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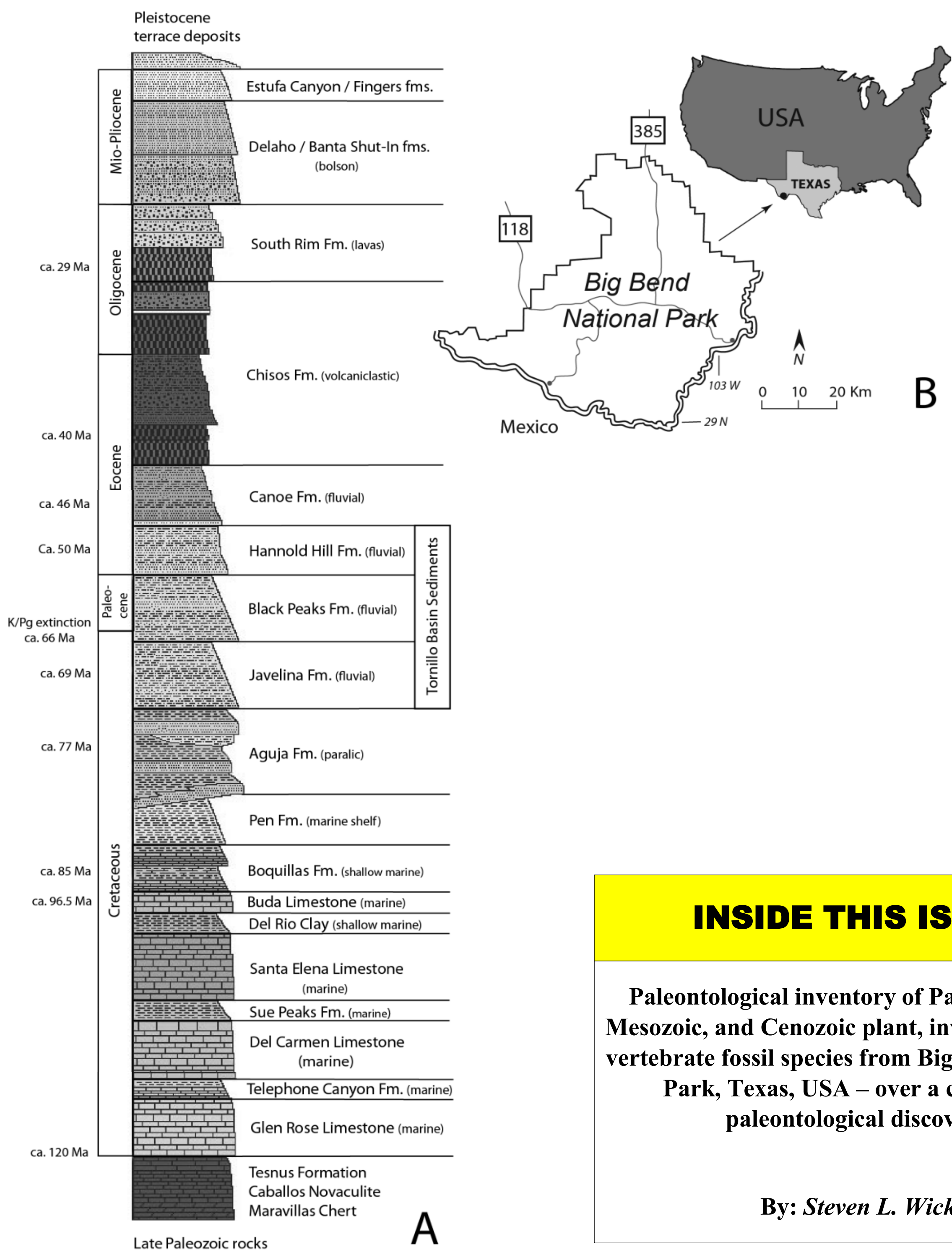

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Paleontological inventory of Paleozoic, Late Mesozoic, and Cenozoic plant, invertebrate, and vertebrate fossil species from Big Bend National Park, Texas, USA – over a century of paleontological discovery

By: ***Steven L. Wick***

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Volume XLIV Issue No. 8

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On The Cover

A stratigraphic column of the exposed strata in Big Bend National Park from Wick's inventory of paleontological fossils from the study area

STGS Meeting Notice

Date: May 16th, 2024

Time: Thursday, 6:00 PM

Speaker and Topic: *Neil Bockoven, Paleo Cave Art Mysteries*

Location: Petroleum Club 8620 N New Braunfels Ave #700 San Antonio, TX 78217

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Paleontological inventory of Paleozoic, Late Mesozoic, and Cenozoic plant, invertebrate, and vertebrate fossil species from Big Bend National Park, Texas, USA – over a century of paleontological discovery

DEAR STGS MEMBERS,

What a year! From the luncheons to the fundraisers to the happy hours to the GeoGulf conference, this year was jam-packed with events. These events were all made possible by some amazing STGS members who worked harder than ever to make each event a success. Two people in particular deserve a special thanks: David Clay arranged and hosted the Crawfish Boil, and raised over $10,000 for our student scholarship fund. We had the highest attendance ever this year, and the event has raised nearly $25,000 for the student scholarship fund since David started the Crawfish Boil in 2022. Secondly, John Casiano put together GeoGulf 2024, a monumental effort that also raised money for the Society. I hope he is enjoying some well-deserved free time.

Regarding the STGS website, we are still on track to complete and finalize the new website for your use starting in the new 2024-2025 term. Our web designer is currently activating plugins to use for different website functions. After that, the website will be tested to make sure all the links work properly, and then it will be ready to go live!

On a personal note, this has been one of the most challenging years for me professionally. If only I had known ahead of time that I would be a Mom and President in the same year…how busy yet rewarding it has been. As many of you know, having a baby is NOT conducive to a busy schedule. I worked three "jobs" this year – as an employee of the Edwards Aquifer Authority, President of STGS, and my side business as a solo violinist. This is par the course for me – I've been working multiple jobs almost constantly since I graduated high school, but I never had the Mom title on top of it all. And yes, the Mom title comes above all the others! Needless to say, I'm just trying to keep my head above water at this point.

I've been part of the Society going on 8 years now, and have spent half of that time as a Board member (2 years as Editor, 1 year President-Elect, 1 year President, and my upcoming 1 year as Past President). It has been incredibly fulfilling and I am glad I have been able to give back to the organization that gave me so much. I've been overwhelmed by the support from so many of you and am grateful for all our Board members this year for having my back when I couldn't make it to luncheons or other events. I'm also ever grateful to my better half, who steadfastly supports me in all my personal and professional pursuits.

As I pass the torch to John Cooper, I have some wisdom to impart to anyone willing to take it – embrace risk. You can't succeed if you aren't willing to challenge yourself and try new things. Seize opportunities when they arise, as you never know when the next one will come around, or what it will lead to. Most importantly, prioritize your loved ones. They are the ones who bring joy to life, and we only get one chance to do life

Sincerely,

Alyssa Blaise Balzen, P.G.

STGS President, 2023-2024

HOWDY GEOS,

In honor of all of the students receiving scholarships this month, I wanted to share a little background information on who some of the geologists were that inspired the awards STGS gives to students. The names behind these awards were pioneers in their trades who built a life on research, exploration, or teaching. Many were also local San Antonians whose impact is still very much felt, especially since these exceptional geologists have only recently passed, and many of their colleagues are still practicing in the field today.

Hopefully you students who receive these awards will also become esteemed researchers, explorers and pioneers in your field. If you are a name your local geologist community knows well, you will have made the impact that the spirit of these scholarships encapsulates. Congratulations to this year's scholarship recipients, and THANK YOU to all of this year's sponsors who contributed, and to all of our members that made it happen, this year and every year!

◊ Jones-Amsbury Research Grant –*Named for James Jones and David Amsbury*

David L. Amsbury (1932-2002) was a depositional carbonate geologist who received his BS degree from Sul Ross and received his Ph.D. from UT. He was a member of SEPM, and GSA and worked for Shell Development Co in the 1950's and 60's. In 1967 he joined NASA's Earth Resources in using remote sensing to learn about planetary surficial processes. He taught astronauts how to photograph the Earth's surface, and students today use these photographs to learn geomorphology. He taught geology at UT, UTSA, UH Clear Lake and was adjunct professor for Baylor. He was based right here in Central Texas and led many geologic field trips for our geologic community.

James O. Jones (1935-1999) was a geology professor, consultant and military man who was active with GCSSEPM, GSA, Texas Academy of Sciences, STGS, SIPES and AAPG. He received his BS from Baylor and his Ph. D. from the University of Iowa and taught geology at UTSA for many years. He spent summers consulting companies on mineral, oil and gas evaluation, as well as for federal organizations on waste management. His dedication to teaching was apparent, and his students still remember him fondly.

◊ George Pinkley-Edward C. Roy Jr. Scholarship –*Named for George Pinkley and Edward Carl Roy Jr.*

George R. Pinkley (1905-2006) was a petroleum geologist who helped discover and map the South Texas oil fields, back when mapping was based on surface expressions, cores and drillers logs. He didn't mind traveling for work and thus worked in Missouri, Wisconsin, New Mexico, Colorado, Oklahoma, and overseas before settling in San Antonio. He drilled in the South Texas patch for 65 years, and spent a lot of that time sharing data by publishing his work for STGS and attending its monthly meetings.

Dr. Edward Carl Roy Jr. (1936-2007) was a paleontologist and sedimentary geologist who taught geology for Trinity University for almost 40 years. He received his BS and his Ph.D from Ohio State University, and after graduating he worked for Shell Oil Co until 1966, when he began teaching. He was a member of AAPG, STGS, AAAS, AGI, GCAGS and SEPM. He was also a member of the Board of Earth Sciences and Resources of the National Research Council, a member of the Citizens Advisory Panel for SAWS, a Trustee of the American Geological Institute Foundation, and was appointed chair to the Texas Earth Science Task Force. He was truly an educator and was a great advocator for science.

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MAY 2024

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
			1	2 STGS Happy Hour	3	4 *May the 4th be with you*
5 Cinco de Mayo	6	7	8	9	10	11
12 Mother's Day	13	14 *Early Registration for Hydro-Geo ends. Entry raises to $65 after this day*	15	16 May Dinner & Scholarship Night	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31 *May concludes the STGS fiscal year. We will see you again in September! Enjoy your summer!*	

STGS AFFILIATES' EVENTS:

SEG Society of Exploration Geophysicists

May 7th-8th - Passive surface wave methods using ambient noise: from basic 1D soundings to high-resolution 3D imaging. Short course, virtual.

May 13th –Advancing Subsurface Exploration: Precision Fault Detection in Vertical Electrical Sounding Data Through Machine Learning Innovations. Virtual.

May 15th -SEG Hydrogeophysics Webinar: So you want to be a practicing near-surface geophysicist? Virtual.

SPE International, Society of Petroleum Engineers

May 14th-15th –SPE Workshop: Cementing Challenges with Carbon Capture and Storage Wells. Galveston TX.

AAPG

May 6th-9th -Offshore Technology Conference. Houston TX.

May 20th - Resources and Reserves, The Geologic Perspective. Workshop. Houston TX.

May 23rd -Petroleum Resources Management System. Course. Houston TX.

Let's Rock! GEOGULF2024

SAN ANTONIO
10–12 APRIL 2024

Closing remarks from the General Chair,

Carrying on with this music theme, I couldn't help but think of the song "Good Riddance" by Green Day, as I rode home after the last field trip on Sunday.

Thank you to my committee, members of STGS and a few from Austin and East Tx. Thank you to all the brilliant session chairs that agreed to participate. Thank you to all the presenters. There was so much valuable content shared at GeoGulf 2024. I hope everyone appreciated the quality geologists that were here to share their work. Thank you Milly Wright representing GCS-SEPM. Thank you to our GCAGS President David Clay. We had great luncheon speakers, Dr. Jon Olson, and Dr. Fernando Sanchez Ferrer. The field trips were superb. Thank you to our field trip leaders. Field trips are always my favorite part of geology. Thank you to AGS and HGS past GeoGulf committees for their guidance. And special thanks to our student volunteers who stepped in and crushed it for us.

The sponsors and exhibitors were out of sight. We did very well in sponsorships and filled the house with the best exhibitors. You are major reasons for this year's success. Sponsors, exhibitors, and the tech program are the legs that hold up this conference tripod. Thank you!

For those of you hesitant to volunteer at your local society, do it. It can give you more back than you can even believe, trust me. Thank you to my friends at STGS and THE AAPG. Most of them I consider family. This conference was great because of all of you. YOU are all ROCKSTARS. This was an experience I will NEVER forget. Thank you. I look forward to working and smashing rocks with all of you and new friends for a long time to come. It's been a couple of days since the van ride from Del Rio, and I've realized the ending song to this conference isn't "Good Riddance". This is more like the end of a famous Robert Earl Keen song, "The road goes on forever and the party never ends!" So, to be continued in Nacogdoches in 2025, with Julie Bloxson, Hunter Carr and Kurt Ley carrying the torch for our amazing section. I wish the best to the geologists working the gulf coast and geologists across the globe in the AAPG. And apologies if you had to hear me sing on Thursday, I felt obligated. Drill more wells.

Have a good one!

John Casiano

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Call For Papers

Attention Geologic Community,

Here at the South Texas Geological Society we pride ourselves upon providing a Bulletin for you the scientific community that is centered around a geologic article. We have been around since 1929 and we serve a large audience of nearly 1000 people in this area of Texas. Encompassed in our South Texas reach are a number of prestigious schools which churn out large numbers of STEM students that are conducting research every semester. Also in our little corner of Texas are a vast number of esteemed faculty and professionals who are publishing their own research in the geologic subjects.

In order to continue our Bulletin each year, we depend on the work of these students, faculty and industry professionals and their insight. As a knowledge sharing Society, we ask that you consider submitting your research to the editor of the STGS so we can continue sharing new research with our community. We are always in need of new material to print, and we want the research you, the expert, have published.

There is no fee involved in submitting articles to publish. We prefer to print material that is centered around Texas, but as geologists we are interested in topics worldwide. Our Bulletin has gone digital, so we are no longer limited by page numbers. However we do prefer to print articles ranging from 10 to 60 pages in length. All images, graphs and tables should be included within the article upon submittal, or in a separate file with directions on image placement within the article. Sometimes page sizing and formatting changes from article to reprint, so the images may be moved in order to best fit, but we strive to maintain the integrity of the article and will place images nearest their reference with as few changes as possible.

Please encourage your graduate students to submit their research! Having a student's first paper be published in a state Bulletin is a huge triumph and should be celebrated. Our large audience will help introduce students' names to the scientific community, and is an excellent way to network with potential employers. Please, help us continue our work of sharing new geologic research by encouraging your publishing colleagues to submit their article to the South Texas Geological Society. Thank you.

From the editor,

-Shelby Sckittone

shelbysckittone@yahoo.com

Featured Article

Paleontological inventory of Paleozoic, Late Mesozoic, and Cenozoic plant, invertebrate, and vertebrate fossil species from Big Bend National Park, Texas, USA – over a century of paleontological discovery

Steven L. Wick[1]

1 *Texas Vertebrate Paleontology Collections, 10100 Burnet Road, Austin, TX 78758, USA*

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Abstract

The extraordinary paleontological record from Big Bend National Park (BIBE), Texas chronicles nearly 120 million years of largely uninterrupted deposition through Late Cretaceous, Paleogene and Neogene time. Therefore, the park records one of the most complete and continuous fossil records of its kind in North America, if not the world. Paleontologists have collected and studied fossils from BIBE for over a century and nearly 1400 fossil species have been reported thus far. The BIBE paleontological record includes type specimens representing 44 scientifically valid species (five plants, nine invertebrates, and 30 vertebrates). Numerous other reported specimens are very likely new to science but have yet to be formally named. The present catalog presents the currently known assemblage of fossil plant, invertebrate, and vertebrate species from BIBE within a single, comprehensive record with significant references for each. This work is designed and written to be a research and resource management tool for scientists and non-scientists alike.

Keywords

Cretaceous, Neogene, paleobiodiversity, Paleogene, paleontology, taxonomy

Introduction

For more than 100 years, paleontological researchers have made some of North America's most important fossil discoveries in the Big Bend region of West Texas, USA – many of those in what is now Big Bend National Park (BIBE) (Fig. 1). Many other 'fossil' parks within the National Park Service (NPS) system contain strata which represent a relatively brief geologic interval providing a snapshot of the paleoenvironment represented in the rocks (e.g., Petrified Forest, Dinosaur, and Florissant national parks). On the other hand, BIBE's fossils come from a geologically long (ca. 120 Ma) and mostly uninterrupted series of strata which make it possible to study the succession of paleocommunities over geologic time. This is especially important in that the significance of fossil resources is directly related to degree of scientific information provided by the environmental contexts in which they are preserved. In fact, Big Bend National Park contains more than fossilized plants and animals; it contains a succession of "fossilized" aquatic and terrestrial ecosystems spanning ca. 120 Ma of Earth's history. Aside from the sheer number of fossil species discovered within the park, Big Bend is also known for several iconic fossil species including the largest flying creature known – the giant pterosaur Quetzalcoatlus northropi (Lawson), the colossal titanosaur Alamosaurus (Gilmore) and the hyper-giant alligatoroid Deinosuchus riograndensis (Colbert and Bird). The updated taxonomic catalog herein is derived from a seminal paleontological inventory of Big Bend National Park produced by Wick and Corrick (2015). The present fossil inventory represents the most significant portion of that earlier work. It involves a comprehensive listing of all reported fossil species (currently around 1300) having been discovered in BIBE by professional paleontologists and academic researchers so that the astonishing number and variety of fossil taxa from BIBE are included in a single published reference. Along with the taxonomic tables are brief descriptions of the park's geologic history and formations so that the reader has a convenient point of reference. Each reported species is accompanied by at least one (or more) significant references so that researchers can use them as a springboard for further research.

The original 2015 (unpublished) catalog was developed as an internal NPS document so that NPS interpretive and law enforcement personnel, resource managers, and qualified permitted academics might better explain, protect, manage, and research the diversity and significance of the park's fossil resources. Hence, it was written using uncomplicated language so that it could be better understood by readers with variable levels of interest and expertise. That approach is maintained here. Whatever the case, it must be noted that this catalog (like all projects of its type) remains a work-inprogress. New discoveries will undoubtedly add to the park's paleobiodiversity and new explorers will emerge over the coming decades to expand upon what we have discovered thus far. It must also be noted that several fossil species relevant to the BIBE paleontological story have been discovered just outside of the park in the same geologic formations exposed within it. These were also included in the present catalog under the assumption that these species are very likely present in the park as well but have yet to be found there.

Relevant references involving the various individual species reported here is provided within each of the taxonomic lists and so specific references are not included within the preliminary text. Repositories and accession numbers for the specimens representing the species listed in the catalog can be found in their respective referenced works. Furthermore, understanding the changing landscape of Big Bend is critical to understanding its paleontological story. The reader is, therefore, strongly encouraged to review Blakey and Ranney (2018) as their work provides an excellent and coherent geotectonic synthesis involving the changing landscape of western North America during Late Cretaceous, Paleogene, and Neogene time. Finally, in order to better understand the geologic context of the park, as well as the stratigraphic and geospatial relationships of the formations outlined in this report, the reader is encouraged to visit https://pubs.usgs.gov/sim/3142/ for the online version of the latest geologic map of BIBE produced by the U.S Geological Survey (Turner et al. 2011).

Overview of Big Bend geologic history and paleoenvironments

Paleozoic era

Fossils from Big Bend National Park are widespread within Mesozoic and Cenozoic strata which are well-exposed throughout the park. Paleozoic strata are not well exposed within the park and are largely confined to its northern margins and so fossils from this time are not well known. These older rocks were laid down some 330–285 million years ago then subsequently deformed during the Ouachita orogeny. They appear in the configuration that we see today as the subsequent result of Laramide compression, faulting, and erosion during more recent times (e.g., Page et al. 2008). Those fossils that that have been found (e.g., conodonts, graptolites, and brachiopods) suggest deposition generally within deep-water, basinal marine habitats. Within the park, the Paleozoic and Mesozoic stratigraphic sequences are separated by a significant unconformity representing a depositional hiatus and/or erosion during Triassic, Jurassic, and early Cretaceous time.

Late Cretaceous system

Around 120 million years ago, a warm, shallow sea (the Western Interior Seaway) bisected North America dividing the continent in half from today's Gulf of Mexico to the Arctic Ocean (Blakey and Ranney 2018), providing the setting for deposition of limy, marine muds and calcareous oozes. Today, these limestones and shales preserve the remains of sea-dwelling invertebrates such as urchins, foraminifera, and mollusks. Within and around BIBE, these strata create the sheer walls of Santa Elena, Mariscal, and Boquillas Canyons, almost the entire range of the Dead Horse Mountains, as well as the magnificent cliffs of the Sierra Ponce and Sierra del Carmen in nearby Mexico. Strata from this interval comprise the Lower Cretaceous, Comanchean Series (marine carbonate) rocks of the Glen Rose, Telephone Canyon, Del Carmen, Sue Peaks, Santa Elena, Del Rio, and Buda formations (Maxwell et al. 1967; Busbey and Lehman 1989; Turner et al. 2011). Approximately 90 million years ago, the shallow Cretaceous seaway began a gradual retreat to its present location – today's Gulf of Mexico. Calcareous marine muds, and silty clay containing more terrigenously-derived sediments were deposited on the nearby shallow, marine shelf along with the remains of giant bivalves, oysters, sharks, fish, ammonites, and mosasaurs. Gulfian Series limestones and shales of the flaggy Boquillas Formation and soft bentonitic clays of the Pen Formation were deposited during this time (Maxwell et al. 1967; Cooper et al. 2017). Around 78 million years ago, Big Bend was situated upon the shore of the ancient seaway (Blakey and Ranney 2018). A complex of coastal rivers, meandering streams, estuaries, and marshlands developed in the tropical climate. Alternating periods of marine transgression and shoreline progradation are responsible for the cyclic deposition of the sandstones, mudstones, and shales contained within the Aguja Formation's complex ensemble of intertonguing facies (Lehman 1985). These deposits have yielded fossilized trees, oysters, turtles, crocodiles, dinosaurs, and mammals. This was a time of remarkable diversity within the ancient ecosystem of ancient BIBE as marine, brackish, and fresh-water subaquatic habitats were situated very near to each other as well as to better drained, terrestrial floodplain environs. Some 70 to 65 million years ago, Laramide tectonism began uplifting the proto-Rocky Mountains to the west. As a result, the Late Cretaceous shoreline had retreated well to the east of today's park (Blakey and Ranney 2018). This new tectonic regime resulted in significant changes involving deposition and resultant lithology compared to deposits of the older Aguja Formation (Lehman et al. 2018). The most significant of these changes was the development of the Tornillo Basin across the Big Bend region (e.g., Lehman 1986) (Fig. 1). During this time, a river-floodplain environment dominated the deposition of fluvial sands and muds within the Tornillo Basin which are preserved within the Javelina and Black Peaks Formations within the Park. Today, fluvial channel sandstones, colorful overbank mudstones, and thin lacustrine facies can be found in many areas of BIBE which harbor the remains of many creatures including dinosaurs, pterosaurs, and many types of smaller reptiles, as well as conifer trees and flowering plants. The climate had changed since Aguja time and it was becoming cooler and more seasonal (e.g., Linnert et al. 2014). Dinosaurs reached their largest sizes during this time (e.g., Woodward 2005; Woodward and Lehman 2009). The end of the Cretaceous Period was also a time of great change for life on Earth. Although there are several hypotheses for the extinction of the dinosaurs some 66 million years ago, their disappearance at the end of the Cretaceous gave rise to the 'Age' of mammals.

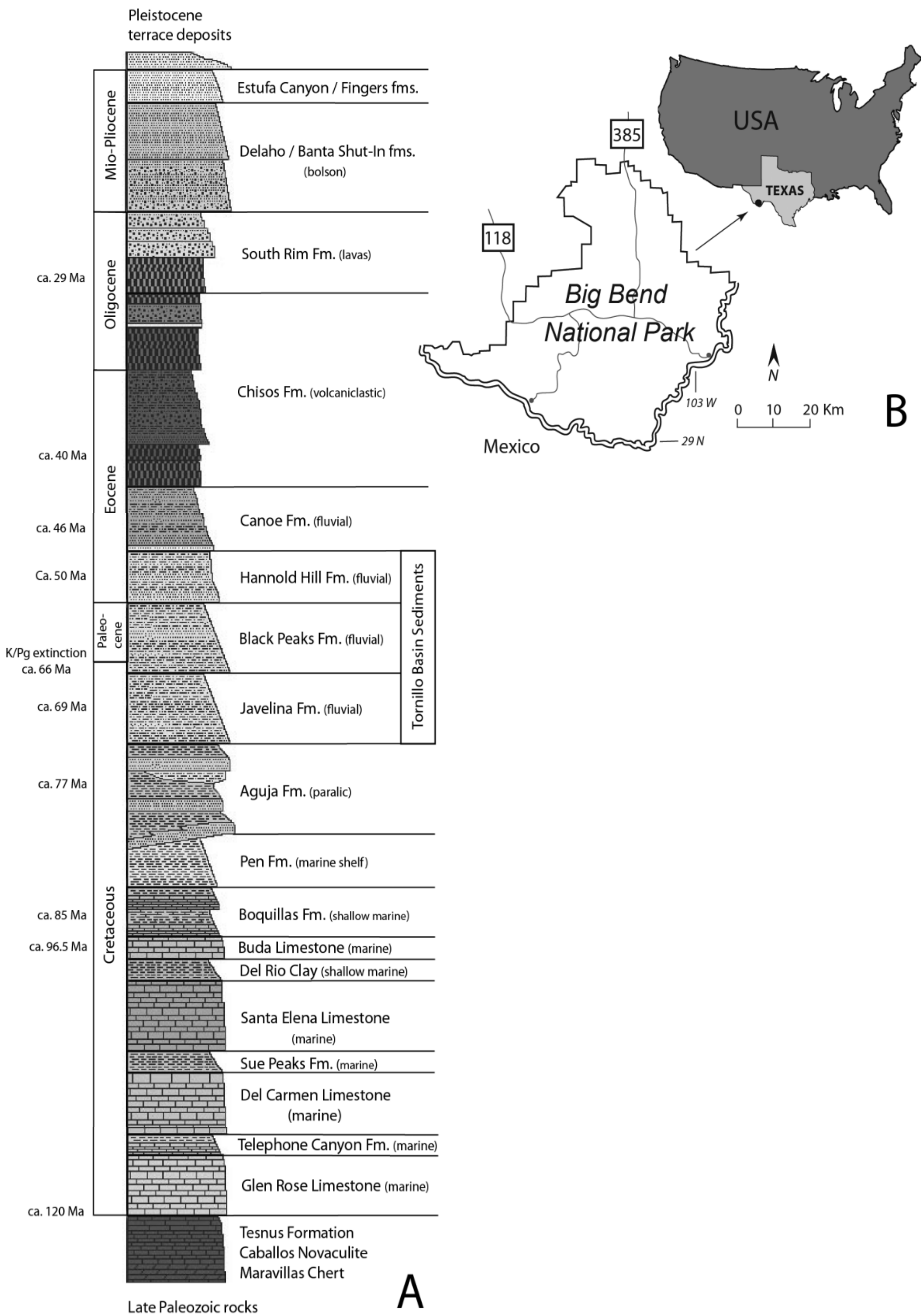

Figure 1. Generalized stratigraphic column (**A**) exposed within Big Bend National Park, Texas, USA (**B**). Approximate absolute stratigraphic ages are based upon biostratigraphic and radiometric information from multiple sources (Maxwell et al. 1967; Lehman et al. 2006; Befus et al. 2008; Tiedemann 2010; Cooper and Cooper 2018). Chart modified from USGS (public domain).

Whether caused by climate change, disease, or the impact of a large meteor in the Yucatan of Mexico, this extinction event occurred during deposition of the Black Peaks formation in BIBE, one of the few public lands in North America which contain strata that span the Cretaceous-Paleogene (K-Pg) extinction boundary.

Paleogene system

Around 63 million years ago (Paleocene time) the dinosaurs were gone. However, ancient mammals survived the K-Pg extinction event (as did avian dinosaurs – the birds) and began to evolve on the ancient river floodplains in BIBE. Although this was the same river system which originated millions of years earlier during Javelina Formation time, the Rocky Mountains continued their unrelenting uplift (e.g., Lehman 1986; Blakey and Ranney 2018). Therefore, the fluvially-derived Black Peaks Formation continued to be deposited even further inland as the sea continued its slow retreat to the east. Bright maroon and somber grey/black 'candy-striped' paleosol (ancient soil) horizons characterize this portion of the Black Peaks section and signal a time when silty, fluvial muds were deposited on a stable, well-developed inland floodplain (Lehman et al. 2018). Huge trees that lined these sandy drainages and were often undercut by the currents, causing them to topple into the river where they became oriented to the paleocurrent direction (now informally called the "log jam sandstone" interval of the Black Peaks). The fossils of these trees show no growth rings, whereas those from the surrounding floodplain (conifers) do have them (Wheeler and Lehman 2005; 2009). This circumstance suggests that the climate afforded constant growth for only those trees along the river and that others went seasonally dormant as rainfall became scarce. Mammals thrived; however, they were small during this time with the largest being only the size of a medium- to small-sized dog.

55 million years ago during early Eocene time, the Tornillo Basin continued to aggrade with fluvial sediments of the Hannold Hill Formation in BIBE (Maxwell et al. 1967; Beatty 1992) (Fig. 1). These deposits consisted of coarser sands deposited in higher gradient river channels. The bright purple and peach-colored paleosol horizons we see now are today's expressions of the confined, muddy overbank deposits emplaced during deposition. Interestingly, some Hannold Hill exposures exhibit striking evidence for compressional deformation during deposition (Lehman and Busbey 2007) which records the final "push" of the Laramide Orogeny in Big Bend as well as the conclusion of basinal development within BIBE. As a result, the Hannold Hill Formation is limited to the northeast portion of the park as the Tornillo Basin, by this time, was almost completely infilled elsewhere by fluvial deposits. At long last, the ancient river system which had long coursed through the basin had reached its closing stages. Paleogene time saw an explosion of new species; mammals diversified in BIBE and became larger (e.g., Wilson 1967).

During mid-Eocene time (about 46 million years ago), the Laramide Orogeny had almost reached its culmination and the Big Bend region was now elevated several thousand feet. Erosion then became the dominant regime, stripping away much of the Hannold Hill, Black Peaks, Javelina, and Aguja formations throughout BIBE and surrounds. All of these strata (as well as the fossils preserved within) might have been lost. However, what remained of them was then covered by deposits laid down by a new river system that developed atop the ancient, infilled basin. As a result, sediments of the Canoe Formation were laid down unconformably on the previously eroded surface. These new rocks were made up of thick fluvial channel sands and gravels (the Big Yellow Sandstone in the park) as part of a braided river system (Maxwell et al. 1967; Rigsby 1986). Mammals had flourished and were now of many types and sizes. Turtles also inhabited the new river corridor which was lined with conifers and flowering plants.

Approximately 42 million to 32 million years ago (during middle Eocene to early Oligocene time) Big Bend experienced a strikingly different depositional regime as widespread volcanism commenced. Strata deposited during this time differ markedly across the region as the result of the changing loci and composition of various igneous intrusions, lavas, ash-falls, as well as the fluvial volcaniclastics derived from them via weathering (Maxwell et al. 1967). Within BIBE, these deposits became the Chisos Formation, a colorfully diverse collection of tuffs, conglomerates, fluvially re-worked ash deposits, stream channel sandstones, and variegated mudstones situated between ensembles of extrusive lavas (e.g., the Alamo Creek Basalt). Portions of the Chisos Formation are locally fossiliferous whereas others are completely devoid of fossils. It is generally believed that the volcanism involved here was subduction-related and that a temporary shallowing of the angle of subduction of the Farallon plate (descending eastward, below the western edge of North America) resulted in the emplacement of various plutons and volcanoes far inland from the margin of subduction along western North America. Because of their complexity, these deposits are named differently in different areas (e.g., Canoe and Chisos formations within BIBE and Devil’s Graveyard Formation outside of the park to the northwest) (e.g., Maxwell et al. 1967; Wilson and Runkel 1989). Whatever the case, similarities involving their geologic makeup and fossil evidence suggest that these formations are broadly coeval. Although the Devil’s Graveyard Formation is very fossiliferous, these taxa were not included in the present catalog as that formation does not crop out within the park.

During early Oligocene time (around 32 to 26 million years ago), volcanism continued with a series of eruptions in what is today BIBE (Maxwell et al. 1967; Lehman and Busbey 2007). Higher in section, the un-fossiliferous South Rim Formation (along with the so-called “Burro Mesa” Formation of Turner et al. 2011) capped the Chisos Formation with a series of thick, brightly colored rhyolitic lavas which are particularly striking along the Ross Maxell Scenic Drive in the western part of the park. The Chisos Mountains within BIBE were fully formed by this time and, along their flanks, new and even larger mammals replaced older forms. Volcanic deposition in the region ended some 26 million years ago (Henry et al. 1989). As a result, erosion again resumed.

Neogene system

By the end of Oligocene time (around 20 million years ago), the Rocky Mountains stood in bold relief above the western plains. Compressional stresses involved in mountain-building finally eased across the North American continent resulting in a ‘relaxation’ of continental crust. As a result of this trans-continental stretching, rift zones developed which, over time, allowed large bodies of rock to slide downward along active faults, producing a horst-and-graben topography. This created the North American, Basin and Range Province which spans southern Canada to northern Mexico including Big Bend. The Big Bend region saw the development of several grabens and resultant bolsons including one within the central part of today’s BIBE (from the Sierra del Carmen to the east to the Mesa de Anguila to the west). This graben formed a “sunken block” of strata, down-dropped several thousand feet by faulting (Maxwell et al. 1967; Lehman and Busbey 2007). As a result, two half-bolsons formed in BIBE (one on either flank of the eroding Chisos Mountains): the Delaho Bolson in the west and Estufa Bolson in the east (Stevens and Stevens 1985, 1989). During Miocene and Pliocene times, these bolsons slowly aggraded with alluvium and colluvium transported in streams and deposited as alluvial fans along the flanks of the nearby eroding Chisos Mountains. These coarsely-laminated sands and gravels formed today’s Delaho and Banta Shut-In formations. On the Maxwell et. al, (1967) geologic map of the park, these bolson-fill deposits were mapped collectively as Quaternary/Tertiary “old gravels” (abbreviated thereon as QTog). Portions of these alluvial fans supported intermittent faunal communities comprised of mammals such as early camels, skunks, and carnivores, as well as turtles, lizards, and amphibians.

Eventually, similar bolsons throughout west Texas were infilled and subsequently linked by the Rio Grande (achieving through-flow to the Gulf of Mexico only within the last 2 million years or so). Once established, the downcutting Rio Grande and its tributaries (forerunners of today’s Terlingua and Tornillo creeks within BIBE) largely gutted the infilled bolsons during Pleistocene time leaving only remnants of them today. The Rio Grande is the youngest major river system in the United States and continues to serve as the principal erosional conduit in the region.

Geologic formations within Big Bend National Park: a primer

The geologic formations within BIBE vary widely regarding composition, thickness, depositional environments, and fossil content. However, many are fossiliferous. Many formations exposed within the park also crop out on private lands just outside of its boundaries and so some fossils from just outside the park are also included here as well. In general, older, Late Cretaceous open marine carbonate strata are separated by unconformities representing relatively brief geologic intervals. Younger, Late Cretaceous (marine shelf) strata generally grade conformably into, and sometimes intertongue with, broadly coeval terrestrial rocks. These deposits then grade conformably into overlying Paleocene strata. Some localized unconformities are present in some strata (e.g., the Aguja/Javelina formations contact) as the result of penecontemporaneous erosion (i.e., stream downcutting which occurred simultaneously with overbank deposition in some areas), but these minor depositional gaps generally do not represent geologically significant intervals. Significant erosion of Cretaceous and Paleocene strata did occur as the result of Laramide uplifting in Eocene time however these eroded deposits were then covered by even younger fluvial deposits, volcaniclastics, and extrusive rocks. Basin and range development along with continued erosion of the Chisos Mountains volcanic complex initiated yet another period of deposition which resulted in infilling of the surrounding bolson. Despite the presence of unconformities, many of the strata within the park and immediate surrounds preserve a relatively continuous, 135 million-yearlong depositional sequence. The following formations are arranged in stratigraphic succession (low to high) (Fig. 1).

Paleozoic Era

Maravillas Chert (Baker and Bowman 1917)

Ordovician, marine, around 50 m thick. The Maravillas was deposited in a deep-water, basinal environment (Turner et al. 2011). The formation is exposed along the northern margins of the park northward (Persimmon Gap and Dog Canyon areas within BIBE) and is convolutedly deformed in some areas by pre- and post-Cretaceous thrusting. The formation contains dark brown/blackish cherts and thin conglomerate lenses, and a few limestone beds Fossils from BIBE include graptolites, brachiopods, bryozoans, and conodonts. Extensive deformation and poor exposures make sectional thickness measurements and definition of individual members within BIBE difficult.

Caballos Novaculite (Udden et al. 1916)

Silurian–Devonian, marine, only 20 m thick. The origin of both the novaculite and chert members leads to contrasting interpretations of water depth during deposition (e.g., Folk and McBride 1978). This formation contains chert and silicious shale with thin but conspicuous, white novaculite beds. The unit is modestly exposed near Persimmon Gap near the entrance of the park however no fossils have been reported from BIBE.

Tesnus Formation (Udden et al. 1916)

Mississippian – Pennsylvanian, marine, variably thick from 15–200 m. Deep-water sediments, thin to thickly bedded sandstone and dark gray, brown, and black shale. Several small outcrops are situated in the northernmost part of BIBE. No fossils have been collected from the park however nearby areas have produced conodonts, foraminifera, and a few Pennsylvanian Period plant fossils (King 1937).

Mesozoic Era – Lower Cretaceous (Comanchian Series)

Glen Rose Limestone (Hill 1891)

Marine, massive, about 100–150 m thick. Primarily a massive limestone but contains clay, minor sandstone, marl, and conglomerate deposited in near-shore tidal and sub-tidal marine environs (Maxwell 1967; Busbey 1989). This unit is exposed in several areas of BIBE including Persimmon Gap and Dog Canyon in the north, Marufo Vega trail in the southeast and Santa Elena Canyon in the southwest (Turner et al. 2011). These outcrops are generally exposed in areas which have been subjected to Cretaceous Laramide folding and/or the development of horst and graben structures emplaced during Miocene time. Invertebrate fossils include ammonites, oysters, gastropods, and echinoids. Rarely, dinosaur fossils have been found elsewhere in Texas from this formation (Upchurch et al. 2004). Although dinosaur trackways are somewhat common in the Glen Rose of Texas (e.g., Bird 1985) none have been reported in BIBE. However, several theropod dinosaur tracks are preserved along the Rio Grande in the Glen Rose Formation of Mexico just east of the park within the lower canyons (photos shown to the author by D. Corrick, BIBE Geologist).

Telephone Canyon Formation (Maxwell et al. 1967)

Marine, generally 20–45 m thick. Lagoonal sediments (Busbey 1989) containing thin nodular limestone with marl beds This formation can be seen in several areas of BIBE including Heath Creek, along the Marufo Vega Trail in the east, and Santa Elena Canyon in the southwest where folding and faulting have exposed it (Turner et al. 2011). Common invertebrate fossils in this formation include gastropods, oysters, and echinoids. Ammonites have also been reported.

Del Carmen Limestone (Maxwell et al. 1967)

Marine, massive, from 100–150 m thick. Open lagoon, tidal flat, and rudistid biostromal facies (Busbey 1989). Generally, a massive, dense limestone with abundant rudistids. This karstic formation also contains lenticular cherts and minor marl beds. Within the park, it is exposed in areas of tectonic folding and faulting such as Santa Elena Canyon in the southeast and Marufo Vega Trail, and Sierra del Caballo Muerto in the east (Turner et al. 2011). Typical invertebrate fossils include bivalves and gastropods although recovery of them from the hard matrix is difficult which makes their identification problematic.

Sue Peaks Formation (Maxwell et al. 1967)

Marine, around 25–30 m thick. Transgressional marine sediments containing shale, marl, thin nodular limestone ledges (Maxwell 1967; Busbey 1989). The formation is exposed in eastern and southwestern areas of the park including portions of the Sierra del Carmen, as well as Santa Elena Canyon where faults and folding have exposed it. Common invertebrate fossils include oysters, echinoids, gastropods, and numerous types of ammonites.

Santa Elena Limestone (Maxwell et al. 1967)

Marine, massive, up to 225 m thick. Open shelf carbonate environments (Busbey 1989). The Santa Elena is a massive, karstic limestone, hard, with some finely crystalline bedding along with nodular chert masses. Upper portions of this formation contain massive limestones with interbedded marls that weather to form a terrace-like topography. The formation can be found in eastern and southwestern parts of the park (and surrounds) such as the Sierra del Carmen, Santa Elena Canyon, and Sierra Ponce where faulting and folding have exposed it (Maxwell et al. 1967; Turner et al. 2011). Common invertebrate fossils include rudists with other pelycopods and gastropods being uncommon.

Del Rio Clay (Hill and Vaughn 1898)

Marine, fissile, around 1–35 m thick. A regressive marine environment facilitated development of this shaly, shallow-water facies (Busbey 1989). This formation consists mostly of claystone with interbeds of limestone and friable sandstone. It is exposed in the eastern and southwestern portions of the park including Mesa de Anguila, Dog Canyon, Alto Relex, and Sierra del Caballo Muerto (Turner et al. 2011). Invertebrate fossils include oysters, echinoids, and gastropods.

Buda Limestone (Vaughan 1900)

Marine, 20–30 m thick. Shallow, inner-shelf environment. This formation primarily crops out in eastern, southern. and southwestern areas of the park such as Dog Canyon, Dagger Mountain, Mariscal Mountain, and Mesa de Anguila (Turner et al. 2011). Invertebrate fossils are rare in finegrained limestones and more common in marls including echinoids, gastropods, and bivalves. West of the park along route 170, the Buda/Boquillas limestone contact interval harbors the typical reddish tint of cinnabar.

Mesozoic Era – Upper Cretaceous (Gulfian Series)

Boquillas Formation (Udden 1907)

Marine, massive to shaley, from 220–245 m thick. Foraminiferal limestone and shale deposited in relatively shallow, open marine (platform) conditions (Lehman 1989b; Cooper et al. 2017).

This formation contains two members including the lower Ernst Member and upper San Vicente Member (Maxwell et al. 1967). The Ernst Member contains silty limestone flags, siltstone, and calcarious clay while the San Vicente Member contains chalk, marly clay, and shale. It is exposed widely in the park in areas such as San Vicente, Hot Springs, Mariscal Mountain, McKinney Hills and Mesa de Anguila (Turner et al. 2011). The Boquillas Formation is very fossiliferous. Fossils include invertebrates such as cephalopods, bivalves, and echinoids as well as a few vertebrate fossils from mosasaurs, fish, and sharks. Even soft-bodied organisms (squids) have been discovered in the Boquillas.

Pen Formation (Maxwell et al. 1967)

Marine shelf, 70–200 m thick. Calcareous clay shale and chalky limestone with concretionary intervals. The Pen Formation was deposited upon a shallow marine shelf. This unit also includes a westerly-thinning wedge of dark gray marine shale within the overlying Aguja Formation (e.g., Lehman 1985). This formation is widely exposed in the park in areas such as San Vicente, Mariscal Mountain, Maverick Mountain and the McKinney Hills (Turner et al. 2011). Invertebrate fossils include echinoids, bivalves, gastropods, and ammonites. Vertebrate fossils are uncommon but include fragmentary sharks, fish, and mosasaurs. However, shed shark teeth and fish vertebrae are common throughout the formation. Rarely, reworked dinosaur bones (resulting from floods washing carcasses seaward) are also encountered (pers obs. by the author).

Aguja Formation (Adkins 1933)

Originally named “Rattlesnake Beds” by Udden (1907), these strata were later re-named the Aguja Formation as the previous name was already in use elsewhere. Nearshore marine, deltaic, and continental facies including paralic, estuarial, and coastal marsh and swamp deposits (Maxwell et al. 1967; Lehman 1985), 120–280 m thick. The coastal Aguja Formation records fluctuating periods of marine transgression and shoreline progradation. Transgressive and regressive marine Aguja facies include thicker, well-indurated marine sandstones, poorly developed coals, lignitic shales, and thin cross-bedded fluvial channel sandstones. The upper part of the formation contains coastal floodplain mudstones; some with incipient paleosol development. The Aguja Formation is widely exposed in BIBE in areas such as Dawson Creek, Rattlesnake Mountain, San Vicente, and McKinney Springs (Turner et al. 2011).

Some facies within these units are very fossiliferous while others are not. Plant fossils are locally abundant in the Aguja Formation. These usually include fossilized woods from conifers, palms (monocots), and flowering plants (dicots). Rarely, tree stumps are found upright, situated in their original growing positions. Fossil leaves have been found in a couple areas preserved as carbonate films within mudstone horizons or, in one area, as impressions within reworked volcanic ash. This ash bed and its fossils are currently under study by the author

(S.W.). Aguja invertebrate fossils include bivalves, gastropods, cephalopods and rarely, crustaceans. Trace fossils from some of these taxa are also relatively common (e.g., Ophiomorpha burrows).

Occasionally, vertebrate fossils (and microfossils) are also found at various stratigraphic intervals in strata representing numerous environs. Taxa include sharks, fish, turtles, crocodilians, as well as dinosaurs among other reptiles. Very rarely, small fossil mammals are encountered (mostly teeth) as are dinosaur eggshell fragments. The vertebrate fossil assemblage of the Aguja Formation is the most inclusive of its kind reported from southernmost North America.

Javelina Formation (Maxwell et al. 1967)

Continental, 100–190 m thick. The formation can be found along the flanks of the Chisos Mountains and is well exposed along the drainages of Tornillo, Terlingua, and Dawson creeks, as well as Rough Run (Turner et al. 2011). This formation contains facies from inland floodplain environs. Sedimentary strata include well-cemented fluvial sandstones, rhythmically-bedded lacustrine deposits, and floodplain mudstones – some containing fairly well-developed paleosol and paleocaliche horizons (Lehman et al. 2018). Generally, fossils are uncommon throughout this formation; however, several discreet areas (and representative habitats) are quite fossiliferous (e.g., Lehman and Langston 1996). Fossil wood is common in the Javelina Formation and includes fossils from fan palms as well as conifers and flowering plants. Abundant prone fossil logs can be found along a few stratigraphic horizons while others harbor stumps in their original growing positions. Invertebrate fossils are very rare but include fresh-water gastropods and crustacean burrows.

Isolated, broken vertebrate fossils are somewhat common within scree along deflated surfaces atop fluvial sandstone hogbacks but are also found in-situ at local intervals within overbank mudstones. Vertebrate fossils include those from fish, turtles, pterosaurs, dinosaurs, and small mammals (represented mostly by teeth). Vertebrate fossils usually occur as isolated, fragmentary bones. However, a few dinosaur skeletons have been found partially articulated or with bones in close association. Although typically well-preserved, Javelina Formation fossils are seemingly not as numerous as those of the underlying Aguja Formation. As such, I surmise that the paralic Aguja environment favored a greater variety (and populations) of vertebrate species and/or the paralic environment was more conducive the burial and preservation of remains. Lehman et al. (2006) obtained a radiometric date of around 69 Ma. for the middle of the formation.

Black Peaks Formation (Maxwell et al. 1967) – Cretaceous interval

Continental, around 40 m thick (widely variable) (e.g., Lehman et al. 2018). The Black Peaks Formation contains inland flood plain deposits with interstitial fluvial sandstones. The formation is exposed widely in BIBE especially near Grapevine Hills, Dogie Mountain, and Tornillo Flat. Paleosols are sometimes well developed, appearing as somber red and black bands which are, in places, interrupted stratigraphically by fluvial sandstones. The bottom third of the formation is Cretaceous in age. Plant fossils present in the lower Black Peaks Formation including conifers and flowering plants. Invertebrate fossils are virtually unknown; however, freshwater crustacean burrow structures have been observed. Vertebrate fossils are uncommon in this portion of the formation but include those of fish, reptiles, as well as dinosaurs (especially those of the huge titanosaur Alamosaurus). Usually, vertebrate fossils are found isolated, weathering out of fluvial channel sandstones. Rarely, associated dinosaur bones have been located eroding from overbank mudstones.

The Cretaceous-Paleogene (K-Pg) boundary is situated in the lower third of the Black Peaks Formation although its exact stratigraphic position remains obscure. It has been defined within a two-meter section near the Grapevine Hills (Lehman and Coulson 2002). However, it has not been this well-defined elsewhere in BIBE (see discussion in Lehman et al. 2018, p. 2225). It is possible that there was a depositional hiatus during the K/ Pg time interval and that the K/Pg boundary is only preserved in very localized lenses of deposition (if at all) within the park.

Cenozoic Era – Paleogene (Paleocene Series)

Black Peaks Formation (Maxwell et al. 1967) – Paleogene interval

Continental, up to 400 m thick (widely variable). The Black Peaks Formation straddles the K-Pg boundary. The Paleogene portion of the formation contains inland floodplain deposits with thick, fluvial sandstones. It is exposed near Dogie Mountain, Grapevine Hills, and Tornillo Flat (Turner et al. 2011). Paleosol horizons are often striking, appearing maroon, black or somber gray sometimes with interstitial, tan fluvial channel sandstones. Paleosols within the Cretaceous, Aguja and Javelina formations are often poorly developed. However, they become increasingly better developed higher in section with the Black Peaks having the most conspicuous forms. Typical vertebrate fossils include garfish, turtles, and mammals.

Plant fossils (mostly conifers) are rarely found in the lower part of the formation but are more common higher in section. Two, closely-space stratigraphic intervals of very large fossil dicot logs (Paraphylanthoxylon) in the middle portion (Torrejonian-Tiffinian) of the Black Peaks section (informally called the “log jam sandstone”) suggest the post K-Pg resurgence of trees during this time. This fossil log horizon is conspicuous in many areas of the park and is a useful stratigraphic marker (Lehman et al. 2018).

Cenozoic Era – Paleogene (Eocene Series)

Hannold Hill Formation (Maxwell et al. 1967)

Continental, varies from around 30 to 70 m in thickness (e.g., Lehman et al. 2018). This relatively thin formation is very limited in area with all known outcrops in the Tornillo Flat region of BIBE and represents the final infilling of the Tornillo Basin (Turner et al. 2011). The inland floodplain formation contains variegated mudstone-dominated facies along with coarse fluvial sandstones and conglomerates. Vertebrate fossils include those from several mammalian taxa. The fossil bone exhibit in BIBE is situated atop fluvial channel sandstones of the Hannold Hill Formation (Exhibit Ridge Sandstone Member) where numerous specimens of Coryphodon were excavated and displayed as part of the park's original Fossil Bone Exhibit.

Canoe Formation (Maxwell et al. 1967)

Continental (upland), up to 350 m thick. This formation is exposed in the north-central portion of BIBE especially on Tornillo Flat (Turner et al. 2011). It contains rocks from a sandy, braided fluvial system with associated flood plain deposits (e.g., Rigsby 1986; Runkel 1988) which rest unconformably on the Hannold Hill Formation. Thick sandstones and conglomerates comprising the conspicuous Big Yellow Sandstone Member are present in the lowest part of the Canoe Formation with gray and variegated mudstones situated a bit higher in section. These paleosol horizons (along with interstitial sandstones and tuffaceous mudstones) make up a large portion of the Canoe Formation section above the Big Yellow Sandstone.

Vertebrate fossils are widespread within the formation in BIBE as well as areas northwest of the park in the Devil's Graveyard Formation which is temporally coeval with the Canoe Formation (e.g., Runkel 1988). The reader is cautioned that the Devil's Graveyard Fm. is not exposed within the park so its reported taxa are not included herein. Vertebrate fossils in the Canoe include those from mammals, turtles, and crocodilians. Fossilized wood is also common in the Big Yellow Sandstone including not only Eocene conifers and dicots but reworked and abraded, fossilized Cretaceous wood fragments exhumed during entrenchment of the younger, Eocene fluvial system. A striking example of its fossil ensemble includes a dense 'forest' of at least 92 fossil tree stumps in their original growing position observed by the author near the McKinney Hills. Whether these represent conifers or dicot trees is not yet known. However, these stumps (~10 to 15 cm in diameter) are the remains of smaller trees that apparently grew on islets within the confines of the braided fluvial corridor.

Cenozoic Era – Paleogene Period (Late Eocene and Oligocene Series)

Chisos Formation (Udden 1907)

Continental (upland), from 500–700 m thick. The Chisos Formation is exposed in many areas of BIBE along the flanks of the Chisos Mountains (Turner et al. 2011). This widely variable formation contains lavas, tuff, tuffaceous sandstone, clay, and conglomerates. Vertebrate fossils include turtles and large mammals while invertebrates include fresh-water gastropods and snails). Fossil wood is present but not common.

South Rim Formation and "Burro Mesa" Formation (Maxwell et al. 1967; Turner et al. 2011, respectively)

Please note that the Burro Mesa Formation is not considered valid by all researchers and so both are included together here. Continental (volcanic), from 300–500 m thick. These typically massive, volcanically-derived strata are exposed in the central and southwest portions of BIBE in the Chisos Mountains and near Burro Mesa. They contain lavas, flow breccias, conglomerates, tuff, and tuffaceous sediments from various localized eruptive events and are apparently non-fossiliferous.

Neogene (Miocene Series)

Delaho Formation (Stevens et al. 1969)

Continental (bolson deposits), up to 300 m thick. The formation is exposed on the west side of BIBE near Castolon (Lehman and Busbey 2007; Turner et al. 2011). Originally identified by Maxwell et al. (1967) as 'older gravels', the Delaho has two members including the lower member and Smokey Creek Member. These contain pink friable sandstone and gray conglomerate representing mid and distal alluvial fan deposits that accumulated in a fault bounded basin in the western half of BIBE (the Delaho Bolson). Vertebrate fossils include those from small and large mammals as well as from several reptiles including a unique Gila monster.

Banta Shut-In formation (informally proposed by Stevens and Stevens 1985)

Continental (bolson deposits), up to 150 m thick. This formation is exposed in the east-central portion of BIBE near Banta Shut-In. These include pink fine-grained sandstone, siltstone and red mudstone which represent distal alluvial fan facies in the eastern half of BIBE (Estufa Bolson). Vertebrate fossils include amphibians, reptiles, and mammals (including those from canids, camels, and primitive horses). This formation is exposed in areas along Tornillo Creek that are not easy to reach and it is likely that its fossiliferous nature has yet to be fully realized.

Neogene (Pliocene – Pleistocene series)

Fingers and Estufa Canyon formations (informally named by Stevens and Stevens 1989)

Continental (bolson deposits), variably thick up to 300 m. These formations are exposed in the western portion of BIBE near Sotol Vista and along the flanks of Tornillo Creek east of Dugout Wells and consist mostly of bolson deposits. They were originally identified as 'older gravels' by Maxwell et al. (1967) and consist of proximal alluvial fan facies which overlie the Delaho and Banta Shut-In formations (Turner et al.2011). Primarily these contain larger sand and gravel clasts eroded relatively recently from the volcanic and plutonic rocks of the Chisos Mountains. However, they also contain scree from Paleozoic and Late Cretaceous strata exposed along the margins of the ancient bolson. The fingers and Estufa Canyon formations represent the youngest deposits within the Delaho and Estufa bolsons and have yet to produce fossils.

Pleistocene terrace deposits and grottos

Thin alluvial gravels, sands, silts, caliche-cemented silts, small dune fields harboring a variety of localized cut-and-fill structures and small head-cutting drainages harboring a variety of finely to poorly sorted rock types. These thin deposits form desert pavement atop alluvial terrace remnants where aeolian erosion and sheet-wash have often removed finer sediments (Turner et al. 2011). Fossils from the Pleistocene of BIBE are almost unknown at present however mammoth teeth have been found within a caliche deposit in BIBE near Grapevine Spring which may represent the former location of a Pleistocene ciénega during the most recent glacial age (see Maxwell et al. 1967, p. 154 for a photo of the in-situ teeth).

Numerous cliffside grottos can be also found throughout BIBE. Of interest is the discovery within one of these near Mule Ears Peaks of remains pertaining to California condors which no longer live in the Big Bend region. Whether these remains are truly fossils or not is debatable. However, they are estimated to be thousands of years old (Wetmore and Friedmann 1933).

Fossil taxonomic lists: methods

'Taxonomy' is the scientific study of naming, defining, and classifying groups of biological organisms based on shared or differing morphological characteristics. The following taxonomic lists were compiled from hundreds of reliable sources. These included peer-reviewed scientific reports, graduate-level academic studies (e.g., Ph.D. dissertations and Master's Theses), field trip guidebooks, scientific abstracts, as well as verifiable first-hand accounts (current research) reported to the author by qualified researchers. In the interest of compiling a comprehensive taxonomic catalog of fossils from Big Bend National Park (and immediate surrounds), all reported taxa are included. This distinction is important because, in some cases, a species reported decades ago may have more recently been taxonomically re-classified differently as something else. As a result, some older taxa may no longer be valid and/or a few may be recorded twice as the result of different taxonomic interpretations. In other cases, taxa may be listed multiple times with varying degrees of certainty (e.g., sometimes with a question mark or designated as a possible new species – see below). These are all included in the present report as they may represent more than one species. This circumstance serves to illustrate our constantly changing understanding of how species relate to one another.

The taxonomic lists presented here are organized alphabetically within classes of the Linnaean taxonomic classification system. Their common names are also provided as well. This serves to simplify the identification and listing of each species (from the perspective of interpretation) and allows for the convenient addition of future data within each table. This simplified method was chosen because taxonomic groupings at family-level (and below) often complicate matters to the point of utter confusion for non-scientists – especially as classification systems and taxonomic relationships are revised when new information comes to light.

Furthermore, additional taxa have been added to the original catalog produced by Wick and Corrick (2015) given that new discoveries have occurred since that time. For example, new taxonomic information was included by the author as late as September 2021 as the result of his ongoing (preliminary) research involving boney fishes from the Aguja Formation. However, although the present catalog is an exhaustive listing of taxa, it likely does not include absolutely every fossil species known from BIBE. Certainly, some discoveries have yet to be formally recorded (for example, the author and his colleagues have several works in progress), or some species may have been presented in older, more obscure, and/or unpublished contexts such as field trip guides and/or scientific abstracts and academic poster sessions. As such, some species have likely been missed during the literature survey. However, there are around 1400 different fossil species listed in this catalog alone.

These lists also embrace the 'morphotype concept' of taxonomy and is used so that scientists can communicate with each other more effectively. For example, different types of plant fossils from a single taxon are often named differently because that plant species may be expressed in the paleontological record by multiple fossil morphotypes (such as fossil wood, leaf impressions, and/or pollen). From this example, unless all three types of plant fossils are found in close association, each type of fossil cannot be conclusively determined to pertain to the same plant species. Hence, each form is given its own name until a direct association can be confirmed. As such, a single plant species may unknowingly be represented here by more than one morphotype (and scientific name). Also included in these lists are non-body fossils (such as crustacean burrows and dinosaur eggshell fragments) produced by a living organism. These are also classified and named using the morphotype concept since they do not represent the actual fossilized remains of a particular animal, but only the preserved evidence of its lifeway.

Also included are the formations in which the fossils occur as well as the original (or significant) publications in which they were reported. Because commonly encountered species (e.g., various sharks among others) are mentioned in numerous reports, it is simply impractical to include every reference for many of these commonly reported species. It is, therefore, up to the reader to use the listed sources as springboards for further research. Problematic taxa and /or references indicated by an asterisk are discussed at the bottom of each list.

Finally, the reader needs to be aware that the author of the present work did not make any of the taxonomic interpretations for a particular species listed herein unless (as in a few cases) he actually authored one of the referenced papers. Among the names of the species listed herein, the reader will sometimes see various abbreviations associated with them. The applications of abbreviations such as these are standard practice among taxonomists (e.g., see Bengston 1988) and were assigned by the various authors of the referenced works and serve to indicate that they had some doubt regarding their taxonomic assignment of a particular species. This doubt may have resulted from a specimen being broken or incomplete, being obscured by rock, or the fact that it exhibits some morphological variation compared to others of its kind. For example, the use of "cf." before a species name indicates that a particular author felt that a particular specimen "compared favorably" enough to the listed species to suggests that it likely pertains to it. On the other hand, the term "aff." suggests that although a specimen has "affinities" to particular taxon, it is different enough that it may, in fact, represent a different, closely related species. Question marks are also sometimes used immediately before a specie's name to indicate even more doubt. In any case, a number of specimens listed here represent new genera and/or species that were deemed by the various authors of the referenced works as potentially being new (or potentially new) to science (e.g., those designated with n. gen and/or n. sp. in the taxonomic tables). These species are indicated immediately after their listed names in the following manner: 1) formally published new species (scientifically valid holotypes) are designated by a black dot; 2) specimens that are likely new to science (but have yet to be formally named) are designated by a cross; and 3) specimens that have been named but not published in a formal context (e.g., an unpublished Ph.D. dissertation) are designated by an open triangle. A legend to this effect is present at the bottom of each table. It is worth noting that among the many species new and potentially new to science listed here, only 44 are presently considered to be scientifically valid species (black dots). The remainder (open triangles and crosses) are not considered scientifically valid at the present time. Their inclusion in this publication was done out of thoroughness and their listings herein are not an attempt to formally validate them.

Discussion

Fossil plants (Table 1)

Since 1907, when Johan Udden first reported the occurrence of fossil wood in what would become Big Bend National Park, over 300 fossil plant taxa have been described including flowering plants (dicots), palms (monocots), conifers, tree ferns, leaf impressions, algae, palynomorphs and tree resin (amber). Because of the changing environment over time, fossil plant remains range from marine, coastal, and inland varieties spanning a diverse range of paleohabitats. Numerous type specimens (nine) have been formally described with several others having been recognized but not yet reported. Two-thirds of the fossil plant species reported from BIBE pertain to palynomorphs (e.g., pollen, spores, fungi, etc.).

Although fragmentary fossil wood specimens are observed within many continental strata in BIBE, they are uncommon or absent in most locations. However, a few horizons produce spectacular fossil logs, sometimes by the dozens (Lehman et al. 2018). The fossils within these assemblages normally occur as prone trunk segments up to several meters in length and up to three meters in diameter. In some areas, dozens of fossil trunks can be observed holding up small ridges within mudstone-dominated flats or protruding from fluvial sandstone horizons. In rare occurrences, stumps are preserved intact in their original positions of growth with root buttresses splayed from their bases. Several sites of this type have multiple individuals of the same species or a combination of species forming true fossilized paleoforests (e.g., Lehman and Wheeler 2001; Lehman and Shiller 2020).

The degree of preservation involving fossil woods from BIBE ranges from those having experienced near-complete permineralization (i.e., exhibiting few visible diagnostic attributes) to those that preserve very detailed morphological features such as growth rings and cellular structure such as compression wood, parenchyma, and cross-field pitting (e.g., Wheeler and Lehman 2000, 2005). It is the latter type which is most useful from a diagnostic standpoint. This has resulted in the diagnosis of several new fossil species and provided insights into tree growth rates, sizes, and their preferred environments. Other specimens of fossilized wood are interesting from additional perspectives. In some cases, fossil woods are almost completely carbonized suggesting the occurrence of acient forest fires. In others, insect (?termite) borings and frass have also been preserved (Rohr et al. 1986). Fossil wood is widespread in BIBE and many specimens are situated near roads, trails or camping areas. From the public's perspective, they are also some of the most recognizable types of fossils in BIBE and as a result, are often reported to park management by visitors. Because they are somewhat obvious and popular, "petrified" woods also Zitteliana 95, 2021, 95–134 111 remain one of the most easily vandalized fossil types in many NPS fossil-parks which has led to the loss of valuable scientific information (Wick and Corrick 2015).

Invertebrate fossils (Table 2)

Over 500 fossil invertebrate taxa have been reported from BIBE including sponges, corals, bivalves, gastropods, ammonites, nautiloids and crustaceans, as well as a host of foraminifera. Invertebrates have been observed in many formations within BIBE from marine, brackish and freshwater facies. Five, scientifically valid type specimens have been described from BIBE and several 'new' taxa have yet to be formally reported.

Invertebrate fossils are regularly discovered in marine and brackish water facies within BIBE. Because of their abundance, form, and common occurrence along the modern shores of North America, invertebrate fossils are very popular as they are easily recognizable to park visitors of all ages. Fresh water taxa are much less common than their saltwater counterparts however they are occasionally discovered in lacustrine and fluvial deposits within some continental strata in the park. Many invertebrate fossils are preserved as steinkerns which represent the fossilized fill of a hollow organic struc-

Table 1. Fossil plants.

CLASSIFICATION	TAXON	FORMATIONS												REFERENCES
		GR	TC	DC	SE	DR	BO	PN	AG	JV	BP	HH	CN	
CYANOPHYTA														
blue-green algae	Stromatolites	X		X	X									Tarasconi 2000
ULVOPHYCEAE														
calcareous algae	*Cylindroporella* sp.	X		X	X									Tarasconi 2000
	Heteroporella sp.			X										Tarasconi 2000
	Permocalculus irenae	X		X										Tarasconi 2000
	Salpingoporella sp.				X									Tarasconi 2000
	Terquemella sp.				X									Tarasconi 2000
BRYOPSIDOPHYCEAE														
calcareous algae	*Boueina* sp.		X											Tarasconi 2000
CHAROPHYTA														
algae (oogonia)	?Charophytes Indet.									X	X			Schiebout 1970; Coulson 1998
PHAEOPHYCEAE														
brown algae	Fucales indet.					X	X							Eley 1938
	Halymenites sp.								X					Udden 1907; Eley 1938
PTERIDOPSIDA														
tree ferns	*Tempskya* sp.										X			Chang 1973
CONIFEROPHYTA														
GYMNOSPERM TREES	*Abeitoxylon maxwellii* Δ										X			Chang 1973; *Abbott 1985
	Araucariaceae indet.								X	X	X			Wheeler and Lehman 2005
	Araucarioxylon maxwellii Δ										X			*Abbott 1985
	Araucarioxylon sp.										X			Chang 1973
	Brachyphyllum sp.								X					Baghai 1998
	Coniferophyta indet.											X		Maxwell et al. 1967
	Glyptostrobus sp.								X					Baghai 1998
	Podocarpaceae indet.								X	X				Wheeler and Lehman 2005
	Sequoia sp.								X					Baghai 1998
	?*Sequoia reichenbachia*								X					Dorf 1939
	Thuyoxylon maxwellii Δ										X			Chang 1973; *Abbott 1985
	Tornilloxylon maxwellii Δ										X			Chang 1973; *Abbott 1985
MONOCOTYLEDONEAE														
PALM TREES	*Sabal bigbendense* •								X					Manchester et. al 2010
	Sabal bracknellense								X					Manchester et. al. 2010
	Sabalites ungeri (leaf impression)								X					Dorf 1939
DICOTYLEDONEAE														
ANGIOSPERM TREES	*Acalyphoxylon maxwellii* Δ										X			Chang 1973; *Abbott 1985
	Agujoxylon olacaceoides •								X					Lehman and Wheeler 2001
	Baasoxylon parenchymatosum •								X	X				Wheeler and Lehman 2000
	Baileyan Big Bend wood type I (scrambling vine)								X					Wheeler and Lehman 2000
	Bombacoxylon langstoni •								X					Wheeler and Lehman 2000
	Canarioxylon maxwellii Δ										X			Chang 1973; *Abbott 1985
	Chimarrhioxylon maxwellii Δ										X			Chang 1973; *Abbott 1985
	Cissus sp.								X					Baghai 1998
	Crataveoxylon maxwellii Δ										X			Chang 1973; *Abbott 1985
	cf. *Cunonioxylon* sp.										X			Wheeler and Lehman 2009
	Dialyantheroxylon maxwellii Δ										X			Chang 1973; *Abbott 1985
	Dicotyledoneae indet.											X		Maxwell et al. 1967
	Ericales indet.								X					Wheeler and Lehman 2009
	Gassonoxylon araliosum •								X	X				Wheeler and Lehman 2000
	Hasseltioxylon maxwellii Δ										X			Chang 1973; *Abbott 1985
	Javelinoxylon multiporosum •									X				Wheeler et al. 1994
	Metcalfeoxylon kirtlandense								X					Lehman and Wheeler 2001; Lehman and Shiller 2020
	Pachirioxylon maxwellii Δ										X			Chang 1973; *Abbott 1985
	Pageoxylon cretaceum •								X					Wheeler and Lehman 2000
	Paraphyllanthoxylon abbottii •										X			Wheeler 1991; Adams 2014
	cf. *Paraphyllanthoxylon anazasii*								X	X				Wheeler and Lehman 2000
	Platanoid wood type I (scrambling vine)								X					Wheeler and Lehman 2000
	Platanoid wood type II (scrambling vine)								X					Wheeler and Lehman 2000
	Platanoxylon sp.										X			Chang 1973
	cf. *Platinus haydenii*										X			Wheeler 1991
	Preplatanoxylon maxwellii Δ										X			*Abbott 1985
	Pycnanthoxylon maxwellii Δ										X			Chang 1973; *Abbott 1985
	Sabinoxylon wicki •									X				Wheeler and Lehman 2009
	Sloaneoxylon maxwellii Δ										X			Chang 1973; *Abbott 1985
	Vitexoxylon maxwellii Δ										X			Chang 1973; *Abbott 1985
FOSSIL LEAVES														
VARIOUS TAXA	*Ampelopis acerifolia*												X	*Lawson 1972
	Carbonized leaf impressions								X					Montogomery and Clark 2016
	Cheirolepidaceae								X					Baghai 1998
	Chloranthaceae								X					Baghai 1998
	Ficus cf. *F. tennesseensis*												X	*Lawson 1972

CLASSIFICATION	TAXON	FORMATIONS												REFERENCES
		GR	TC	DC	SE	DR	BO	PN	AG	JV	BP	HH	CN	
FOSSIL LEAVES (continued)														
VARIOUS TAXA	**"Hamamelid-like"**								X					Baghai 1998
	Laurus socialis												X	*Lawson 1972
	Monocotyledonae indet.									X				Lehman and Langston unpublished
	***Paracredneria* sp.**								X					Baghai 1998
	cf. *Persea*								X					Baghai 1998
	Platanacea								X					Baghai 1998
	Platanus raynoldsi												X	*Lawson 1972
	Podocarpaceae								X					Baghai 1998
	Rhizophoracea								X					Baghai 1998
	Taxodiaceae								X					Baghai 1998
	***Typha* sp.**												X	*Lawson 1972
	Dicot and fern leaf impressions in volcanic ash - multiple taxa under study								X					Wick in prep.
MISCELLANEOUS														
	Fossilized tree resin (amber)								X					Udden 1907; Maxwell et al. 1967
	Indeterminate fossil wood												X	Maxwell et al. 1967
PALYNOMORPHS														
SPORES, POLLEN, FUNGI, ETC.	***Alnipollenites trina***												X	*Lawson 1972
	Alnipollenites verus												X	*Lawson 1972
	Alsophiliidites kerquelensis												X	*Lawson 1972
	***Apiculatisporites* sp.**								X					Baghai 1996
	Appendicisporites prolematicus								X					Baghai 1996
	***Appendicisporites* sp.**								X					Baghai 1996
	Appendicisporites tricornitatus								X					Baghai 1996
	***Apteodinium* sp.**							X						Baghai 1996
	Arecipites microreticulatus								X					Baghai 1996
	***Arecipites* sp.**								X					Record 1988; Baghai 1996
	***Baltisphaeridium* sp.**							X	X					Baghai 1996
	Betulaceae indet.								X					Baghai 1996
	Betulaceoipollenites infrequens												X	*Lawson 1972
	Bombacacopites nacimientoensis												X	*Lawson 1972
	***Caligodinium* sp.**							X	X					Baghai 1996
	***Callialasporites* sp.**								X					Baghai 1996
	Camarozonsporites rudis								X					Baghai 1996
	***Camarozonsporites* sp.**							X	X					Baghai 1996
	***Canningia* sp.**								X					Baghai 1996
	***Cannosphaeropsis* sp.**								X					Baghai 1996
	Caryapollenites simplex								X					Baghai 1996
	***Caryapollenites* sp.**								X					Baghai 1996
	***Casaurinidites* sp.**								X					Baghai 1996
	***Ceratosporites* sp.**								X					Baghai 1996
	Cerodinium diebelii							X	X					Baghai 1996
	***Chatangiella* sp.**								X					Baghai 1996
	***Cicatricosisporites* sp.**								X					Baghai 1996
	Cicatricosporites dorogensis												X	*Lawson 1972
	***Cingulatisporites* sp.**								X					Baghai 1996
	Circulina parva							X	X					Baghai 1996
	Classopollis classoides								X					Baghai 1996
	Cleistosphaeridium polypes							X						Baghai 1996
	Complexipollis abditus								X					Baghai 1996
	***Complexipollis* sp.**								X					Baghai 1996
	Concavisporites* cf. *arugulatus								X					Baghai 1996
	***Cordosphaeridium* sp.**								X					Baghai 1996
	***Corsinipollenites* sp.**								X					Baghai 1996
	Cupuliferoipollenites pusillus								X					Baghai 1996
	***Cupuliferoipollenites* sp.**								X					Baghai 1996
	Cyathidites australis								X					Baghai 1996
	Cyathidites foveolatus								X					Baghai 1996
	Cyathidites minor								X					Baghai 1996
	***Cyathidites* sp.**								X					Baghai 1994; Baghai 1996
	Cycadopites carpentieri								X					Baghai 1996
	Cycadopites pollicularis												X	*Lawson 1972
	Cycadopites scabratus							X	X				X	*Lawson 1972; Baghai 1996
	***Cycadopites* sp.**							X	X					Baghai 1994; Baghai 1996
	***Cyclopsiella* sp.**							X	X					Baghai 1996
	Cyrilla minima												X	*Lawson 1972
	Cyrillaceaepollenites exactus								X					Baghai 1996
	Deflandrea cooksoniae								X					Baghai 1996
	Deflandrea obscura							X	X					Baghai 1996
	Deflandrea oebisfeldensis								X					Baghai 1996
	***Deflanrdea* sp.**							X	X					Baghai 1996
	Deltoidospora diaphana								X					Baghai 1996
	Deltoidospora mesozoica								X					Baghai 1996

CLASSIFICATION	TAXON	GR	TC	DC	SE	DR	BO	PN	AG	JV	BP	HH	CN	REFERENCES
PALYNOMORPHS (continued)														
SPORES, POLLEN, FUNGI, ETC.	***Deltoidospora minor***								X					Baghai 1996
	Deltoidospora **sp.**								X					Baghai 1996
	cf. *Didymoporisporonites* **sp.**								X					Baghai 1996
	Dinogymnium **sp.**							X	X					Baghai 1996
	Echinatisporites longechinus								X					Baghai 1996
	Echinatisporites **sp.**							X	X					Baghai 1996
	Engelhardtia microfoveolate												X	*Lawson 1972
	Equisetosporites multicostatus								X					Baghai 1996
	Exesipollenites tumulus								X					Baghai 1996
	Faguspollenites granulatus												X	Lawson 1972
	cf. *Foveodiporites* **sp.**								X					Baghai 1996
	Gleicheniidites senonicus								X				X	*Lawson 1972; Baghai 1996
	Gleicheniidites senonicus								X					Baghai 1996
	Gleicheniidites **sp.**								X					Baghai 1994, 1996
	Gnetaceapollenites eocenipites								X					Baghai 1996
	Granulatisporites **sp.**								X					Baghai 1994, 1996
	Gymnodinium **sp.**								X					Baghai 1996
	Hymenozonotriletes **sp.**								X					Baghai 1996
	Hyphites **sp.**								X					Baghai 1996
	hypoxylonites **sp.**								X					Baghai 1996
	Hystrichosphaera **sp.**								X					Baghai 1996
	Hystrichosphaeridium **sp.**								X					Baghai 1996
	Hystrichosphaeridium tubiferum								X					Baghai 1996
	Inapertisporites **sp.**							X	X					Baghai 1996
	Inaperturepollenites magnus								X					Baghai 1996
	Inaperturepollenites **sp.**							X	X					Baghai 1994, 1996
	Inaperturopollenites dubius												X	*Lawson 1972
	Interpollis supplingensis								X					Baghai 1996
	Intertrilites scrobiculatus												X	*Lawson 1972
	Intratrioporopollenites **sp.**								X					Baghai 1996
	Kuylisporites scutatus								X					Baghai 1996
	Kuylisporites **sp.**								X					Baghai 1996
	Lacrimasporites levis												X	*Lawson 1972
	Laevigatosporites haardti												X	*Lawson 1972
	Laevigatosporites ovatus								X				X	*Lawson 1972; Baghai 1996
	Laevigatosporites percrassus												X	*Lawson 1972
	Laevigatosporites **sp.**								X					Baghai 1996
	Leiotriletes **sp.**								X					Baghai 1996
	Leptodinium **sp.**								X					Baghai 1996
	Lilacidites dividuus								X					Baghai 1996
	Lilacidites leei								X					Baghai 1996
	Lilacidites **sp.**							X	X					Baghai 1996
	Lilacidites variegatus								X					Baghai 1996
	Liliacidites **cf. *L. complexus***							X	X					Baghai 1996
	Liliacidites **sp.**												X	*Lawson 1972
	Lusatisporis indistincta								X					Baghai 1996
	Lusatisporis **sp.**								X					Baghai 1996
	Lycopodiumsporites **sp.**								X					Baghai 1996
	Lygodiumsporites sp.								X					Baghai 1996
	Margocolporites cribellatus								X					Baghai 1996
	Margocolporites **sp.**								X					Baghai 1996
	Matonisporites **cf. *M. phelbopteroides***								X					Baghai 1996
	Michrystridium **sp.**								X					Baghai 1996
	Microretiulatasporites **cf. *M. uniformis***								X					Baghai 1996
	Microretiulatasporites **sp.**								X					Baghai 1996
	Microthyrites **sp.**								X					Baghai 1996
	Momipites **cf. *M. coryloides***								X					Baghai 1996
	Momipites **cf. *M. tenuipolis***								X					Baghai 1996
	Momipites **cf. *M. wyomingensis***								X					Baghai 1996
	Momipites coryloides												X	*Lawson 1972
	Momipites **sp.**							X	X					Baghai 1994, 1996
	Monocolpopollenites **cf. *M. magnus***								X					Baghai 1996
	Monocolpopollenites **sp.**								X					Baghai 1996
	Monoporisporites stoverii												X	*Lawson 1972
	Monosulcites **cf. *M. glottus***								X					Baghai 1996
	Monosulcites perispinosis								X					Baghai 1996
	Monosulcites **sp.**								X				X	*Lawson 1972; Baghai 1996
	Multilinaenites **sp.**								X					Baghai 1996
	Multiporopollenites **sp.**								X					Baghai 1996
	Neoraistrickia **sp.**								X					Baghai 1996
	Nyssapollenites analepticus								X					Baghai 1996
	Nyssoidites larsoni												X	*Lawson 1972
	Osmundacidites **cf. *O. wellmanii***								X					Baghai 1996
	Osmundacidites **sp.**								X					Baghai 1996

CLASSIFICATION	TAXON	GR	TC	DC	SE	DR	BO	PN	AG	JV	BP	HH	CN	REFERENCES
PALYNOMORPHS (continued)														
SPORES, POLLEN, FUNGI, ETC.	***Osmundacidites wellmanii***								X					Baghai 1996
	Ovoidites ligneolus								X					Baghai 1996
	Palaeohystrichophora infusorioides								X					Baghai 1996
	***Palaeohystrichophora* sp.**								X					Baghai 1996
	***Paleostomocystis* sp.**								X					Baghai 1996
	Palmaepollenites tranquilis								X					Baghai 1996
	Palmaepollenites* cf. *P. tranquillis								X					Baghai 1996
	***Palmaepollenites* sp.**							X	X					Baghai 1996
	Parvisacctes radiatus								X					Baghai 1996
	***Parvisacctes* sp.**								X					Baghai 1996
	***Pediastrum* sp.**								X					Baghai 1996
	***Peregrinipollis* sp.**								X					Baghai 1996
	Phelodinium magnifica								X					Baghai 1996
	Pinus haploxylon												X	*Lawson 1972
	***Pinuspollenites* sp.**								X					Baghai 1996
	***Planctonites* sp.**								X					Baghai 1996
	Plicapollis retusus								X					Baghai 1996
	***Plicapollis* sp.**								X					Baghai 1994, 1996
	Plicatopollis* cf. *C. plicata								X					Baghai 1996
	***Pluricellaesporites* sp.**								X					Baghai 1996
	***Podocarpidites* sp.**								X					Baghai 1996
	***Polyadosporites* sp.**								X					Baghai 1996
	Polycingulatisporites reduncus								X					Baghai 1996
	***Portalites* sp.**								X					Baghai 1996
	Proteacidites marginus								X					Baghai 1996
	Proteacidites molis								X					Baghai 1996
	Proteacidites retusus								X					Baghai 1996
	***Proteacidites* sp.**								X					Baghai 1996
	Proteacidites thalmanni								X					Baghai 1996
	***Pseudolasopollis* sp.**								X					Baghai 1996
	Pseudolasopollis ventosa								X					Baghai 1996
	***Psilatricolporites* sp.**								X					Baghai 1996
	***Psilatriletes* sp.**								X					Baghai 1996
	Punctatosporites major								X					Baghai 1996
	***Punctatosporites* sp.**												X	*Lawson 1972
	Rectosulcites latus							X	X					Baghai 1996
	***Reticulatosporites* sp.**								X				X	*Lawson 1972; Baghai 1996
	Retipollenites* cf. *R. confusus								X					Baghai 1996
	***Retipollenites* sp.**							X	X					Baghai 1996
	Retitricolpites florentinus								X					Baghai 1996
	Retitriletes muricatus								X					Baghai 1996
	***Retitriletes* sp.**								X					Baghai 1996
	***Retricolpites* sp.**								X					Baghai 1996
	Rhiopites globosus												X	*Lawson 1972
	Rhoipites* cf. *R. cryptoporus								X					Baghai 1996
	***Rhoipites* sp.**								X					Baghai 1996
	Rugulatisporites quintus												X	*Lawson 1972
	Sabalpollenites* cf. *convexus								X					Baghai 1996
	***Scabritricolpites* sp.**								X					Baghai 1996
	Schizaeoisporites eocaenicus								X					Baghai 1996
	***Schizoporis* sp.**												X	*Lawson 1972
	Schizosporis parvus								X					Baghai 1996
	***Schizosporis* sp.**								X					Baghai 1996
	***Seductisporites* sp.**								X					Baghai 1996
	***Septohyphites* sp.**								X					Baghai 1996
	Sphagnumsporites antiquasporites								X					Baghai 1996
	***Sphagnumsporites* sp.**								X					Baghai 1996
	Spinidinium densispenatum							X	X					Baghai 1996
	Spinidinium microceratum							X						Baghai 1996
	***Spinidinium* sp.**							X	X					Baghai 1996
	***Staphlosporonites* sp.**								X					Baghai 1996
	Stereisporites* cf. *S. crassus								X					Baghai 1996
	Stereisporites psilatus												X	*Lawson 1972
	***Stereisporites* sp.**							X	X					Baghai 1996
	***Striadiporites* sp.**								X					Baghai 1996
	***Subtilisphaera* sp.**							X	X					Baghai 1996
	***Subtrudopollis* sp.**								X					Baghai 1996
	***Syncolporopollenites* sp.**								X					Baghai 1996
	Taurocusporites* cf. *T. segmentatus								X					Baghai 1996
	***Taurocusporites* sp.**								X					Baghai 1996
	Taxodiaceaepollenites hiatus							X	X				X	*Lawson 1972; Baghai 1996
	***Tetracellites* sp.**								X					Baghai 1996
	Tetracolporopollenites manifestus												X	*Lawson 1972
	?*Tetradites* sp.								X					Record 1988

CLASSIFICATION	TAXON	GR	TC	DC	SE	DR	BO	PN	AG	JV	BP	HH	CN	REFERENCES
PALYNOMORPHS (continued)														
SPORES, POLLEN, FUNGI, ETC.	***?Tilia* sp.**								X					Record 1988
	Todisporites minor								X					Baghai 1996
	Triatriopollenites* cf. *T. pseudogranulatus								X					Baghai 1996
	Triatriopollenites* cf. *T. pseudovestibulum								X					Baghai 1996
	Triatripollenites rurensis								X					Baghai 1996
	***Triatripollenites* sp.**								X					Baghai 1996
	Tricolpites* cf. *T. reticulatus								X					Baghai 1996
	Tricolpites parvistriatus												X	*Lawson 1972
	***Tricolpites* sp.**								X				X	*Lawson 1972; Baghai 1996
	Tricolpopollenites levitas								X					Baghai 1996
	Tricolpopollenites microhenrici								X					Baghai 1996
	Tricolpopollenites micropunctatus								X					Baghai 1996
	***Tricolpopollenites* sp.**								X					Baghai 1996
	Tricolporites rhomboides								X					Baghai 1996
	***Tricolporites* sp.**								X					Record 1988; Baghai 1996
	Tricolporopollenites kruschii								X					Baghai 1996
	Tricolporopollenites* cf. *T. desultorius								X					Baghai 1996
	***Tricolporopollenites* sp.**								X					Baghai 1996
	Tricolporopollenites triangulus								X					Baghai 1996
	Triplanosporites pseudosinosus												X	*Lawson 1972
	Triplanosporites sinosus												X	*Lawson 1972
	Triporoletes novmexicanus								X					Baghai 1996
	Triporopollenites bituitus								X					Baghai 1996
	Triporopollenites coryloides							X	X					Baghai 1996
	Triporopollenites robustus								X					Baghai 1996
	Triporopollenites rugatus												X	*Lawson 1972
	***Triporopollenites* sp.**							X	X					Baghai 1996
	***Trithyrodinium* sp.**							X	X					Baghai 1996
	***Trivestibulopollenites* sp.**								X					Baghai 1996
	***Trudopollis* sp.**								X					Baghai 1996
	Ulmoideipites krempii								X					Baghai 1996
	***Undulatisporites* sp.**								X					Baghai 1996
	***Verrucatosporites* sp.**								X					Baghai 1996
	***Verrucingulatisporites* sp.**								X					Baghai 1996
	***Verrutriporites* sp.**								X					Baghai 1996
	Vitipites affluens								X					Baghai 1996
	***Vitipites* sp.**								X					Baghai 1994, 1996
	***Wilsonipites* sp.**							X	X					Baghai 1996
	Zlivisporis novamexicanum								X					Baghai 1996
	***Zlivisporis* sp.**								X					Baghai 1996
	***Zygnema* sp.**								X					Baghai 1996
	HOLOTYPE = • **UNPUBLISHED NEW TAXON = Δ** **UNNAMED NEW TAXON = o**	Glen Rose Limestone	Telephone Canyon Formation	Del Carmine Formation	Santa Elena Limestone	Del Rio Clay	Boquillas Formation	Pen Formation	Aguja Formation	Javelina Formation	Black Peaks Formation (K/Pg undifferentiated)	Hannold Hill Formation	Canoe Formation	
		Lower Cretaceous					Upper Cretaceous					Cenozoic		
MISCELLANEOUS	**Unidentified log fragments**	**FORMATIONS** **Chisos Formation (Eocene)**												Maxwell et al. 1967

* Only those formations listed in this table have produced plant fossils in BIBE.
* As it relates to Lawson (1972), the "Tornillo Formation" section containing botanicals and palynomorphs is now recognized as the lower Canoe Formation (Turner et al. 2011; T. Lehman, pers. comm.).
* M.L. Abbot passed away prior to formal submission of her unpublished (1985) manuscript (now accessioned at BIBE). Oddly, Abbott's report contains a number of new taxa (14), all with the specific epithet *maxwellii*. It is not known if all were to be named in honor of Ross A. Maxwell or if the epithet was simply a placekeeper for different specific names to be added later. Additionally, a later review of Abbott's work was conducted by E. Wheeler and T. Lehman during the course of their research on fossil woods from the park. Their findings suggest that Abbott's specimens are, in fact, different morphotypes of the same wood taxon (*Paraphyllanthoxylon*) which casts doubt on the validity of the "holotypes" presented by Abbott. However, Wheeler recognized the contributions made by Abbot and named *Paraphylanthoxylon abbotti* in her honor (Wheeler 1991). A posthumous synthesis of Abbot's work (Abbot 1986) was presented by D. Rohr (Ed.).

ture (such as a mollusk shell) that formed when mud or sediment consolidated within the structure and the structure itself disintegrated or dissolved. Many invertebrate fossils are found in Lower Cretaceous, marine carbonate rocks along the fault-scarps which flank the northeastern and southwestern margins of the park. Upper Cretaceous forms are commonly preserved along with the remains of vertebrate taxa (such as sharks and mosasaurs) in near-shore marine mudstones and marls of the Boquillas and Pen formations surrounding the Chisos Mountains and exposed just west of the park. Some invertebrates from BIBE are particularly useful as stratigraphic index fossils. These include the ammonite Allocrioceras hazzardi (Young) and the bivalve Inoceramus undulatoplicatus (Roemer) both from the shallow marine, Boquillas Formation (e.g., Maxwell et al. 1967).

The preservation of invertebrate fossils varies by formation and facies. Lower Cretaceous, marine carbonate rocks often preserve invertebrate fossils such as bivalves and gastropods, but these are often entombed in dense carbonate matrix and are very difficult to extract without damage. Microinvertebrates are also difficult to separate from these rocks and require laboratory preparation (thin section samples) to study the fossils within. Upper Cretaceous strata have produced well preserved, intact invertebrate specimens (e.g., ammonites and bivalves) which occur as steinkerns in carbonate facies or within concretionary horizons. Some are difficult to remove from bedrock while others can be quarried easily. Other bottom-dwelling invertebrates often occur in marine mudstones and shales as isolated individuals or in loose, congregated groups such as the oyster Flemingostrea pratti (Stephenson) and sea urchin Hemisaster (Desor). Occurrences of this type are often observed in horizons within marine or brackish water facies which may contain dozens of individuals which inhabited muddy estuarial bottoms. Some fossils, such as the oyster Crassostrea cusetta (Sohl and Kauffman) are often found in dense groups (formerly bioherms). Many individuals exhibit obvious warping of their shells as the result of a congested colonial lifeway. Trace fossils (e.g., burrow structures) are also routinely observed in various marine strata.

Vertebrate fossils (Table 3)

Over 250 vertebrate fossil taxa have been reported from strata within BIBE with 30 type specimens (holotypes) having been so far described. Numerous other specimens have been identified as pertaining to unique species but have not yet been formally described or named. The fossil taxa recovered from BIBE involve a variety of animals from marine, brackish, and freshwater habitats as well as many others from inland terrestrial environs. Although the park has good exposures of marine strata representing open marine environs, marine vertebrates are not well represented in the park. For example, marine rocks of the Boquillas Formation have been more productive just outside of BIBE where this formation is better exposed and more accessible; local private collectors have discovered some outstanding vertebrate specimens from these strata (e.g., Bell et al. 2013). Correspondingly well-preserved specimens pertaining to these same marine species are likely present within the park as well but have yet to be found.

Vertebrate fossils are more numerous (but still uncommon) throughout the Late Cretaceous, paralic and terrestrial strata within the park with some Late Cretaceous formations being more productive than others. However, sharks, fish, amphibians, reptiles, and mammals are well-represented in the BIBE fossil record. Most of these fossils are commonly observed as isolated fragmentary bones, many of which show some degree of damage or reworking as the result of pre-burial transport. Furthermore, those formations that more frequently produce vertebrates (e.g., the Aguja and Javelina

Table 2. Invertebrate fossils.

CLASS	TAXON	FORMATIONS												REFERENCES
		GR	TC	DC	SP	SE	DR	BU	BO	PN	AG	JV	BP	
PROTOZOA														
single-celled org.	***Spironema* sp.**										X			Udden 1907
FORAMINIFERA														
	Ammobaculites cuyleri						X							Mauldin 1985
	Ammobaculites dentonensis						X							Mauldin 1985
	Ammobaculites fragmentarium								X					Bostik 1960
	Ammobaculites subcretacea						X		X					Huffman 1960; Mauldin 1985
	Anomalina plummerae						X							Mauldin 1985
	Archaeoglobigerina blowi								X	X				Graham 1995; Ashmore 2003
	Archaeoglobigerina bosquensis								X	X				Graham 1995; Ashmore 2003
	Archaeoglobigerina cretacea								X	X				Graham 1995
	Bolivina textularoides						X							Mauldin 1985
	Bolivinita planata								X					Bostik 1960
	Bolivinitella eleyi								X					Bostik 1960
	Brachycythere sphenoides								X					Bostik 1960
	Bulimina nannina						X							Mauldin 1985
	Buliminella carseyae								X					Bostik 1960
	Buliminella cushman								X					Bostik 1960
	***Charentia* sp.**				X									Tarasconi 2000
	Chrysalogonium* cf. *C. texanum								X					Bostik 1960
	Citharina complanata						X							Mauldin 1985
	Coskinolinoides texanus	X	X	X										Tarasconi 2000
	Costallagerina thompsoni								X	X				Graham 1995
	Costellagerina bulbosa								X	X				Graham 1995
	Costellagerina phlegeri								X	X				Graham 1995
	***Costellagerina smithi* •**									X				Graham 1995
	Cribratina texana						X							Tarasconi 2000
	Cuneolina* cf. *pavonia	X	X	X	X	X	X							Tarasconi 2000
	Cythereis bicornis								X					Bostik 1960
	Cythereis* cf. *C. austinensis								X					Bostik 1960
	Cythereis dallasensis								X					Bostik 1960
	Cytherella austinensis								X					Bostik 1960
	Dentalina communis						X							Mauldin 1985
	Dentalina crypta						X							Mauldin 1985
	Dentalina debilis						X							Mauldin 1985
PLANKTONIC CREATURES	***Dentalina gracilis***								X					Bostik 1960
	Dentalina intrasegma								X					Bostik 1960
	Dentalinopsis excavata						X							Mauldin 1985
	Dentalinopsis tricarinatum						X							Mauldin 1985
	Dentelina soluta						X							Mauldin 1985
	Dentilina hammensis						X							Mauldin 1985
	Dicarinella algeriana							X						Tiedemann 2010
	Dicarinella asymetrica								X	X				Graham 1995
	Dicarinella concavata								X	X				Graham 1995; Ashmore 2003
	***Dicarinella daileyi* •**									X				Graham 1995
	Dicarinella difformis								X	X				Graham 1995
	Dicarinella indica								X	X				Graham 1995
	Dictyoconus walnutensis	X	X	X										Tarasconi 2000
	Discorbis minima						X							Mauldin 1985
	Discorbis minutissima						X							Mauldin 1985
	Dorothia* cf. *D. alexanderi								X					Bostik 1960
	Dorothia* cf. *D. bulletta								X					Bostik 1960
	Dorothia stephensoni								X	X				Bostik 1960; Ashmore 2003
	Ellipsoidella gracillima								X					Bostik 1960
	Eouvigerina plummerae								X					Bostik 1960
	Favusella washitensis	X	X		X	X		X						Tarasconi 2000; Tiedemann 2010
	Flabellammina clava								X					Bostik 1960
	Frondicularia cordata								X					Bostik 1960
	Gaudryina austinana								X	X				Bostik 1960; Ashmore 2003
	Gaudryina rudita								X	X				Bostik 1960; Ashmore 2003
	Globigerina cretacea								X					Huffman 1960
	Globigerina rugosa								X					Huffman 1960; Bostik 1960
	Globigerina saratogaensis								X					Bostik 1960
	***Globigerina* sp.**									X				Udden 1907
	Globigerina voluta								X					Huffman 1960
	Globigerinella aissana								X	X				Bostik 1960; Ashmore 2003
	Globigerinelloides asperus								X	X				Graham 1995
	Globigerinelloides bentonensis							X						Tiedemann 2010
	Globigerellinoides caseyi							X						Tiedemann 2010

CLASS	TAXON	GR	TC	DC	SP	SE	DR	BU	BO	PN	AG	JV	BP	REFERENCES
FORAMINIFERA (continued)														
	Globigerinelloides multispina									X				Graham 1995
	Globiginerelloides prairiehillensis									X				Graham 1995
	Globoratalites umbilicatus								X					Bostik 1960
	Globorotalia arca								X					Huffman 1960
	Globorotalia cushmani								X					Bostik 1960
	Globorotalia membranacea								X					Huffman 1960
	***Globorotalia* sp.**						X							Mauldin 1985
	Globotruncana arca								X					Bostik 1960
	Globotruncana bulloides									X				Graham 1995
	Globotruncana canaliculata								X					Bostik 1960
	Globotruncana contusa								X					Bostik 1960
	Globotruncana cretacea								X					Huffman 1960
	Globotruncana fornicata								X	X				Bostik 1960; Graham 1995
	Globotruncana lapparenti									X				Graham 1995
	Globotruncana marginata								X					Huffman 1960; Bostik 1960
	Globotruncana membanacea								X					Huffman 1960
	Globulina exerta						X							Mauldin 1985
	Globulina lacrima								X					Bostik 1960
	Guembelitria graysonensis						X							Mauldin 1985
	Guembelitria harrisi						X							Mauldin 1985
	Gumbelina globocarinata								X					Bostik 1960
	Gumbelina moremani								X					Huffman 1960; Bostik 1960
	Gumbelina nuttalli								X					Huffman 1960
	Gumbelina plummerae								X					Bostik 1960
	Gumbelina pseudotessera								X					Huffman 1960; Bostik 1960
	Gumbelina reussi								X					Huffman 1960; Bostik 1960
	Gumbelina striata								X					Bostik 1960
	Gyroidina depressa								X	X				Bostik 1960; Ashmore 2003
	Gyroidina girardana								X					Bostik 1960
	Gyroidina globosa								X	X				Bostik 1960; Ashmore 2003
	Haplofragmoides concava						X							Mauldin 1985
	Haplostiche texana						X							Maxwell et al. 1967
PLANKTONIC CREATURES	***Hastigerinella alexanderi***								X					Bostik 1960
	Hastigerinella moremani								X					Bostik 1960; Huffman 1960
	Hastigerinella simplex								X					Huffman 1960
	Hastigerinella watersi								X					Bostik 1960
	Hastingerinoides alexanderi								X	X				Graham 1995
	Hastingerinoides watersi								X	X				Graham 1995
	Hedbergella delrioensis							X						Tiedemann 2010
	Hedbergella planispira						X	X						Mauldin 1985; Tiedemann 2010
	Hedbergella simplex							X						Tiedemann 2010
	***Hedbergella* sp.**	X	X		X	X		X						Tarasconi 2000; Tiedemann 2010
	Heterohelix* cf. *moremani	X			X	X		X						Tarasconi 2000
	Heterohelix globulosa								X	X				Graham 1995; Fry 2015
	Heterohelix moremani						X		X					Mauldin 1985; Fry 2015
	Heterohelix pulchra									X				Graham 1995
	Heterohelix reussi								X	X				Ashmore 2003; Graham 1995
	Heterohelix semicostata									X				Graham 1995
	Heterohelix striata									X				Graham 1995
	Kyphopyxa christneri								X	X				Bostik 1960; Ashmore 2003
	Lagena apiculata						X							Mauldin 1985
	Lagena hispida						X							Mauldin 1985
	Lagena striatifera						X							Mauldin 1985
	Lagena sulcata						X							Mauldin 1985
	Lenticulina gaultina						X							Mauldin 1985
	Lenticulina rotulata								X	X				Bostik 1960; Ashmore 2003
	***Lenticulina* sp.**	X			X	X		X						Tarasconi 2000
	Lingulina lamellata						X							Mauldin 1985
	Lingulina nodosaria						X							Mauldin 1985
	***Lingulina* sp.**								X					Huffman 1960
	Loxostumum cushmani								X					Bostik 1960
	Marginotruncana angusticarenata								X	X				Graham 1995
	Marginotruncana bigbendensis									X				Graham 1995
	Marginotruncana coronata								X	X				Graham 1995; Ashmore 2003
	Marginotruncana marginata								X	X				Graham 1995; Ashmore 2003
	Marginotruncana pseudolinneiana								X	X				Graham 1995
	Marginotruncana renzi								X	X				Graham 1995
	Marginotruncana undulata								X	X				Graham 1995
	Marginulina austinana								X	X				Bostik 1960; Ashmore 2003
	Marginulina directa								X					Bostik 1960
	Marssonella oxycona								X	X				Bostik 1960; Ashmore 2003

CLASS	TAXON	GR	TC	DC	SP	SE	DR	BU	BO	PN	AG	JV	BP	REFERENCES
FORAMINIFERA (continued)														
	Neobulimina canadensis								X					Huffman 1960; Bostik 1960
	Neobulimina irregularis								X					Huffman 1960; Bostik 1960
	Neobulimina minima						X							Mauldin 1985
	Neoflabellina cushmani								X	X				Bostik 1960; Ashmore 2003
	Neoflabellina hebronensis								X					Bostik 1960
	Neoflabellina suturalis								X					Bostik 1960
	Nezzezata conica					X								Tarasconi 2000
	Nezzezata simplex					X								Tarasconi 2000
	Nodosaria affinis								X	X				Bostik 1960; Ashmore 2003
	Nodosaria barkeri						X							Mauldin 1985
	Nodosaria brandi						X							Mauldin 1985
	Nodosaria distans								X					Bostik 1960
	Nodosaria obscura						X							Mauldin 1985
	Nodosaria scotti						X							Mauldin 1985
	***Nodosaria* sp.**								X					Bostik 1960
	Nodosaria tappanae						X							Mauldin 1985
	***Opthalmidium* sp.**	X		X		X								Tarasconi 2000
	Orbitolina texana	X												Maxwell et al. 1967
	Ovalviolina* cf. *maccognoae					X								Tarasconi 2000
	Palmula pilulata								X	X				Bostik 1960; Ashmore 2003
	Paracypris angusta								X					Bostik 1960
	Parathalmanniella appeninnica							X						Tiedemann 2010
	Patellina subcretacea						X							Mauldin 1985
	***Peneroplis* sp.**			X										Tarasconi 2000
	***Planomalina* sp.**					X								Tarasconi 2000; Tiedemann 2010
	Planularia* cf. *P. dissona								X					Bostik 1960
	Planulina arimensis								X					Bostik 1960
	Planulina austinana								X	X				Bostik 1960; Ashmore 2003
	Planulina eaglefordensis								X					Huffman 1960; Bostik 1960
	Planulina kansasensis								X					Bostik 1960
	Pleurostomella austiniana								X					Bostik 1960
	Pleurostomella watersi								X					Bostik 1960
	Praeglobotruncana delrioensis							X						Tiedemann 2010
	Praeglobotruncana stephani							X						Tiedemann 2010
	***Praeglobotruncana* sp.**							X						Tiedemann 2010
PLANKTONIC CREATURES	***Pseudofrondicularia undulosa***								X	X				Bostik 1960; Ashmore 2003
	***Pseudoguembelina pessagnoi* •**									X				Graham 1995
	***Pseudoguembelina halesi* •**								X	X				Graham 1995
	Pseudotextularia elongata								X	X				Graham 1995
	Pterygocythere* cf. *P. saratogana								X					Bostik 1960
	Pyrulina cylindroides						X							Mauldin 1985
	Quinqueloculina aeschria						X							Mauldin 1985
	Rectogumbelina texana								X					Bostik 1960
	Reophax difflugiformis						X							Mauldin 1985
	***Reophax* sp.**					X								Tarasconi 2000
	Robulus munsteri								X					Huffman 1960; Bostik 1960
	Robulus taylorensis								X					Bostik 1960
	Rosita fornicata									X				Ashmore 2003
	Rotilapora montsavensis							X						Tiedemann 2010
	***Rotalipora* sp.**					X			X					Bell 1995; Tarasconi 2000
	Saracenaria triangularis								X					Bostik 1960
	Schackoina multispinata								X	X				Graham 1995
	***Scherochorella* sp.**				X									Tarasconi 2000
	Sculptobaculites goodlandensis	X	X	X	X									Tarasconi 2000
	***Shakoina* sp.**							X						Tiedemann 2010
	***Siderolites* sp.**								X					Bostik 1960
	Sigalia alpina									X				Graham 1995
	Sigalia deflaensis									X				Graham 1995
	Spirillina minima						X							Mauldin 1985
	Spiroplectammina laevis								X					Bostik 1960
	Spiroplectammina lalickeri								X					Bostik 1960
	Spiroplectammina longa						X							Mauldin 1985
	Spiroplectammina nuda						X							Mauldin 1985
	Textularia rioensis						X							Mauldin 1985
	***Textularia* sp.**									X				Udden 1907
	Thalmaninnella brotzeni							X						Tiedemann 2010
	***Thomasinella* sp.**						X							Tarasconi 2000
	***Ticinella* sp.**				X									Tarasconi 2000
	Valvulinaria loetterei						X							Mauldin 1985
	Ventilabrella austiniana								X	X				Bostik 1960; Graham 1995
	Ventilabrella* cf. *V. browni									X				Graham 1995

CLASS	TAXON	GR	TC	DC	SP	SE	DR	BU	BO	PN	AG	JV	BP	REFERENCES
FORAMINIFERA (continued)														
PLANKTONIC CREATURES	***Ventilabrella glabrata***									X				Graham 1995
	Virgulina tegulata								X					Huffman 1960; Bostik 1960
	Vitriwebbina biosculata								X					Bostik 1960
	Washitella typica						X							Mauldin 1985
	Whiteinella aprica								X	X				Graham 1995
	Whiteinella archaeocretacea								X	X				Graham 1995
SPONGIAE														
sponges	***Cliona* sp.**								X	X	X			Lehman 1985; Cooper et al. 2017
	***Myliusia* sp.**								X					Cooper et al. 2017
ARTICULATA														
brachiopods	***Kingena wacoensis***							X						Eley 1938
	Terabratulina brewsterensis								X	X				Eley 1938; Lehman 1985
	***Terabratulina* sp.**								X					Eley 1938
STENOLAEMATA														
bryozoans	**Cyclostomata indet.**						X							Tarasconi 2000
POLYCHAETA														
annelid worms	***Hamulus onyx***									X				Eley 1938; Lehman 1985
	Serpula* cf. *S. adnata										X			Lehman 1985
	Serpula cretacea									X	X			Eley 1938; Lehman 1985
ANTHOZOA														
stoney corals	**Faviidae indet.**								X					Eley 1938
ECHINOIDEA														
SEA URCHINS	**Echinoidia indet.**				X									Tarasconi 2000
	Enallaster calvini						X	X						Maxwell et al. 1967
	Enallaster inflatus						X							Eley 1938
	Enallaster mexicanus				X									Maxwell et al. 1967
	***Enallaster* sp.**		X											Maxwell et al. 1967
	Enallaster texana				X									Maxwell et al. 1967
	Hemiaster calvini						X							Eley 1938
	***Hemiaster* sp.**								X					Maxwell et al. 1967
	Hemiaster texanus									X				Lehman 1985
	Hemiasteridae indet.				X									Tarasconi 2000
	***Heteraster* sp.**				X			X						Tarasconi 2000; Maxwell et al. 1967
	Heteraster texana						X							Eley 1938
	Heterohelix globulosa								X					Fry 2015
	Heterohelix moremani													Fry 2015
	***Heterohelyx* sp.**							X						Tarasconi 2000
	Holectypus limitus						X							Eley 1938
	***Holectypus* sp.**		X											Maxwell et al. 1967
	Leiotomaster bosei								X					Eley 1938
	***Macraster* sp.**								X					Eley 1938
	***Phymosoma* sp.**		X											Maxwell et al. 1967
	***Pseudodiadema* sp.**								X					Eley 1938
CRINOIDA	***Saccocoma* sp.**							X						Tarasconi 2000
BIVALVIA														
CLAMS, OYSTERS, MUSSELS	***Amphidonte* sp.**	X					X							Tarasconi 2000
	Anomia* cf. *A. mexicana										X			Lehman 1985
	Anomia* cf. *A. argentaria										X			Eley 1938
	Anomia* cf. *A. tellinoides										X			Eley 1938
	***Aphrodina* sp.**										X			Eley 1938
	Aphrodina tippana									X	X			Eley 1938; Lehman 1985
	Arcidae indet.				X									Tarasconi 2000
	***Arcopagella* sp.**										X			Eley 1938
	Astartidae indet.				X									Tarasconi 2000
	Bivalvia indet.					X								Maxwell et al. 1967
	***Brachiodontes* sp.**										X			Lehman 1985
	Brachymeris alta										X			Eley 1938
	***Callista* sp.**										X			Eley 1938
	Camptonectes burlingtonensis										X			Udden 1907
	***Camptonectes* sp.**										X			Lehman 1985
	Caprinidae indet.					X								Tarasconi 2000
	Cardium carolinensis										X			?Udden 1907; Eley 1938
	Cardium congestum										X			Udden 1907
	Cardium longstreeti									X	X			Eley 1938
	***Cardium* sp.**		X	X	X						X			Eley 1938; Maxwell et al. 1967
	Cardium subcongesta				X									Maxwell et al. 1967
	Cardium vaughni										X			Eley 1938
	Chondrodontidae indet.					X								Tarasconi 2000
	Cladoceramus undulotplicatus								X					Stevens et al. 1995; Ashmore 2003; Cooper et al. 2017
	Cladoceramus undulatoplicatus michaeli								X					Cooper et al. 2017

CLASS	TAXON	FORMATIONS												REFERENCES
		GR	TC	DC	SP	SE	DR	BU	BO	PN	AG	JV	BP	
BIVALVIA (Continued)														
CLAMS, OYSTERS, MUSSELS	***Corbicula cytheriformis***										X			Udden 1907
	***Corbicula* sp.**										X			Udden 1907
	***Corbula* sp.**									X				Lehman 1985
	***Cordiceramus* sp.**									X				Ashmore 2003
	Crassatella* cf. *C. vadosa										X			Lehman 1985
	Crassatella* cf. *C. obliquata										X			Udden 1907
	Crassostrea cusseta										X			Lehman 1985
	Crassostrea trigonalis										X			Lehman 1985
	Cremnoceramus crassus crassus								X					Cooper et al. 2017
	Cremnoceramus deformis erectus								X					Cooper et al. 2017
	Cremnoceramus walterdorfensis								X					Cooper et al. 2017
	Cyclorisma carolinensis									X				Eley 1938
	***Cyclorisma* sp.**								X					Eley 1938
	Cymbophora berryi									X	X			Lehman 1985
	Cymbophora scabellum										X			Lehman 1985
	***Cymbophora* sp.**										X			Eley 1938
	Cymbophora trigonalis										X			Eley 1938
	Cymella bella										X			Lehman 1985
	Cyprimera depressa									X				Eley 1938; Lehman 1985
	Cyprimeria gabbi									X	X			Eley 1938; Maxwell et al. 1967
	Cyprimeria roddai									X				Lehman 1985
	***Cyprimeria* sp.**		X							X				Maxwell et al. 1967
	Cyprimeria texana				X									Maxwell et al. 1967
	***Cyprina* sp.**										X			Udden 1907
	Dianchora* cf. *austinensis								X					Eley 1938
	Didymotis costatus								X					Cooper et al. 2017
	Dreissena tippana										X			Eley 1938
	Durania austinensis								X					Eley 1938; Maxwell et al. 1967; Cooper et al. 2017
	***Durania* sp.**								X					Maxwell et al. 1967
	Durania terlinguae								X	X	X			Eley 1938; Maxwell et al. 1967
	Eoradiolites* cf. *E. davidsoni			X										Maxwell et al. 1967
	Eoradiolites* cf. *E. quadratus					X								Maxwell et al. 1967
	***Etea* sp.**									X				Lehman 1985
	Ethmocardium* cf. *E. welleri										X			Lehman 1985
	Exogyra arietina						X							Eley 1938; Maxwell et al. 1967
	Exogyra cancellata									X				Eley 1938
	Exogyra cartledgei						X							Eley 1938; Maxwell et al. 1967
	Exogyra clarki							X						Maxwell et al. 1967
	Exogyra costata									X				Eley 1938
	Exogyra costata spinosa									X				Eley 1938
	Exogyra laeviuscula									X				Lehman 1985
	Exogyra ponderosa ponderosa									X	X			Lehman 1985
	Exogyra ponderosa whitneyi									X				Eley 1938
	Exogyra ponderosa erraticostata									X				Lehman 1985
	Exogyra ponderosa upatoiensis									X				Lehman 1985
	Exogyra quitmanensis	X												Maxwell et al. 1967
	***Exogyra* sp.**									X				Maxwell et al. 1967
	Exogyra texana	X	X	X	X									Maxwell et al. 1967
	Exogyra whitneyi						X							Eley 1938; Maxwell et al. 1967
	Flemingostrea pratti										X			Lehman 1985
	***Flemingostrea subspatulata* n. subsp. +**										X			Lehman 1985
	***Gastrochaena* sp.**										X			Lehman 1985
	***Granocardium* sp.**										X			Lehman 1985
	Gryphaea* cf. *G. navia				X									Maxwell et al. 1967
	Gryphaea corrugata							X						Eley 1938
	Gryphaea graysonana						X	X						Maxwell et al. 1967
	Gryphaea mucronata		X				X	X						Eley 1938; Maxwell et al. 1967
	***Gryphaea* sp.**		X	X	X	X		X						Maxwell et al. 1967
	Haploscapha grandis								X					Maxwell et al. 1967
	***Homomya* sp.**				X									Maxwell et al. 1967
	Homomya washita							X						Eley 1938
	Ilmatogyra africana						X							Tarasconi 2000
	Inoceramus anomalus								X					Cooper et al. 2017
	Inoceramus annulatus								X					Udden 1907; Eley 1938
	Inoceramus arvanus								X					Cooper et al. 2017
	Inoceramus barabini									X				Lehman 1985
	Inoceramus biconstrictus										X			Eley 1938
	Inoceramus* cf. *I. concentricus								X					Eley 1938
	Inoceramus* cf. *I. subquadratus								X					Maxwell et al. 1967
	Inoceramus cumminsi										X			Lehman 1985; Eley 1938

CLASS	TAXON	FORMATIONS												REFERENCES
		GR	TC	DC	SP	SE	DR	BU	BO	PN	AG	JV	BP	
BIVALVIA (Continued)														
	Inoceramus dakotensis								X					Cooper et al. 2017
	Inoceramus digitatus								X					Eley 1939
	Inoceramus exogyroides								X					Udden 1907
	Inoceramus ginterensis								X					Cooper et al. 2017
	Inoceramus (Haploscapha) grandis								X					Udden 1907; Eley 1938
	Inoceramus howelli								X					Cooper et al. 2017
	Inoceramus labiatus							X	X					Eley 1938; Maxwell et al. 1967
	Inoceramus oblongus									X				Lehman 1985
	Inoceramus perplexus								X					Cooper et al. 2017
	Inoceramus pertenuis										X			Eley 1938
	Inoceramus pictus								X					Cooper et al. 2017
	Inoceramus platinus									X				Lehman 1985
	Inoceramus prefragilis								X					Cooper et al. 2017
	Inoceramus problematicus								X		X			Eley 1938
	Inoceramus rutherfordi								X					Cooper et al. 2017
	***Inoceramus* sp.**								X	X	X			Udden 1907; Eley 1938; Maxwell et al. 1967
	Inoceramus umbonatus								X					Udden 1907
	Inoceramus undabundus								X					Cooper et al. 2017
	Inoceramus undulatoplicatus								X					Eley 1938; Maxwell et al. 1967; Bell et al. 2013
	***Inoperna* sp.**	X												Maxwell et al. 1967
	Isocardia medialis							X						Eley 1938
	***Leda* sp.**										X			Udden 1907
	Leptosolen* cf. *L. quadrilaterus										X			Lehman 1985
	Lima reticulata										X			Eley 1938; Lehman 1985
	Lima coahuilensis										X			Lehman 1985
	Lima shumardi							X						Eley 1938
	***Lima* sp.**										X			Udden 1907
	Lima wacoensis						X	X						Eley 1938; Maxwell et al. 1967
	***Linearea* sp.**									X	X			Lehman 1985
	Lingula* cf. *L. rauliniana										X			Udden 1907
	Lingula subspatulata										X			Eley 1938
	Liopistha bella										X			Eley 1938
	***Lopha* sp.**									X				Lehman 1985
	Lophia subovata				X									Maxwell et al. 1967
CLAMS, OYSTERS, MUSSELS	***Lucina linearia***									X				Lehman 1985
	***Lucina* sp.**									X				Lehman 1985
	Lucinidae indet.				X									Tarasconi 2000
	***Lucinoma* sp.**									X				Lehman 1985
	Lycettia tippanus										X			Lehman 1985
	Mactra texana										X			Udden 1907
	Magadiceramus complicatus								X					Cooper et al. 2017
	Magadiceramus crenelatus								X					Cooper et al. 2017
	Magadiceramus subquadratus								X					Ashmore 2003
	Monopleuridae indet.					X								Tarasconi 2000
	Mytiloides goppelnensis								X					Cooper et al. 2017
	Mytiloides herbichi								X					Cooper et al. 2017
	Mytiloides mytiloidiformis								X					Cooper et al. 2017
	Mytiloides puebloensis								X					Cooper et al. 2017
	Mytiloides ratonensis								X					Cooper et al. 2017
	Mytiloides scupini								X					Cooper et al. 2017
	Mytiloides striatoconcentricus								X					Cooper et al. 2017
	***Mytilus* sp.**								X					Udden 1907; Eley 1938
	Neithia irregularis		X											Maxwell et al. 1967
	***Neithia* sp.**				X									Maxwell et al. 1967
	Nemodon eufaulensis										X			Lehman 1985
	Nicaisolopha lugubris								X					Cooper et al. 2017
	***Nucula* sp.**									X	X			Eley 1938; Lehman 1985
	Nuculidae indet.				X									Tarasconi 2000
	Ostrea beloiti								X					Cooper et al. 2017
	Ostrea congesta								X	X				Eley 1938; Maxwell et al. 1967
	Ostrea contracta										X			Udden 1907
	Ostrea cretacea										X			Eley 1938
	Ostrea elegantula										X			Udden 1907
	Ostrea falcata									X				Eley 1938
	Ostrea glabra										X			Udden 1907; Eley 1938
	Ostrea Johnsoni										X			Eley 1938
	Ostrea larva nasuta									X				Eley 1938
	Ostrea plumosa								X		X			Eley 1938
	Ostrea pratti									X	X			Eley 1938
	Ostrea satellites								X					Eley 1938
	Ostrea* cf. *O. veleniana										X			Udden 1907

CLASS	TAXON	GR	TC	DC	SP	SE	DR	BU	BO	PN	AG	JV	BP	REFERENCES
BIVALVIA (Continued)														
	Ostrea subspatulata									X	X			Eley 1938
	Ostrea tecticostata										X			Udden 1907
	***Paranomia* sp.**								X					Eley 1938
	Pecinidae indet.				X		X							Tarasconi 2000
	Pecten cliffwoodensis										X			Eley 1938
	Pecten roemeri							X						Eley 1938; Maxwell et al. 1967
	Pecten subalpinus						X							Eley 1938
	Pecten texanus							X						Eley 1938
	***Pedalion* sp.**									X				Eley 1938
	Pholadomya* cf. *P. coahuilensis										X			Lehman 1985
	Pholadomya sanctisabae			X	X									Maxwell et al. 1967
	***Pholadomya* sp.**		X											Maxwell et al. 1967
	Pholadomyidae indet.				X									Tarasconi 2000
	Platyceramus americanus								X					Cooper et al. 2017
	Platyceramus* cf. *mantelli								X					Cooper et al. 2017
	Platyceramus platinus								X					Stevens et al. 1995; Ashmore 2003
	***Platyceramus* sp.**								X					Cooper et al. 2017
	Pleuromyidae indet.				X									Tarasconi 2000
	Porocystis globularis	X												Maxwell et al. 1967
	Protocardia multistriata				X									Tarasconi 2000
	Protocardia texana			X	X									Maxwell et al. 1967; Tarasconi 2000
	***Protocardium* sp.**		X	X										Maxwell et al. 1967
	Pseudoperna congesta									X				Lehman 1985; Ashmore 2003
CLAMS, OYSTERS, MUSSELS	***Pseudoperna* n. sp. +**										X			Lehman 1985
	***Pseudoperna* sp.**								X					Cooper et al. 2017
	***Pteria* sp.**										X			Eley 1938; Cooper et al. 2017
	Pycnodontae aucella									X				Lehman 1985
	***Pycnodontae* sp.**	X	X	X	X	X	X							Tarasconi 2000
	Radiolites austinensis									X				Udden 1907
	***Radiolites* sp.**			X										Maxwell et al. 1967
	Radiolitidae indet.					X				X				Udden 1907; Tarasconi 2000
	Sphenoceramus digitatus								X					Ashmore 2003
	***Sphenoceramus* sp.**									X				Ashmore 2003
	Spondylus* cf. *S. guadalupae									X				Lehman 1985
	***Spondylus* sp.**								X					Eley 1938; Cooper et al. 2017
	Striarca poguei									X				Eley 1938
	Tapes chihuahuaensis		X		X									Maxwell et al. 1967
	***Tapes* sp.**			X										Maxwell et al. 1967
	Tellenia elliptica										X			Eley 1938
	Tellenia simplex										X			Eley 1938
	***Tellina* sp.**									X	X			Lehman 1985
	Teredo irregularis										X			Eley 1938
	***Teredo* sp.**								X					Eley 1938
	***Teredolites* sp.**									X	X			Lehman 1985
	Thracia gracilis										X			Udden 1907
	***Thracia* sp.**										X			Udden 1907
	Trapezium truncatum									X				Eley 1938
	Trigonia bartrami									X				Eley 1938
	***Trigonia* sp.**		X		X			X		X				Maxwell et al. 1967
	***Unio* sp.**										X	X	X	Lehman 1985; Schiebout 1970
	***Venericardia* sp.**										X			Lehman 1985
	Veneridae indet.				X									Tarasconi 2000
	Veniella carolinensis									X				Eley 1938
	Veniella conradi									X				Udden 1907; Eley 1938; Lehman 1985
	Veniella mullinensis									X				Eley 1938; Lehman 1985
GASTROPODA														
	***Amauropsis* sp.**		X											Maxwell et al. 1967
	Anchura kiowana										X			Eley 1938
	***Anchura* sp.**										X			Eley 1938
	Aporrhais* cf. *A. subfusiformis				X									Maxwell et al. 1967
	Aporrhais tarrantensis		X	X										Maxwell et al. 1967
	Buccinopsis greenensis										X			Lehman 1985
	Buccinopsis globosa										X			Lehman 1985
SNAILS, WHELKS	***Buccinopsis parryi***										X			Udden 1907
	Campeloma vetulum										X			Lehman 1985
	***Cerithidea* indet.**								X					*Cooper et al. current research
	***Cerithium* sp.**									X				Lehman 1985
	certhiid gastropods								X					Cooper et al. 2017
	***Cithara* sp.**										X			Eley 1938
	Gastropoda indet. (fresh water)											X	X	*Coulson 1998; Schiebout 1970
	Gastropoda indet. (marine)	X		X	X	X								Maxwell et al. 1967; Tarasconi 2000;
	Goniobasis tenera											X		*Coulson 1998

CLASS	TAXON	GR	TC	DC	SP	SE	DR	BU	BO	PN	AG	JV	BP	REFERENCES
		FORMATIONS												
GASTROPODA (Continued)														
	Gyrodes americanus										X			Lehman 1985
	***Gyrodes* sp.**		X		X						X			Udden 1907; Eley 1938; Maxwell et al. 1967
	Gyrodes supraplicatus									X	X			Eley 1938; Lehman 1985
	Liopeplum thoracium									X				Eley 1938
	***Longoconcha* sp.**										X			Lehman 1985
	Lunatia carolinensis										X			Eley 1938
	Lunatia halli									X	X			Eley 1938
	Lunatia pedernalis						X							Eley 1938
	***Lunatia* sp.**										X			Eley 1938
	Margarita ornata										X			Eley 1938
	Melanatria vanusta										X			Eley 1938; Lehman 1985
	Morea reticulata tenuis										X			Eley 1938
	***Morea* sp.**										X			Lehman 1985
	***Natica* sp.**										X			Udden 1907
	***Nerinea* sp.**		X											Maxwell et al. 1967
	Perissolax dubia										X			Eley 1938
	Pugnellus abnormalis										X			Lehman 1985
	***Pugnellus* sp.**										X			Eley 1938
	Pyrifusus* cf. *P. bairdi										X			Lehman 1985
	***Pyrifusus* sp.**										X			Eley 1938; Lehman 1985
SNAILS, WHELKS	***Rostellites* cf. *R. biconicus***										X			Eley 1938
	Rostellites texana										X			Udden 1907
	***Scurria* sp.**										X			Udden 1907
	Seminola globosa										X			Eley 1938
	Seminola greenensis										X			Eley 1938
	Stantonella interrupta										X			Lehman 1985
	Surcula stringosa										X			Eley 1938
	Trachytrition ?holmdelense										X			Eley 1938
	Turritella ola										X			Eley 1938
	Turritella quadrilira									X				Eley 1938; Maxwell et al. 1967
	Turritella quadrilirata									X				Lehman 1985
	***Turritella* sp.**		X	X	X		X	X		X				Maxwell et al. 1967
	Turritella trilira									X	X			Eley 1938; Lehman 1985
	Tylostoma hilli							X						Eley 1938
	***Tylostoma* sp.**		X	X				X		X	X			Maxwell et al. 1967; Eley 1938
	Viviparus retusus											X		*Coulson 1998
	Viviparus trochiformis											X		*Coulson 1998
	Viviparus* cf. *V. raynoldsanus										X			Udden 1907
	Voluta parvula										X			Eley 1938
	Volutaderma ovata									X				Eley 1938
	***Volutaderma* sp.**										X			Eley 1938
	Volutamorpha bella										X			Eley 1938
	Volutamorpha* cf. *V. raynoldsanus										X	X		Lehman 1985
	Volutamorpha conradi									X	X			Eley 1938
	***Volutamorpha* sp.**									X	X			Eley 1938
	Volutilithes cancellatus										X			Eley 1938
SCAPHOPODA														
tusk shells	***Dentalium gracile***										X			Udden 1907
CEPHALOPODA														
	Acanthoceras bellense								X					Cooper et al. 2017
	Acanthoceras amphibolum								X					White 2019
	Allocrioceras annulatum								X					Cooper et al. 2017
	Allocrioceras hazzardi								X					Maxwell et al. 1967; Cooper et al. 2017; White 2019
	***Allocrioceras* sp.**								X					*Cooper et al. current research
	Baculites asperiformis									X				Udden 1907; Lehman 1985
	Baculites* cf. *B. codyensis								X					Cooper et al. 2017
	Baculites haresi										X			Waggoner 2006
	Baculites ovatus								X	X	X			Eley 1938
AMMONITES, NAUTILOIDS	***Baculites* sp.**								X	X	X			Maxwell et al. 1967; Lehman 1985; Cooper et al. 2017
	Belemnoidea indet.								X					*Cooper et al. current research
	***Budaiceras* sp.**							X						Eley 1938; Maxwell et al. 1967
	***Calycoceras* sp.**								X					Cooper et al. 2017
	***Coilopceras* sp.**								X					Maxwell et al. 1967; Bell et al. 2013
	Coilopceras springeri								X					Bell et al. 2013
	Collignoniceras woolgari								X					Bell 1995; Cooper et al. 2017
	***Craginites* sp.**				X									Maxwell et al. 1967
	Crioceras* cf. *latus								X					Udden 1907; Eley 1938
	***Cymatoceras* sp.**								X					Eley 1938
	Delawarella delawarenisis									X				Maxwell et al. 1967

CLASS	TAXON	FORMATIONS												REFERENCES
		GR	TC	DC	SP	SE	DR	BU	BO	PN	AG	JV	BP	
CEPHALOPODA (Continued)														
AMMONITES, NAUTILOIDS	***Delawarella sabinalensis***									X				Lehman 1985
	***Delawarella* sp.**									X				Maxwell et al. 1967
	***Desmoceras* sp.**				X									Maxwell et al. 1967
	Diploceras* cf. *D. cristatum				X									Tarasconi 2000
	Douvilleiceras* cf. *D. mammilatum	X												Maxwell et al. 1967
	***Egonoceras* sp.**		X											Maxwell et al. 1967
	Euhystrichoceras adkinsi								X					Cooper et al. 2017
	Euomphaloceras septemseriatum								X					Cooper et al. 2017
	Eupachydiscus* cf. *E. isculensis								X					Cooper et al. 2017
	Eutrephoceras dekayi									X	X			Udden 1907; Eley 1938; Lehman 1985
	Eutrephoceras* cf. *perlatum								X					Cooper et al. 2017
	***Eutrephoceras* sp.**								X					Maxwell et al. 1967
	***Forresteria* sp.**								X					Cooper et al. 2017
	***Gauthiericeras* sp.**								X					Cooper et al. 2017
	Glyptoxoceras ellisoni									X				Lehman 1985
	Hamites simplex								X					Cooper et al. 2017
	***Hypoturrilites* sp.**						X							Tarasconi 2000
	***Hoplitoplacenticeras* n. sp. +**										X			Waggoner 2006
	Idiohamites fremonti				X									Maxwell et. al. 1967
	***Mantelliceras* sp.**								X					Eley 1938
	Menabites delawarensis									X				Waggoner 2006
	***Menabites* sp.**								X					Cooper et al. 2017
	Metengonoceras* cf. *M. ambiguum		X											Maxwell et al. 1967
	Moremanoceras bravoense								X					Cooper et al. 2017
	Mortoniceras delawarensis									X				Eley 1938
	***Mortoniceras* sp.**				X				X					Eley 1938; Maxwell et al. 1967
	Oxytropidoceras bravoensis				X									Maxwell et al. 1967
	Oxytropidoceras geniculatum				X									Maxwell et al. 1967
	Pachydiscus paulsoni										X			Waggoner 2006
	Peroniceras* cf. *P. tridorsatum								X					Cooper et al. 2017
	***Peroniceras* sp.**								X					Maxwell et al. 1967; Ashmore 2003
	***Pervinquieria* sp.**				X									Maxwell et al. 1967
	Placenticeras placenta									X	X			Eley 1938; Maxwell et al. 1967
	Placenticeras intercalare									X	X			Waggoner 2006
	Placenticeras meeki									X	X			Maxwell et al. 1967; Lehman 1985
	***Placenticeras* sp.**									X	X			Eley 1938; Maxwell et al. 1967
	Placenticeras syrtale									X	X			Lehman 1985; Waggoner 2006
	Placenticeras whitfieldi									X				Udden 1907; Eley 1938
	Plesiotexanites americanus								X					Cooper et al. 2017
	Plesiotexanites shiloensis								X					Cooper et al. 2017
	Prionocycloceras hazzardi								X					Cooper et al. 2017
	Prionocyclus hyatti								X					Cooper et al. 2017; Bell et al. 2013
	***Prohysteroceras* sp.**				X									Maxwell et al. 1967
	Protexanites bourgeoisianus								X					Cooper et al. 2017
	Pseudocalycoceras angolaense								X					Cooper et al. 2017
	***Pseudocalycoceras* sp.**								X					Cooper et al. 2017
	***Pseudoschloenbachia* sp.**									X				Lehman 1985
	Scaphites hippocrepis									X				Waggoner 2006
	Scaphites semicostatus								X					Cooper et al. 2017
	***?Scaphites* sp.**						X		X	X				Lehman 1985; Tarasconi 2000
	Schloenbachia conensis									X				Udden 1907
	Schloenbachia leonensis									X				Udden 1907
	Scipinoceras* cf. *S. gracilis								X					Maxwell et al. 1967
	Spinaptychus sternbergi									X				Maxwell et al. 1967
	***Stantoceras* sp.**								X					Cooper et al. 2017
	Stoliczkaia adkinsi						X	X						Eley 1938
	***Stoliczkaia* sp.**						X							Maxwell et al. 1967
	Submortoniceras belli									X				Lehman 1985
	Submortoniceras chicoense									X				Lehman 1985
	***Submortoniceras mariscalense* •**									X				Young 1963; Lehman 1985
	Submortoniceras vanuxemi									X				Lehman 1985
	Tarrantoceras sellardsi								X					Cooper et al. 2017
	Texanites* cf. *T. quinquenodosus								X					Cooper et al. 2017
	Texanites* cf. *T. texanus								X	X				Maxwell et al. 1967
	Texanites* cf. *T. stangeri								X					Cooper et al. 2017
	***Texanites* sp.**								X					Maxwell et al. 1967
	Texanites twiningi									X				Lehman 1985
	Texasia dentatocarinata									X				Lehman 1985
	Turrilites acutus								X					Cooper et al. 2017
	Yezoites kieslingswaldensis								X					*Cooper et al. current research
	***Yezoites* sp.**								X					Cooper et al. 2017

CLASS	TAXON	GR	TC	DC	SP	SE	DR	BU	BO	PN	AG	JV	BP	REFERENCES
CRUSTACEA														
crabs	**?*Avitelmessus* sp.**										X			Lehman 1985
fecal pellets	**Arthropoda indet.**											X		*Coulson 1998
OSTRACODA														
seed shrimp	**Ostracoda indet.**			X										Tarasconi 2000
MISCELLANEOUS														
	The following have been reported in BIBE (Eley 1938) from undivided Lower Cretaceous strata he called "Devil's River Limestone".													
	***Alectryonia* sp. (Bivalvia)**			?X										Eley 1938
	***Crassatollina* sp. (Bivalvia)**													Eley 1938
	***Gryphaea marcoi* (Bivalvia)**													Eley 1938
	***Gryphaea washitaensis* (Bivalvia)**													Eley 1938
	***Kingena wacoensis* (Articulata)**													Eley 1938
	***Lunatia* sp. (Gastropoda)**													Eley 1938
	***Nerina* sp. (Gastropoda)**													Eley 1938
	***Toucasia patagiata* (Maxillopoda)**													Eley 1938
TRACE FOSSILS														
	***Chondrites* burrows (marine)**								X					Sanders 1988: White 2019
	***Fodichnia* burrows (marine)**									X				Mosely 1992
	***Gastrochaenolites* burrows (marine)**								X					Sanders 1988
	***Gyrolithes* burrows (marine)**									X				Mosely 1992
	***Ophiomorpha* burrows (marine)**										X			Lehman 1985; Wick and Corrick 2015
	***Planolites* burrows (marine)**								X					Sanders 1988
	***Rhizocorallium* burrows (marine)**								X					Sanders 1988
	***Thalassinoides* burrows (marine)**								X					Sanders 1988
	?Crustacean burrows indet. (fresh water)											X	X	*Coulson 1998
	Clinoid sponge borings (on marine oysters)										X			Lehman 1985
	Lithophagid borings (on marine oysters)										X			Lehman 1985; Wick and Corrick 2015
	Termite borings and frass												X	Rohr et al. 1986
		GR	TC	DC	SP	SE	DR	BU	BO	PN	AG	JV	BP	
		Glen Rose Limestone	Telephone Canyon Formation	Del Carmen Limestone	Sue Peaks Formation	Santa Elena Limestone	Del Rio Clay	Buda Limestone	Boquillas Formation	Pen Formation	Aguja Formation	Javelina Formation	Black Peaks Formation	
			LOWER CRETACEOUS						UPPER CRETACEOUS					

HOLOTYPE = •

UNPUBLISHED NEW TAXON = Δ

UNNAMED NEW TAXON = +

CLASS	TAXON	FORMATIONS	REFERENCES
GRAPTOLITES		**Maravillas Formation (Ordivician)**	
colonial animals	**Graptolithina indet.**	X	Maxwell et al. 1967
CONODONTS		**Maravillas Formation (Ordivician)**	
eel-like chordates	***Amorphagnathus ordovicicus***	X	Turner et al. 2011
	***Belodina* sp.**	X	Turner et al. 2011
	Oistodus venustus	X	Turner et al. 2011
	Panderodus gracilis	X	Turner et al. 2011
	Panderodus unicostatus	X	Turner et al. 2011
	Protopanderodus insculptus	X	Turner et al. 2011
	Periodon aculeatus	X	Turner et al. 2011
	Phragmodus undatus	X	Turner et al. 2011
GASTROPODA		**Canoe Formation (Eocene)**	
snail	***Helix* sp.**	X	Maxwell et al. 1967

* Cooper et. al. (current research) indicates taxa collected by Roger Cooper and colleagues, currently residing in the collections of the Texas Memorial Museum (copies of this record on file at BBNP). Please note that 'current research' may ultimately result in taxonomic revision.
* Coulson (1998) reports these taxa from the Javelina Fm. although this part of the section is now recognized as being in the Cretaceous (lower) portion of the Black Peaks Fm. (Lehman and Coulson 2002).

Table 3. Vertebrate fossils.

CLASS	TAXON	COMMON NAME	FORMATIONS											REFERENCES
			BO	PN	AG	JV	KBP	PgBP	HH	CN	CH	DE	BS	
CHONDRICHTHEYS														
CARTILAGINOUS	***Anomotodon augustidens***	Shark			X									Lehman 1985
FISHES	***Brachyrhyzodus wichitaensis***	Guitarfish			X									Schubert et al. 2017
	Cantioscyllium* aff. *C. myersi	Shark			X									Schubert et al. 2017
	Chiloscyllium* aff. *C. greeni	Shark			X									Schubert et al. 2017
	Chondrichthyes indet.	Shark	X	X	X									Maxwell et al. 1967; Schubert et al. 2017
	***Columbusia* sp.**	Carpet Shark			X									Schubert et al. 2017
	Cretalamna appendiculata	Shark		X										Standhardt in Langston et al. 1989
	Cretalamna* cf. *C. sarcoportheta	Shark			X									Schubert et al. 2017
	Cretorectolobus olsoni	Shark		X	X									Standhardt 1986; Lehman 1985
	***Dasyatidea* indet.**	Stingray			X									Sankey 1998; Sankey 2010
	***Dasyatus* sp.**	Stingray						X						Standhardt 1986
	***Hybodus* sp.**	Shark			X									Sankey 1998
	Hybodontidae indet.	Shark			X									Lehman et al. 2019
	Igdabatis* cf. *I. indicus	Stingray			X									Schubert et al. 2017
	Ischyriza avonicola	Sawfish			X									Sankey 1998; Montgomery and Clark 2016
	Ischyrhyza* cf. *I. avonicola	Sawfish			X									Schubert et al. 2017
	Ischyriza mira	Sawfish		X	X									Lehman 1985; Schubert et al. 2017
	Lamna appendiculata	Shark			X									Applegate 1972
	Lamna texana	Shark			X									Udden 1907*
	Lamna* cf. *L. elegans	Shark			X									Udden 1907*
	Lissodus selachos	Shark		X	X									Standhardt 1986; Sankey 1998
	Lonchidion selachos	Shark			X									Schubert et al. 2017
	***Meristodon* sp.**	Shark			X									Schubert et al. 2017
	?Myledaphus bipartitus	Skate			X									Standhardt 1986; Montgomery and Clark 2016
	***Myliobatus* sp.**	Eagle Ray							X					Standhardt in Langston et al. 1989
	***Myliobatiformes* indet.**	Eagle Ray			X									Schubert et al. 2017
	***Odontaspis* sp.**	Sand Shark			X									Standhardt 1986
	Onchopristis dunklei	Sawfish			X									Sankey 1998; Montgomery and Clark 2016
	***Onchopristis* sp.**	Sawfish			X									Davies 1983
	Protoplatyrhina renae	Guitarfish			X									Schubert et al. 2017
	Ptychodus mortoni	Shark	X											Eley 1938
	Ptychotrygon agujaensis •	Skate			X									McNulty and Slaughter 1972; Schubert et al. 2017
	Ptychotrygon* cf. *P. cuspidata	Skate			X									Schubert et al. 2017
	Ptychotrygon triangularis	Skate			X									Schubert et al. 2017
	***Ptychotrygon* sp.**	Skate		X	X									Standhardt 1986; Schubert et al. 2017
	***Rhinobatos* sp.**	Guitarfish			X									Schubert et al. 2017
	Rhombodus levis	Eagle Ray			X									Schubert et al. 2017
	***Rhombodus* sp.**	Eagle Ray						X						Standhardt 1986
	Scapanorynchus raphiodon	Shark			X									Applegate 1972
	Scapanorynchus texanus	Shark			X									Lehman 1985; Sankey 1998; Schubert et al. 2017
	Serratolamna* cf. *S. caraibaea	Shark			X									Schubert et al. 2017
	Squalicorax kaupi	Shark		X	X									Lehman 1985; Schubert et al. 2017
	Squalicorax aff. S. yangaensis	Shark			X									Schubert et al. 2017
	Squalicoraz aff. S. lindstromi	Shark			X									Schubert et al. 2017
	***Squatina* sp.**	Shark			X									Schubert et al. 2017
	Squatirhina americana	Carpet Shark			X									Sankey 1998; Montgomery and Clark 2016
	Texatrygon* cf. *T. copei	Skate			X									Schubert et al. 2017
CHONDRICHTHEYS MISC.														
coprolites (fossil dung)	**Chondrichthyes indet.**	Shark			X									Wick and Corrick 2015
OSTEICHTHYES														
	Acanthomorpha indet.	Boney Fish			X									Wick in review
	***Albula* sp.**	Boney Fish			X									Schubert et al. 2017; Wick current research 2021
	Amia uintaensis	Bowfin Fish			X									Lehman 1985
	Amiinae indet.	Bowfin Fish			X									Wick in review
	Amiidea indet.	Bowfin Fish			X									Lehman 1985; Standhardt 1986; Rowe et al. 1992
	cf. *Anomoeodus* sp.	Boney Fish			X									Wick in review
	***Atractosteus* sp.**	Gar			X									Standhardt 1986; 1995
Boney FISHES	**cf. ?*Coriops* sp.**	Boney Fish			X									Wick current research 2021
	***Cylindracanthus* sp.**	Boney Fish			X									Montgomery and Clark 2016
	Ellimmichthyiformes indet.	Boney Fish			X									Wick in review
	aff. *Enchodus* sp.	Boney Fish			X									Wick in review
	?*Enchodus* sp.	Boney Fish			X									Schubert et al. 2017
	Eotexachara malateres •	Boney Fish			X									Wick 2021c
	cf. Gonoryhnchiformes indet.	Boney Fish			X									Wick in review
	Hiodontidae indet.	Boney Fish			X									Wick in review
	Laminospondylus transversus	Boney Fish	X											*Cooper et al. current research

CLASS	TAXON	COMMON NAME	FORMATIONS											REFERENCES
			BO	PN	AG	JV	KBP	PgBP	HH	CN	CH	DE	BS	
OSTEICHTHYES (Continued)														
Boney FISHES	*?Lepidotes* sp.	Boney Fish			X									Schubert et al. 2017
	Lepisosteus occidentalis	Gar			X									Sankey 1998
	Lepisostidae indet.	Gar		X	X	X	X	X	X					Davies 1983; Standhardt 1986; Rowe et al. 1992
	Melvius thomasi	Bowfin Fish			X									Boreske 1974; Standhardt 1986; Rowe et al. 1992
	Melvius sp.	Bowfin Fish			X									Lehman et al. 2019
	cf. *Melvius* sp.	Bowfin Fish			X									Wick in review
	cf. *Micropycnodon* sp.	Boney Fish			X									Wick in review
	Ostariophysi indet.	Boney Fish			X									Wick in review
	Osteichthyes indet.	Indet.	X		X	X								Standhardt 1986; Schubert et al. 2017
	cf. *Wilsonichthys* sp.	Boney Fish			X									Wick in review
	Paralbula casei	Boney Fish			X									Schubert et al. 2017
	Paralbula cf. *P. casei*	Boney Fish			X									Wick in review
	Paralbula sp.	Boney Fish			X									Montgomery and Clark 2016
	Primuluchara laramidensis •	Boney Fish			X									Wick 2021c
	Phyllodonitdae indet.	Bonefish			X									Sankey 1998; Rowe et al. 1992
	Semionotifomes	Boney Fish			X									Wick, current research 2021
	?Stephanodus sp.	Boney Fish			X									Schubert et al. 2017
	Teleostei indet.	Indet.			X	X	X							Lehman 1985; Standhardt 1986
	cf. *Xiphactinus* sp.	Boney Fish		X										Lehman current research
AMPHIBIA														
FROGS, TOADS, SLAMANDERS	*Albanerpeton* cf. *galaktion*	Salamander			X									Wick 2021a
	Albanerpeton gracile	Salamander			X									Wick 2021a
	Albanerpeton nexousum	Salamander			X									Standhardt 1986; Wick 2021
	Albanerpeton sp.	Salamander			X									Rowe et al. 1992; Sankey 1998
	Anura indet. (multiple species)	Frog			X			X						Standhardt 1986; Rowe et al. 1992; Wick 2021b
	Bufo cf. *B. marinus*	True Toad											X	Stevens 1977; Stevens and Stevens 1989
	Habrosaurus dilatus	Salamander				X								Standhardt 1986
	Opisthotriton kayi	Salamander				X								Standhardt 1986
	Scapherpeton sp.	Salamander			X									Sankey 1998; Montgomery and Clark 2016
	Scapherpeton tectum	Salamander			X									Standhardt 1986
REPTILIA														
TURTLES, LIZARDS, CROCODYLIANS, PTEROSAURS, DINOSAURS	*Adocus* sp.	Turtle			X									Lehman 1985
	Agujaceratops mariscalensis •	Dinosaur			X									Lucas et al. 2006
	Agujaceratops mavericus •	Dinosaur			X									Lehman et al. 2017
	Alamosaurus sanjuanensis	Dinosaur				X	X							Lehman and Coulson 2002; Tykoski and Fiorillo 2016
	Alamosaurus ?n. sp.	Dinosaur					X							Fronimos 2010
	Allognathosuchus sp.	Alligator-Like						X	X					Schiebout 1973; Hartnell 1980
	Anguidae indet.	Lizard			X									Sankey 1998
	Angulomasticator daviesi •	Dinosaur			X									Wagner and Lehman 2009
	Ankylosauridae indet.	Dinosaur			X									Standhardt 1986; Rowe et al. 1992
	Anomalepididae indet.	Snake						X						Standhardt 1986
	Apsgnathus triptodon •	Lizard			X									Nydam et al. 2013
	Aspideretes sp.	Turtle			X	X								Lehman 1985; Rowe et al. 1992
	Baena cf. *B. nodosa*	Turtle			X									Lehman 1985
	Baena sp.	Turtle			X	X								Lehman 1985; Rowe et al. 1992
	Basilemys sp.	Turtle			X									Lehman et al. 2019
	cf. *Basilemys* sp.	Turtle			X	X								Davies 1983; Lehman 1985
	Borealosuchus sp.	Crocodylian						X						Brochu 2000
	Bothriagenys mysterion	Lizard			X									Wick and Shiller 2020
	Bothriagenys flectomendax •	Lizard			X									Wick and Shiller 2020
	cf. *Bothriagenys* sp.	Lizard			X									Wick and Shiller 2020
	cf. *Brachychampsa* sp.	Alligator-Like			X	X	X	X						Standhardt 1986
	Bravoceratops polyphemus •	Dinosaur				X								Wick and Lehman 2013
	Bothremys sp.	Turtle			X									Anglen 2001
	Caenagnathidae indet.	Dinosaur			X									Longrich et al. 2010
	Catactegenys solaster •	Lizard			X									Nydam et al. 2013; Wick and Shiller 2020
	Ceratopsidae indet.	Dinosaur			X									Rowe et al. 1992; Lehman et al. 2019; Strain 1940
	Chamops sp.	Lizard			X									Sankey 1998; 2008
	Chamopsiidae indet.	Lizard			X									Wick and Shiller 2020
	aff. Chamopsiidae	Lizard			X									Wick and Shiller 2020
	Champsosauridae indet.	Crocodile-Like						X						Standhardt in Langston et al. 1989
	Chasmosaurus mariscalensis	Dinosaur			X									Lehman 1982, 1989a; Forster et al. 1993*
	Chelonia indet.	Turtle			X				X					Hartnell 1980; Rowe et al. 1992
	Chupacabrachelys complexus •	Turtle			X									Lehman and Wick 2010
	?Claosaurus sp.	Dinosaur			X									Udden 1907*
	Clidastes liodontus	Mosasaur		X										Bell et al. 2013
	Clidastes sp.	Mosasaur		X										Bell et al. 2013
	Compsemys victa	Turtle			X									Standhardt 1986
	aff. *Coniophis* sp.	Snake			X									Wick and Shiller 2020
	Crocodylia indet.	Crocodylian			X					X				Maxwell et al. 1967; Sankey 1998

CLASS	TAXON	COMMON NAME	FORMATIONS											REFERENCES
			BO	PN	AG	JV	KBP	PgBP	HH	CN	CH	DE	BS	
REPTILIA (Continued)														
TURTLES, LIZARDS, CROCODYLIANS, PTEROSAURS, DINOSAURS	***?Crotalus* sp.**	Snake											X	Stevens et al. 1969; Stevens 1977
	***Ctenosaura* or *Sauromalus* sp.**	Lizard										X		Stevens 1977; Steven and Stevens 1989
	***Deinosuchus riograndensis* •**	Crocodylian			X									Colbert and Bird 1954; Anglen and Lehman 2000
	cf. *Deinosuchus* sp.	Crocodylian			X									Lehman et al. 2019
	Denazinemys	Turtle			X									Lucas and Sullivan 2006
	cf. *Denazinemys* sp.	Turtle			X									Lehman et al. 2019
	Dermatemydidae indet.	Turtle						X						Schiebout 1973
	Diplocynodon* cf. *D. stuckeri	Alligator-Like						X						Schiebout 1973
	Dipsosaurus* cf. *D. dorsalis	Lizard										X		Stevens et al. 1969; Steven and Stevens 1989
	cf. *Dromaeosaurus*	Dinosaur			X									Rowe et al. 1992
	Dromaeosauridae indet.	Dinosaur			X									Lehman et al. 2019
	***Dryadissector shilleri* •**	Lizard			X									Wick et al. 2015; Wick and Shiller 2020
	?Dryptosaurus	Dinosaur			X									Udden 1907*
	Dunnophis* cf. *D. microechinis	Snake						X						Standhardt 1986
	***Ectenosaurus* n. sp. +**	Mosasaur												Bell et al. 2013
	cf. *Edmontonia* sp.	Dinosaur			X									Sankey 2010; A.M.N.H. collections records.
	cf. *Edmontosaurus* sp.	Dinosaur				X								Lawson 1972; Davies 1983
	cf. *Euoplocephalus* sp.	Dinosaur			X									Standhardt 1986
	***?Geochelone* sp.**	Tortoise										X		Stevens 1977; Steven and Stevens 1989
	Glyptosaurus* cf. *G. sylvestris	Lizard						X						Standhardt 1986
	Glyptosaurinae indet.	Lizard			X									Sankey 1998, 2008
	Goniopholis* cf. *G. kirtlandicus	Crocodile			X									Lehman 1985
	***Goniophoididae* n. gen. n. sp. +**	Crocodile			X									Lehman et al. 2019
	***Goniopholididae* indet.**	Crocodile			X									Rowe et al. 1992
	***Gopherus* sp.**	Tortoise											X	Stevens et al. 1969; Steven and Stevens 1989
	?Gryposaurus alsatei	Dinosaur				X								Lehman et al. 2016
	***?Gryposaurus* n. sp. o Δ**	Dinosaur			X									Wagner and Lehman 2001
	Hadrosauridae indet.	Dinosaur			X									Strain 1940; Davies and Lehman 1989
	Hadrosauridae n. gen. n. sp. +	Dinosaur				X								Lehman et al. 2019
	***Heloderma texana* •**	Lizard										X		Stevens et al. 1969; Stevens 1977
	cf. *Helopanoplia* sp.	Turtle			X									Sankey 2006, 2010
	***Hoplochelys* sp.**	Turtle						X						Standhardt in Langston et al. 1989; Sankey 2010
	***Hydrargysaurus gladius* •**	Lizard			X									Wick and Shiller 2020
	Hypsilophodontidae indet.	Dinosaur			X									Davies 1983
	***Hypostylos lehmani* •**	Lizard			X									Wick and Shiller 2020
	Kritosaurus* cf. *K. navajovius	Dinosaur			X	X								Davies 1983
	***Kritosaurus* sp.**	Dinosaur				X								Lehman et al. 2016
	***Lambeosaurinae* indet.**	Dinosaur			X									Davies 1983
	cf. *Leidyosuchus* sp.	Alligator-Like			X	X	X	X						Standhardt in Langston et al. 1989
	Leptorhynchos gaddisi	dinosaur			X									Longrich et al. 2013
	Mosasauridae indet.	Mosasaur	X	X	X									Maxwell et al. 1967; Shubert 2013
	Mosasauroidea indet.	Mosasaur	X											Bell et al. 2013
	Necrosauridae indet.	Lizard			X									Rowe et al. 1992; Miller 1997
	***Nodosauridae* n. gen. n. sp. +**	Dinosaur			X	X								Longrich et al. 2010
	Odaxosaurus piger	Lizard			X									Miller 1997; Nydam et al. 2013
	***Odaxosaurus* sp.**	Lizard			X									Rowe et al. 1992; Miller 1997
	Ornithomimidae n. gen. n. sp. +	Dinosaur			X									Lehman et al. 2019
	Ornithomimidae indet.	Dinosaur			X									Longrich et al. 2010
	cf. *Paleosaniwa canadensis*	Lizard			X									Miller 1997
	cf. *Parasaniwa wyomingensis*	Lizard			X									Nydam et al. 2013
	cf. *Parasaniwa* sp.	Lizard			X									Miller 1997
	***Panoplosaurus* sp.**	Dinosaur			X									Coombs 1978
	Paronychodon lacustris	Dinosaur			X									Standhardt 1986; Sankey 2005
	cf. *Paronychodon*	Dinosaur			X									Wick et al. 2015
	***Peneteius* sp.**	Lizard			X									Nydam et al. 2007; Sankey 1998, 2008
	***Phylodactylus* sp.**	Gekko			X									Montgomery and Clark 2016
	Platecarpus planifrons	Mosasaur	X											Bell et al. 2013
	Platecarpus* cf. *P. planifrons	Mosasaur	X											Bell et al. 2013
	Plioplatecarinae indet.	Mosasaur			X									Bell et al. 2013
	Pristichampsus* cf. *P. vorax	Crocodile							X					Langston et al. 1989 (appendix)
	***Provaranosaurus* sp.**	Lizard						X						Maxwell et al. 1967; Standhardt 1986
	***Proxestops* sp.**	Lizard			X									Rowe et al. 1992
	***?Proxestops* sp.**	Lizard			X									Montgomery and Clark 2016
	***Pterosauria* n. gen n. sp. +**	Pterosaur				X								Lehman and Busbey 2007
	***Quetzalcoatlus northropi* •**	Pterosaur				X								Lawson 1975; Langston 1981
	***Quetzalcoatlus* sp.**	Pterosaur				X								Langston 1986; Kellner and Langston 1996
	***Restes* sp.**	Lizard			X									Rowe et al. 1992
	Richardoestesia* cf. *R. gilmorei	Dinosaur			X									Sankey 2001
	cf. *Richardoestesia*	Dinosaur			X									Rowe et al. 1992; Wick et al. 2015
	Russellosaurinae indet.	Mosasaur	X											Bell et al. 2013

CLASS	TAXON	COMMON NAME	FORMATIONS											REFERENCES
			BO	PN	AG	JV	KBP	PgBP	HH	CN	CH	DE	BS	
REPTILIA (Continued)														
TURTLES, LIZARDS, CROCODYLIANS, PTEROSAURS, DINOSAURS	***Richardoestesia isoceles*** •	Dinosaur			X									Sankey 2001
	***Sauriscus* sp.**	Lizard			X									Rowe et al. 1992
	***Saurolophinae* indet.**	Dinosaur				X								Lehman et al. 2016
	Saurornitholestes langstoni	Dinosaur			X									Sankey 2001
	cf. *Sauromitholestes*	Dinosaur			X									Rowe et al. 1992; Wick et. al 2015
	***Saurornitholestes* indet.**	Dinosaur			X									Sankey 2010
	Serpentes indet.	Snake			X									Rowe et al. 1992; Nydam et al. 2013
	cf. *Socognathus* sp.	Lizard			X									Wick and Shiller 2020
	cf. *Stegoceras* sp.	Dinosaur			X									Lehman 1985
	***?Stegoceras* sp.**	Dinosaur			X									Lehman 2010
	Teiidae indet.	Lizard			X									Rowe et al. 1992; Sankey 1998, 2008
	Terlinguachelys fischbecki •	Sea Turtle			X									Lehman and Tomlinson 2004
	Texacephale langstoni •	Dinosaur			X									Longrich et al. 2010
	Therapoda indet.	Dinosaur			X									Wick et al. 2015
	Thescelus* cf. *T. insiliens	Turtle			X									Lehman 1985
	***Thescelus* sp.**	Turtle			X									Lawson 1972
	Titanosauridae indet.	Dinosaur				X								Wick and Lehman 2014
	Torosaurus utahensis	Dinosaur				X								Lawson 1976; Hunt and Lehman 2008
	Trionychidae indet.	Turtle			X									Sankey 1998; Lehman et al. 2019
	***Troodon* sp.**	Dinosaur			X	X								Standhardt 1986; Sankey 1998
	cf. *Troodon*	Dinosaur			X									Rowe et al. 1992
	Tyannosauridae indet.	Dinosaur			X	X	X							Lehman 1985; Sankey 2010; Wick et al. 2015
	Tyrannosaurinae indet.	Dinosaur			X									Lehman and Wick 2012
	Tyrannosaurus rex	Dinosaur												Lawson 1976
	?Tyrannosaurus* cf. *T. rex	Dinosaur				X								Wick 2014
	Tyrannosaurus vannus **Δ**	Dinosaur				X								Lawson 1972
	Tylosaurus kansasensis	Mosasaur	X											Bell et al. 2013
	Tylosaurus nepaeolicus	Mosasaur	X											Bell et al. 2013
	***Tylosaurus* sp.**	Mosasaur	X	X										Bell et al. 2013
	***Tylosaurus* indet.**	Mosasaur	X											Bell et al. 2013
	Varanoidea indet.	Lizard			X									Nydam et al. 2013; Wick and Shiller 2020
	Xenosauridae indet.	Lizard			X									Rowe et al. 1992; Nydam et al. 2013
REPTILIA misc.														
eggshell fragments	***?Continuoolithus***	unknown			X									Montgomery and Clark 2016
	Ornithischia indet.	Dinosaur			X									Welsh and Sankey 2008
	Saurischia indet.	Dinosaur			X									Welsh and Sankey 2008
	Reptilia indet.	Indet.				X								Lehman and Langston unpublished
coprolite	**Dinosauria indet.**	Dinosaur			X									Baghai-Riding and DiBenedetto 2001
coprolites	**Reptilia indet.**	Indet.			X	X								Coulson 1998; Montgomery and Clark 2016
feeding traces (bite marks)	**Crocodylia indet.**	Crocodile			X									Schwimmer 2002; Lehman and Wick 2010
	Tyrannosauridea indet.	Dinosaur			X	X								Montgomery and Clark 2016
skin impressions	***?Gryposaurus alsatei*** •	Dinosaur				X								Lehman et al. 2016
AVES														
birds	**cf. Aves indet.**	Bird			X	X								Sankey 2005; Wick et al. 2015
MAMMALIA														
PRIMITIVE AND ADVNCED MAMMALS	***Albertatherium primus***	Marsupial			X									Brink 2015; 2016
	Alphadon* cf. *A. marshi	Marsupial			X	X								Standhardt 1986
	Alphadon halleyi	Marsupial			X									Brink 2015; 2016
	Alphadon* cf. *A. halleyi	Marsupial			X									Sankey 1998
	Alphadon* cf. *A. sahnii	Marsupial			X									Sankey 1998
	Alphadon* cf. *A. wilsoni	Marsupial			X									Rowe et al. 1992
	***Alphadon* n. sp. +**	Marsupial			X									Rowe et al. 1992
	***Alphadon* sp.**	Marsupial			X									Sankey 2001; Montgomery and Clark 2016
	Alphadon perexiguus •	Marsupial			X									Cifelli 1994
	***Aquascalientia* sp.**	Camelid										X		Stevens 1977; Stevens and Stevens 1989
	***Aquiladelphis* sp.**	Marsupial			X									Brink 2015, 2016
	Archaeolagus buangulus	Rabbit										X		Stevens et al. 1969
	Archaeolagus* cf. *A. acaricolus	Rabbit										X		Stevens et al. 1969
	Arctocyonides* cf. *A. ferox	Carnivore						X						Schiebout 1974
	Baioconodon	Condylarth						X						Standhardt 1995
	Barylambda jackwilsoni	Pantodont						X						Schiebout 1974
	***Barylambda* sp.**	Pantodont							X					Hartnell 1980
	Bomburia prisca	Condylarth						X						Standhardt 1995
	?Brachyerix hibbardi	Hedgehog										X		Stevens 1977
	Buisnictis chisoensis •	Skunk											X	Stevens et al. 1969; Stevens and Stevens 1989
	Caenolambda jepseni	Pantodont						X						Hartnell 1980
	Caenolambda pattersoni	Pantodont						X						Hartnell 1980
	***Caenolambda* sp.**	Pantodont						X						Schiebout 1974
	Canidae indet.	Carnivore										X		Stevens et al. 1969; Stevens 1977
	Carsioptychus coarctatus	Condylarth						X						Standhardt 1986, 1995
	Cedaromys* cf. *C. hutchisoni	Multituberculate			X									Brink 2015, 2016

CLASS	TAXON	COMMON NAME	FORMATIONS											REFERENCES
			BO	PN	AG	JV	KBP	PgBP	HH	CN	CH	DE	BS	
MAMMALIA (Continued)														
PRIMITIVE AND ADVANCED MAMMALS														
	Chiromyoides caesor	Primate						X						Schiebout 1974
	Chriacus baldwini	Racoon-Like						X						Schiebout 1974
	***Cimexomys* sp.**	Multituberculate			X									Sankey 2001
	***Cimolomyidae* n. gen. n. sp. +**	Multituberculate			X									Standhardt 1986
	Cimolodon* cf. *electus	Multituberculate			X									Rowe et al. 1992
	***Cimolodon* sp.**	Multituberculate			X									Brink 2015, 2016
	cf. *Cimolodon* sp.	Multituberculate			X									Rowe et al. 1992
	Cimolomys clarki	Multituberculate			X									Rowe et al. 1992
	***Cimolomys* sp.**	Multituberculate			X									Sankey 2001
	***Citellus* n. sp. +**	Ground squirrel											X	Stevens 1977; Stevens and Stevens 1989
	***Coryphodon* sp.**	Pantodont							X					Maxwell et al. 1967; Hartnell 1980
	Dakotamys shakespeari	Multituberculate			X									Brink 2015, 2016
	***Delahomeryx browni* •**	Deer-Like										X		Stevens et al. 1969; Stevens and Stevens 1989
	***?Deuterogonodon* sp.**	Carnivore						X						Schiebout 1974
	Ectocion* cf. *E. montanensis	Condylarth						X						Schiebout 1974
	Ectypodus musculus	Multituberculate						X						Schiebout 1974
	Ellipsodon priscus	Condylarth						X						Standhardt 1986
	***Eoalphadon* n. sp. +**	Marsupial			X									Brink 2015, 2016
	Eoconodon coryphaeus	Condylarth						X						Standhardt 1986
	***Eoconodon* sp.**	Condylarth						X						Standhardt 1986
	Epicyon haydeni	Carnivore											X	Stevens and Stevens 2003
	Epihippis gracilis	Primitive Horse									X			Runkel 1988
	Eucosmodontidae indet.	Multituberculate			X									Standhardt 1986
	cf. *Eucyon* sp.	Fox-Like											X	Stevens and Stevens 2003
	?Ferugliotheriidae	?Multituberculate			X									Brink 2015, 2016
	***Gallolestes agujaensis* •**	Eutherian			X									Cifelli 1994
	***Gallolestes* sp.**	Eutherian												Rowe et al. 1992
	***?Gallolestes* n. sp. +**	Eutherian			X									Brink 2015, 2016
	***Gelestops* sp.**	Shrew-Like				X								Standhardt 1986, 1995
	***Gregorymys riograndensis* •**	Gopher										X		Stevens 1977
	Haplaletes disceptatrix	Condylarth						X						Schiebout 1974
	Haploconus inopinatus	Condylarth						X						Standhardt 1986, 1995
	Helohyus lentus	Pig-Like								X				Maxwell et al. 1967
	***Hemiauchenia* sp.**	Camel-Like											X	Stevens et al. 1969; Stevens 1977
	Heteromyidae indet.	Kangaroo Rat										X	X	Stevens et al. 1969; Stevens 1977
	Hyopsodus* cf. *H. paulus	Weasel-Like								X				Runkel 1988
	Hyopsodus* cf. *H. wortmani	Weasel-Like							X					Hartnell 1980
	Hyopsodus miticulus	Weasel-Like							X					Hartnell 1980
	***Hyopsodus* sp.**	Weasel-Like								X				Runkel 1988
	***Hypolagus* n. sp. +**	Rabbit											X	Stevens 1977; Stevens and Stevens 1989
	***Hypsiops leptoscelos* •**	Oreodont										X		Stevens et al. 1969
	Hypsiops* cf. *H. luskensis	Oreodont										X		Maxwell et al. 1967
	Hyrachyus* cf. *H. modestus	Tapir-Like								X				Maxwell et al. 1967
	***Hyrachyus* sp.**	Tapir-Like										X		Stevens et al. 1969; Stevens and Stevens 1989
	Hyracotherium angustidens	Horse-Like						X	X					Scheibout 1974
	Hyracotherium vasacciense	Horse-Like							X					Maxwell et al. 1967; Hartnell 1980
	cf. *Isectolophus*	Tapir-Like								X				Runkel 1988
	***?Janumys* sp.**	Multituberculate			X									Brink 2015, 2016
	***Jepsenella* n. sp. +**	Elephant shrew-like						X						Schiebout 1974
	***Lambdotherium* sp.**	Brontothere							X					Maxwell et al. 1967
	Lambertocyon eximius	Conylarth						X						Schiebout 1974; Gingerich 1979
	Leptocyon* cf. *L. vafer	Carnivore											X	Stevens et al. 1969; Stevens and Stevens 1989
	Leptoreodon edwardsi	Deer-LIke								X				Runkel 1988
	Leptoreodon pusillis	Deer-Like								X				Runkel 1988
	cf. *Loxolophus* sp.	Primitive Omnivore						X						Langston et al. 1989 (appendix)
	Mammalia n. sp.	"Tribotheria"												Rowe et al. 1992
	***Martes* sp.**	Marten-Like											X	Stevens and Stevens 2003
	***?Megatylopus* sp.**	Large Camelid											X	Stevens 1977; Stevens and Stevens 1989
	***Meniscoessus* n. sp. +**	Multituberculate			X									Rowe et al. 1992
	***Meniscoessus* sp.**	Multituberculate			X	X								Standhardt 1986; Brink 2015, 2016
	Menodus bakeri	Brontothere									X			Wilson 1977
	Merychyus* cf. *M. calaminthus	Oreodont										X		Stevens 1977; Stevens and Stevens 1989
	***Mesodma* sp.**	Multituberculate			X									Sankey 2001
	Mesdoma thompsoni	Multituberculate						X						Standhardt 1986
	Mesocyon venator	Canid										X		Stevens et al. 1969; Stevens and Stevens 1989
	***Mesodma* sp.**	Multituberculate			X									Sankey and Gose 2001; Montgomery and Clark 2016

CLASS	TAXON	COMMON NAME	FORMATIONS											REFERENCES
			BO	PN	AG	JV	KBP	PgBP	HH	CN	CH	DE	BS	
MAMMALIA (Continued)														
PRIMITIVE AND ADVANCED MAMMALS	***Metamynodon mckinneyi***	Rhinoceros-Like								X				Runkel 1988
	?Michenia australis	Camel-Lke										X		Stevens et al. 1969; Stevens 1977
	Mimetodon silberlingi	Multituberculate						X						Schiebout 1974
	***Mioclaenidea* n. gen. n. sp. +**	Condylarth						X						Standhardt 1995
	Mixodectes malaris	Rodent-Like						X						Standhardt 1986
	***?Mookomys* sp.**	Rodent										X		Stevens et al. 1969
	***Moschoedestes delahoensis* •**	Rhinoceros										X		Stevens et al. 1969
	Multituberculata n. gen. n. sp. +	Multituberculate			X									Rowe et al. 1992
	Nannodectes* cf. *gidleyi	Primate-Like						X						Schiebout 1974; Gingerich 1976
	Nanotragulus ordinatus	musk-deer										X		Stevens 1977; Steven and Stevens 1989
	Navajovius kohlhaasae	Primate						X						Schiebout 1974
	cf. *Neohipparion*	Horse-Like											X	Stevens et al. 1969; Steven and Stevens 1989
	Neoplagiaulax douglassi	Multituberculate						X						Hartnell 1980
	Neoplagiaulacidae	Multituberculate			X									Rowe et al. 1992
	cf. *Nimravides catocopis*	Felid											X	Stevens and Stevens 2003
	?Nothocyon* cf. *N. annectens	carnivore										X		Stevens et al. 1969
	Omomyidae indet.	Primate								X				Runkel 1988
	Oxydactylus* cf. *gibbi	Camel-Like										X		Maxwell et al. 1967
	Palaechthon* cf. *woodi	primate						X						Standhardt 1986
	***?Palaeictops* sp.**	"Hedge-rat"						X						Schiebout 1974
	***Paleomolops langstoni* •**	Tritubercuate			X									Cifelli 1994
	Paleotomus senior	Carnivore						X						Standhardt 1986
	Paracimexomys* cf. *P. perplexus	Multituberculate			X									Brink 2015, 2016
	***Paracimexomys* sp.**	Multituberculate												Brink 2015, 2016
	cf. *Paracimexomys*	Multituberculate			X									Sankey 2001
	***Paracimexomys* ?n. gen. n. sp. +**	Multituberculate			X									Brink 2015, 2016
	***Paracimexomys* indet.**	Multituberculate			X									Brink 2015, 2016
	Paramys excavatus	Rodent							X					Hartnell 1980
	***?Paranyctoides* sp.**	Eutherian			X									Brink 2015, 2016
	Parectypodus sinclairi	Multituberculate						X						Schiebout 1974; Standhardt 1986
	Parectypodus sloani	Multituberculate						X						Schiebout 1974
	***?Paroligobunis* sp.**	Weasel-Like										X		Stevens et al. 1969
	Pediomys* cf. *krejcii	Marsupialk			X									Rowe et al. 1992
	***?Peratherium* sp.**	Marsupial						X				X		Standhardt 1986; Stevens 1977
	Periptychus carinidens	Condylarth						X						Maxwell et al. 1967; Standhardt 1986
	Periptychus superstes	Condylarth						X						Maxwell et al. 1967
	Phenacocoelus leptoscelos	Oreodont										X		Stevens et al. 1969; Steven and Stevens 1989
	Phenacodus bisonensis	Condylarth						X						Schiebout 1974; Standhardt 1986
	Phenacodus* cf. *P. matthewi	Condylarth						X						Hartnell 1980
	Phenacodus grangeri	Condylarth						X						Hartnell 1980
	Phenacodus primaevis	Condylarth						X	X					Schiebout 1974; Maxwell et al. 1967
	Phenacolemur* cf. *P. praecox	Primate							X					Hartnell 1980
	Phenacolemur frugivoris	Primate						X						Schiebout 1974; Hartnell 1980
	Plesiadapsis gidleyi	Primate-Like						X						Hartnell 1980
	***Pliohippus* or *Astrohippus* sp.**	Horse-Like											X	Stevens 1977; Steven and Stevens 1989
	***Priscocamelus wilsoni* •**	Camel-Like										X		Stevens et al. 1969; Steven and Stevens 1989
	Prolapsus sibilatoris	Large rodent								X				Runkel 1988
	Prolapsus junctionis	Large Rodent								X				Runkel 1988
	Promioclaenus acolytus	Condylarth						X						Schiebout 1974; Hartnell 1980
	***Promioclaenus* sp.**	Condylarth						X						Standhardt 1986
	***Prothryptacodon* sp.**	Condylarth						X						Standhardt 1986
	***Protictis* n. sp. +**	Weasel-Like						X						Standhardt 1986
	Protoreodon pumilis	Oreodont								X	X			Runkel 1988
	Protoselene opisthacus	Condylarth						X						Schiebout 1974
	cf. *Pseudaelurus* sp.	Felid											X	Stevens and Stevens 2003
	Psittacotherium multifragum	Taeniodont						X						Maxwell et al. 1967; Schoch 1981
	Ptilodontoidea indet.	Multituberculate			X									Standhardt 1986
	Ptilodus douglassi	Multituberculate						X						Maxwell et al. 1967
	Ptilodus mediaevus	Multituberculate						X						Schiebout 1974
	***Ptilodus* n. sp. +**	Multituberculate						X						Standhardt 1986
	***Ptilodus* sp.**	Multituberculate						X						Standhardt 1986
	Similisciurus maxwelli	Squirrel-Like										X		Stevens 1977
	Spalacolestinae indet.	Symmetrodont			X									Brink 2015, 2016
	?Stagnodontidae indet.	Marsupial			X									Brink 2015, 2016
	***Stenomylus* sp.**	Camelid										X		Stevens 1977; Steven and Stevens 1989
	Stenomylus* cf. *S. crassipes	Camelid										X		Maxwell et al. 1967
	Stygimys vastus	Multituberculate						X						Standhardt 1986
	Symmetrodontoides foxi	Symmetrodont			X									Brink 2015, 2016
	Tetraclaenodon puercensis	Condylarth						X						Maxwell et al. 1967
	Titanoides zeuxis	Pantodont						X						Schiebout 1974

CLASS	TAXON	COMMON NAME	BO	PN	AG	JV	KBP	PgBP	HH	CN	CH	DE	BS	REFERENCES
MAMMALIA (Continued)														
PRIMITIVE AND ADVANCED MAMMALS	***Tricentes truncatus***	Condylarth						X	X					Hartnell 1980
	cf. *Triplopus*	Rhinoceros-Like									X			Wilson and Schiebout 1984; Runkel 1988
	Turgidodon* cf. *T. lillegraveni	Marsupial			X									Cifelli 1994
	***Turgidodon* n. sp. +**	Marsupial			X									Rowe et al. 1992
	?*Turgidodon* n. sp. +	Marsupial			X									Brink 2015; 2016
	Uintacyon scotti	Marten-Like									X			Maxwell et al. 1967
	?*Varalphadon* sp.	Marsupial			X									Brink 2015; 2016
	***Viridomys* n. sp. +**	Multituberculate						X						Standhardt 1986
	***Vulpes* sp.**	Canid											X	Stevens and Stevens 2003
	?*Zanycteris* sp.	Early Primate						X						Schiebout 1974
	HOLOTYPE = •		Boquillas Formation	Pen Formation	Aguja Formation	Javelina Formation	Cretaceous (K) Black Peaks Formation	Paleogene Black Peaks Formation	Harnold Hill Formation	Canoe Formation	Chisos Formation	Delaho Formation	Banta Shut-in Formation	
	UNPUBLISHED NEW TAXON = Δ		UPPER CRETACEOUS (K)					PALEOGENE (Pg)				NEOGENE		
	UNNAMED NEW TAXON = +		FORMATIONS											

MISCELLANEOUS	**THE FOLLOWING VERTEBRATE TAXA HAVE ALSO BEEN FOUND IN BIBE:**			
	Coprolites (fossil dung)	indet.	**Paleocene Black Peaks Formation**	Schiebout 1970
	Elephantidae indet.	Mammoth	**Pleistocene caliche-silt deposit (cienega lake)**	Eley 1938; Maxwell et al. 1967
	Osteichthyes indet.	Fish	**Sue Peaks Formation (Lower Cretaceous - marine)**	Tarasconi 2000
	Gymmogyps califwnianus	Condor	**Holocene deposits in cliffside grottos**	Wetmore and Friedmann 1933

* "*Lambdotherium*" originally identified in Maxwell 1967, p. 104. This specimen was later re-identified in 1975 as cf. *Phenacodus primaevus* or *grangeri* by J. A. Wilson as noted on the specimen card in the collections of the vert. paleo lab at U. T. Austin (specimen # TMM 40181-1). Verified on-site by S. Wick, 5-30-2012.
* Cooper et al. (current research) indicates taxa collected by Roger Cooper and colleagues, currently residing in the collections of the Texas Memorial Museum (copies of this record on file at BBNP). Please note that 'current research' may ultimately result in taxonomic revision.
* Udden 1907. Udden's identification of fossil taxa from Big Bend National Park (e.g. *Cloasaurus*) was based upon the information available at the time. Some of these may no longer be considered taxonomically valid or are in error based on continuing research but are herein included as they are contained iwithin a relevant paleontological report. Furthermore, in some cases, Udden does not specify exact provenience for all specimens reported. It is therefore possible that some taxa identified in his report wer found outside of today's Big Bend National Park in nearby areas.
* *Chasmosaurus marsicalensis* renamed *Agujaceratops mariscalensis* (see entry above).

Formations) are apparently devoid of them in many stratigraphic exposures and horizons while other outcrops are locally productive. In uncommon cases, numerous bones pertaining to a single individual have been found in close association or (more rarely) in articulation (e.g., Lehman and Wick 2010; Tykoski and Fiorillo 2016). However, complete skeletons are unheard of in BIBE. This circumstance has vexed many of us who have spent decades searching for good specimens in the park. However, it is very likely that deposition rates did not favor the rapid burial of carcasses here.

Although complete fossilized bones are infrequently encountered in Late Cretaceous strata, conspicuous vertebrate fossils are less common in Tertiary strata of BIBE. Although some larger, associated specimens have been discovered (e.g., Wilson 1967) most Tertiary fossil taxa have been diagnosed from small bone fragments or isolated teeth (e.g., Stevens et al. 1969; Schiebout 1974; Standhardt 1986).

Vertebrate microfossils are also common within both Cretaceous and Tertiary strata of BIBE although finding especially productive sites is remarkably challenging. Furthermore, although some microvertebrate specimens can be surface picked in the field, much of the microfossil material so far reported from the park has been collected via screen-washing or acidization of bulk matrix and collected microscopically (sometimes over years) in the laboratory – a laborious process. In any case, the critical importance of vertebrate microfossil sites cannot be overstated. Microfossils representing multiple, coexisting species from a single locality almost always tell scientists much more about an ancient ecosystem than do large, isolated bones or partial skeletons of a single animal. For example, just a handful of highly productive sites within the Aguja Formation have produced thousands of microvertebrate fossil specimens (including several new species) and contributed immeasurably to our understanding of Late Cretaceous terrestrial ecosystem of southern North America (e.g., Standhardt 1986; Rowe et al. 1992; Sankey 2008, 2010; Nydam et al. 2013; Wick et al. 2015; Wick and Shiller 2020; Wick 2021a, b, c).

Another significant circumstance is that BIBE sits apart geographically from other regions in North America that have produced fossils of similar age and type (e.g., Late Cretaceous vertebrate fossil-bearing locations in northern Mexico, New Mexico, Montana, and southern Canada among others). This allows for the study of vertebrate faunas from an interregional standpoint to better define endemic faunal regions, taphonomic relationships, continental paleoenvironmental regimes, as well as evolutionary processes unique to one region versus another (sensu Lehman 1997, 2001).

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After acceptance of the current work, the author was made aware of the recent discovery of the new pterosaur Javelinadactylus sagebieli n. gen. n. sp. from the Javelina Formation in Big Bend National Park (Campos 2021).

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ZITTELIANA
An International Journal of Paleontology and Geobiology

Phillip Burton "PB" Snyder

June 25th 1927—March 25th 2024

Phillip Burton "PB" Snyder, 96, of Boerne, Texas passed away on Monday, March 25, 2024. Services will be held at 10:00 AM on Friday, May 17, 2024 at Fort Sam Houston National Cemetery in San Antonio. The ceremonies will include full naval honors and joint interment with his beloved wife, Betty Jean Wentworth Snyder.

P.B. Was born on June 25, 1927, in Vernon, Texas to Leslie J. Snyder and Gwendolyn Watston Snyder. He grew up in the “oil patch" as his father was a career petroleum explorer and Texas Railroad Commission superintendent. From 1930, he lived in San Antonio where he graduated from Harlandale High School in 1944. At age 17 he enlisted in the U.S. Navy, serving in the World War II Asia-Pacific theater as a radarman. In 1946, he met Betty Jean Wentworth, and they were married for 63 years until her passing in 2009. PB received a B.S. Degree in chemistry/geology from Trinity University in 1951; a master of science degree in geology from the University of Texas at Austin in 1968; and a Ph.D. in geology from the University of Texas at Austin in 1972. He retired in 1989 as professor emeritus of geology from Lamar University in Beaumont, Texas. After his retirement, PB and Betty engaged in many adventures traveling the world. They finally settled in Kendall County in 2003.

He is survived by his sons, "Rocky" Snyder and wife Kim James; Grant Snyder and wife "Luly" Snyder; grandchildren: "Abby" Petersen and Joshua Snyder; and great-grandchildren: Barrett Petersen and Blair Petersen.

He was preceded in death by his beloved wife, Betty Jean Wentworth Snyder; his parents; and brother, Donald A. Snyder.

The family would like to express their gratitude towards the many organizations in which PB belonged and was supported by, including the First Baptist Church of San Antonio, the Veterans of Foreign Wars, American Legion, Honor Flight-Alamo Chapter, Soaring Valor, South Texas Geological Society, and the National Museum of the Pacific War where he was a long-time docent.

Instead of floral remembrances, the family suggest that donations can be made to the National Museum of the Pacific War in Fredericksburg, Texas to honor PB's memory.

Arrangements are under the care and direction of the staff of Holt & Holt Funeral Home of Boerne. To share words of comfort with the family, please visit www.holtfh.com.


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Scholarship Night

You are cordially invited to attend the South Texas Geological Society's May Dinner & Scholarship Night. The evening's special guest and presenter will be the esteemed author, Neil Bockoven for his topic of Paleo Cave Art Mysteries.

This formal event will be catered with drinks and will be held at the Petroleum Club. Please register at STGS.org.

16th of May, 2024 6:00 PM to 9:00 PM

Petroleum Club, 8620 N New Braunfels,
San Antonio, Texas, 78215, Suite 700

Presenter: Neil Bockoven
Topic: Paleo Cave Art Mysteries

$50 for students
$70 for STGS members
$75 for non-members
Register at STGS.org

SAVE THE DATE! MAY 9, 2024 Energy Professionals Hiring Event

9 MAY 2024 - IN PERSON Job Fair - 1000-1400 CDT - HOUSTON - NRG PARK - ROOM TBD

You are cordially invited to attend the "ENERGY PROFESSIONALS HIRING EVENT" hosted by the Society of Petroleum Engineers – Gulf Coast Section. We strive to provide a platform for experienced upstream and energy professionals and industry companies to e-meet and create value for both sides.

JOB SEEKERS

Welcome to the SPE Spring 2024 Energy Professional Hiring Event! This event provides job seekers opportunities to meet with potential energy industry hiring companies in upstream oil and gas and renewables.

Event registration is PREFERRED (though walk-ins are welcome), and a resume/CV must be submitted at least 48 hours before the event. Various Event entry times are available for registration to allow job seekers ample time to meet with companies. Job seeker qualifications include:

QUALIFICATIONS:

Be an active member of either SPE or any professional collaborative organization (click here for a summary of participating collaborative organizations). Provide proof of active membership.

And possess a university degree equivalent to a 4-year bachelor's degree in engineering or applied sciences or a 4-year degree in a field other than science or engineering and technical experience working in the energy sector and projects.

Or possess a 2-year science or engineering degree and technical experience working in the energy sector and projects.

https://www.spegcs.org/hiring-event/

9th Annual

TEXAS HYDRO~GEO WORKSHOP

Oct 4-6, 2024

Aquatic biology, hydrology, geology, and environmental science

Over 35 modules on a wide range of field data collection methods

- How to collect water, soil, and rock samples
- Calibrate and utilize field instruments
- Work with soil probes and water wells
- Perform surface and borehole geophysics
- Perform tracer (dye) testing
- Discharge gaging of surface streams
- Collect and identify aquatic biologic material
- Use GIS field mapping applications
- Karst feature evaluation
- Collect water level measurements
- And much more

Keynote speaker

Cynthia Delaney Palomares, P.G.,P.E.
See her full bio on our web.
The Keynote takes place in Cave Without a Name.

Early Registration

$55 Mar 15 – May 14

$65 May 15 – Sep 14

$75 Sep 15 – onsite

Reserve your place early, the Hydro~Geo Workshop has historically sold out!

For students, practitioners, and academics

The Workshop provides the opportunity to work with leading researchers and practitioners from across the state and the nation for collecting, processing, and analysis of field data.

Cave WITHOUT A NAME

Location and lodging

Camping sites are provided as part of the registration fee at Cave Without a Name,

325 Kruetzberg Road, Boerne, Texas

hydrogeoworkshop.org

Like us on FaceBook!

The Texas Hydro Geo Workshop is a 501c3 non-profit incorporated in the state of Texas

Luncheon Speakers

Thank you to all of our incredible luncheon speakers from this year! You are our backbone and the reason why our luncheons are so great. We couldn't do it without you!

If you are interested in presenting to a future STGS Luncheon, contact any board member.

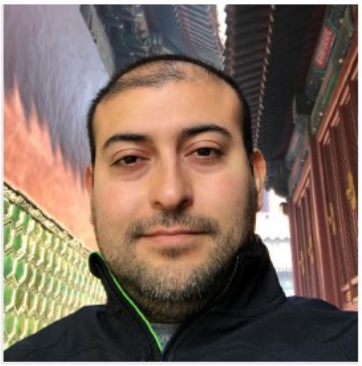
Danny Williams

Chad Williams

Dr. Gregg Eckhardt

Kristoffer Rimaila

Dr. Robert Loucks



Gabriel Gil

Carl Symcox

Dr. Wahid Rahman

Neil Bockoven

Directory

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