
TMM 42180-14.9	BIBE 49807	WL D6	<i>Quetzalcoatlus lawsoni</i>	Metatarsal V left (1); articulated with 42180-14.7 and 42180-14.8
TMM 42180-14.10	BIBE 49808	WL D6	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VI, without ends (1)
TMM 42180-14.11	BIBE 49809	WL D6	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VII (1)
TMM 42180-14.12	BIBE 49802	WL D6	<i>Quetzalcoatlus lawsoni</i>	Proximal syncarpal left (1)
TMM 42180-14.13	BIBE 49802	WL D6	<i>Quetzalcoatlus lawsoni</i>	Distal syncarpal left (1)
TMM 42180-15	BIBE 49810	WL 429	<i>Quetzalcoatlus lawsoni</i>	Metacarpal IV right, distal (1)
TMM 42180-16	BIBE 49811	WL 438	<i>Quetzalcoatlus lawsoni</i>	Long bone, fragment (1)
TMM 42180-17	BIBE 49812	WL 478	<i>Quetzalcoatlus lawsoni</i>	Metacarpal IV right, distal half (1)
TMM 42180-18	BIBE 49813	WL 420	<i>Quetzalcoatlus lawsoni</i>	Metatarsal III left? (1)
TMM 42180-19	BIBE 49814	WL 419	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VI (1)
TMM 42180-20	BIBE 49815	WL 478	<i>Quetzalcoatlus lawsoni</i>	Tibiotarsus left, without distal end (1)
TMM 42180-21.1	BIBE 49816	WL 478	<i>Quetzalcoatlus lawsoni</i>	Second phalanx digit IV right, distal end (1)
TMM 42180-21.2	BIBE 49817	WL 478	<i>Quetzalcoatlus lawsoni</i>	Third phalanx digit IV right, proximal end (1)
TMM 42180-22	BIBE 49818	WL 478	<i>Quetzalcoatlus lawsoni</i>	Bone, fragment (2 pieces)
TMM 42180-23	BIBE 49819	WL 478	<i>Quetzalcoatlus lawsoni</i>	Long bone, fragment (1)
TMM 42180-24	BIBE 49820	WL 478	<i>Quetzalcoatlus lawsoni</i>	Premaxillonasal bar, fragment (16)
TMM 42180-25	BIBE 49821	WL 478	<i>Quetzalcoatlus lawsoni</i>	Bone, fragment (1), with associated fragments (7)

(Continued)

Continued.

Texas catalog no.	NPS catalog no.	Field no.	Taxon determination	Object description
TMM 42246-1	BIBE 49822	WL 433	<i>Quetzalcoatlus lawsoni</i>	Distal carpal right (1)
TMM 42246-2	BIBE 49823	WL 434	<i>Quetzalcoatlus lawsoni</i>	Proximal carpal right (1), with pathology
TMM 42246-3	BIBE 49824	WL 482	<i>Quetzalcoatlus lawsoni</i>	Notarium (1)
TMM 42246-4	BIBE 49825	WL 434	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit IV, midshaft (4)
TMM 42259-1.1	BIBE 49826	WL 421	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VI, anterior end (1)
TMM 42259-1.2	BIBE 49766	WL 421	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VII (1)
TMM 42272-1	BIBE 49827	WL 423.1	<i>Quetzalcoatlus lawsoni</i>	Femur left, proximal shaft (3)
TMM 42272-2	BIBE 49828	WL 423.2	<i>Quetzalcoatlus lawsoni</i>	Tibiotarsus left, midshaft (2)
TMM 42272-3	BIBE 49829	WL 423.3	<i>Quetzalcoatlus lawsoni</i>	Long bone, fragment (15)
TMM 42272-4	BIBE 49733	WL 423.3	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit IV (2)
TMM 42297-1	BIBE 49830	WL 456	<i>Quetzalcoatlus lawsoni</i>	Femur right, midshaft (2)
TMM 42422-1	BIBE 49831	WL 467.29	<i>Quetzalcoatlus lawsoni</i>	Radius left (1)
TMM 42422-2	BIBE 49832	WL 467.28	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit IV left (1)
TMM 42422-3	BIBE 49833	WL 467.26	<i>Quetzalcoatlus lawsoni</i>	Distal syncarpal left (1)
TMM 42422-4	BIBE 49834	WL 467.27	<i>Quetzalcoatlus lawsoni</i>	Proximal syncarpal left (1)
TMM 42422-5	BIBE 49835	WL 467.33	<i>Quetzalcoatlus lawsoni</i>	Second phalanx manual digit IV left (1)
TMM 42422-6.1	BIBE 49836	WL 467.31	<i>Quetzalcoatlus lawsoni</i>	Third phalanx manual digit IV left (1)
TMM 42422-6.2	BIBE 49837	WL 467.31	<i>Quetzalcoatlus lawsoni</i>	Fourth phalanx manual digit IV left (1)
TMM 42422-7	BIBE 49838	WL 467.17	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra IX (1)
TMM 42422-8	BIBE 49839	WL 467.11	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VIII (1)
TMM 42422-9	BIBE 49840	WL 467.32	<i>Quetzalcoatlus lawsoni</i>	Tibiotarsus right (1)
TMM 42422-10	BIBE 49841	WL 467.25	<i>Quetzalcoatlus lawsoni</i>	Tibiotarsus left (1)
TMM 42422-11	BIBE 49842	WL 467.24	<i>Quetzalcoatlus lawsoni</i>	Tibiotarsus left (1)
TMM 42422-12	BIBE 49843	WL 467.13	<i>Quetzalcoatlus lawsoni</i>	Scapulacoracoid right (1)
TMM 42422-13	BIBE 49844	WL 467.5	<i>Quetzalcoatlus lawsoni</i>	Ulna left (1)
TMM 42422-14	BIBE 49906	WL 467.30	<i>Quetzalcoatlus lawsoni</i>	Ungual phalanx manual digit II right (1)
TMM 42422-15.1	BIBE 49904	WL 467.22	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit I left (1)
TMM 42422-15.2	BIBE 49905	WL 467.22	<i>Quetzalcoatlus lawsoni</i>	Ungual phalanx manual digit I left (1)
TMM 42422-16	BIBE 49912	WL 467.23	<i>Quetzalcoatlus lawsoni</i>	Metatarsal V right (1)
TMM 42422-17	BIBE 49907	WL 467.2	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit IV (1)
TMM 42422-18	BIBE 49908	WL 467.3	<i>Quetzalcoatlus lawsoni</i>	Humerus right (1)
TMM 42422-19	BIBE 49909	WL 467.7	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit II left (1)
TMM 42422-20	BIBE 49910	WL 467.8	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VI (1)
TMM 42422-21	BIBE 49911	WL 467.19	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit III left (1)
TMM 42422-22	BIBE 49913	WL 467.18	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra V (1)
TMM 42422-23	BIBE 49914	WL 467.9	<i>Quetzalcoatlus lawsoni</i>	Humerus left, without deltoid crest (1)
TMM 42422-24	BIBE 49915	WL 467.14	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra III (1)
TMM 42422-25	BIBE 49916	WL 467.21	<i>Quetzalcoatlus lawsoni</i>	Scapulacoracoid left (1)
TMM 42422-26	BIBE 49917	WL 467.1	<i>Quetzalcoatlus lawsoni</i>	Ulna left, distal end (1), with fragments (8)
TMM 42422-27	BIBE 49920	WL 467.34	<i>Quetzalcoatlus lawsoni</i>	Femur right, proximal (1)
TMM 42422-28	BIBE 49921	WL 467.20	<i>Quetzalcoatlus lawsoni</i>	Femur right (2 pieces)
TMM 42422-29	BIBE 49922	WL 467.12	<i>Quetzalcoatlus lawsoni</i>	Sternum, central portion (1)
TMM 42422-30	BIBE 49923	WL 472.2	<i>Quetzalcoatlus lawsoni</i>	Skull; quadrate, jugal, maxilla (2 pieces)
TMM 42422-31	BIBE 49918	42422	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VII (1)
TMM 42422-32	BIBE 49919	WL 467.12	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VI (1)
TMM 42422-37	BIBE 49926	WL 467.11	<i>Quetzalcoatlus lawsoni</i>	Carpal sesamoid (1)
TMM 42422-38	BIBE 49927	WL 467	<i>Quetzalcoatlus lawsoni</i>	Long bone, shaft (1, shattered in 3 matrix chunks)
TMM 42422-39	BIBE 49917		<i>Quetzalcoatlus lawsoni</i>	Premaxillonasal bar (1)
TMM 42462-1	BIBE 49695	WL 435	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra IV, posterior portion (1)
TMM 42489-2.1	BIBE 49749	WL 474.6	<i>Wellnhoferus brevirostris</i>	Skull, rostral portion (1), with jugal right (1)
TMM 42489-2.2	BIBE 49749	WL 474.6	<i>Wellnhoferus brevirostris</i>	Mandible, rostral portion (1)
TMM 42489-2.3	BIBE 49750	WL 474.5	<i>Wellnhoferus brevirostris</i>	Cervical IV (1, in articulated series)
TMM 42489-2.4	BIBE 49750	WL 474.5	<i>Wellnhoferus brevirostris</i>	Cervical V (1, in articulated series)
TMM 42489-2.5	BIBE 49750	WL 474.5	<i>Wellnhoferus brevirostris</i>	Cervical VI (1, in articulated series)
TMM 42489-2.6	BIBE 49750	WL 474.5	<i>Wellnhoferus brevirostris</i>	Cervical VII (1, in articulated series)
TMM 42489-2.7	BIBE 49750	WL 474.5	<i>Wellnhoferus brevirostris</i>	Cervical VIII (1, in articulated series)
TMM 42489-2.8	BIBE 49888	WL 474	<i>Wellnhoferus brevirostris</i>	Long bone, fragment (11)
TMM 42489-2.9	BIBE 49888	WL 474	<i>Wellnhoferus brevirostris</i>	Long bone, fragment (17)
TMM 42521-1	BIBE 49886	WL C float	<i>Quetzalcoatlus lawsoni</i>	Rib, fragmentary (15 pieces), in matrix
TMM 42538-1		TL MCS	Pterosauria	Femur?, shaft fragment (1)
TMM 42889-1	BIBE 49751	WL 422	<i>Quetzalcoatlus nortropi</i>	Cervical vertebra V (1)
TMM 43057-151			Pterosauria	First phalanx manual digit IV right, proximal (1)
TMM 44036-1		TL 97-4	<i>Quetzalcoatlus northropi</i>	Ulna left, proximal end (1)

(Continued)

Continued.

Texas catalog no.	NPS catalog no.	Field no.	Taxon determination	Object description
TMM 44037-1		TL 93-2	<i>Quetzalcoatlus lawsoni</i>	Long bone, midshaft fragment (2)
TMM 44037-2		TL 93-2	<i>Quetzalcoatlus lawsoni</i>	Long bone, midshaft fragment (1)
TMM 44048-1.1			<i>Quetzalcoatlus lawsoni</i>	Medial carpal left (1)
TMM 44048-1.2			<i>Quetzalcoatlus lawsoni</i>	Sesamoid (1)
TMM 45616-2		TL 95-5	Pterosauria	?Phalanges digit IV shaft (60+)
TMM 45616-3		TL 95-5	Pterosauria	Skull? And/or long bone, fragments (41)
TMM 45888-2.1		TL 95-7	Pterosauria	Cervical vertebra V, partial (1)
TMM 45888-2.2		TL 95-7	Pterosauria	Distal syncarpal left (1)
TMM 45888-2.3		TL 95-7	Pterosauria	?Tibiotarsus, shaft (5)
TMM 45888-2.4		TL 95-7	Pterosauria	Second or third phalanx?, manual digit IV (1)
TMM 45888-2.5		TL 95-7	Pterosauria	?First phalanx manual digit IV, shaft (3)
TMM 45921-78		KB-B	Pterosauria	Long bone, shaft (25)
TMM 45922-38		KB-A	Pterosauria	Femur right, without distal quarter (1)
TMM 45977-1	BIBE 49753	45977	<i>Quetzalcoatlus lawsoni</i>	Long bone, shaft fragment (1), in matrix
TMM 45977-2	BIBE 49900	45977	<i>Quetzalcoatlus lawsoni</i>	Long bone, shaft fragment (1)
TMM 45997-1.1	BIBE 49894	WL 489	<i>Quetzalcoatlus lawsoni</i>	Metacarpal IV right, without proximal end (1)
TMM 45997-1.2	BIBE 49895	WL 489	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit IV right, proximal (1)
TMM 45997-1.3	BIBE 49896	WL 489	<i>Quetzalcoatlus lawsoni</i>	Distal syncarpal right (1)
TMM 45997-1.4	BIBE 49897	WL 489	<i>Quetzalcoatlus lawsoni</i>	Radius right, distal end (1)
TMM 45997-1.5	BIBE 49898	WL 489	<i>Quetzalcoatlus lawsoni</i>	Ulna right, distal end (1)
TMM 45997-1.6	BIBE 49899	WL 489	<i>Quetzalcoatlus lawsoni</i>	Proximal syncarpal right (1)
TMM 45997-2	BIBE 49901	WL 489	<i>Quetzalcoatlus lawsoni</i>	Third phalanx manual digit IV (1)
TMM 45997-3	BIBE 49902	WL 489	<i>Quetzalcoatlus lawsoni</i>	First phalanx manual digit II, distal end (1)
TMM 45997-4	BIBE 49903	WL 489	<i>Quetzalcoatlus lawsoni</i>	Cervical vertebra VII, neural arch fragment (1)