Zitteliana 95, 2021, 95–134 | DOI 10.3897/zitteliana.95.73026

SNSB Bayerische Staatssammlung für Paläontologie und Geologie

ZITTELIANA
An International Journal of Paleontology and Geobiology

# 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

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*http://zoobank.org/AE8073E6-878D-41F8-A1A4-8335713E7547*

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Academic editor: Oliver Rauhut ♦ **Received** 14 August 2021 ♦ **Accepted** 8 October 2021 ♦ **Published** 19 November 2021

## 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-in-progress. 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 inter-tonguing facies (Lehman 1985). These deposits have yielded fossilized trees, oysters, turtles, crocodiles, dinosaurs, and mammals. This was a time of remarkable

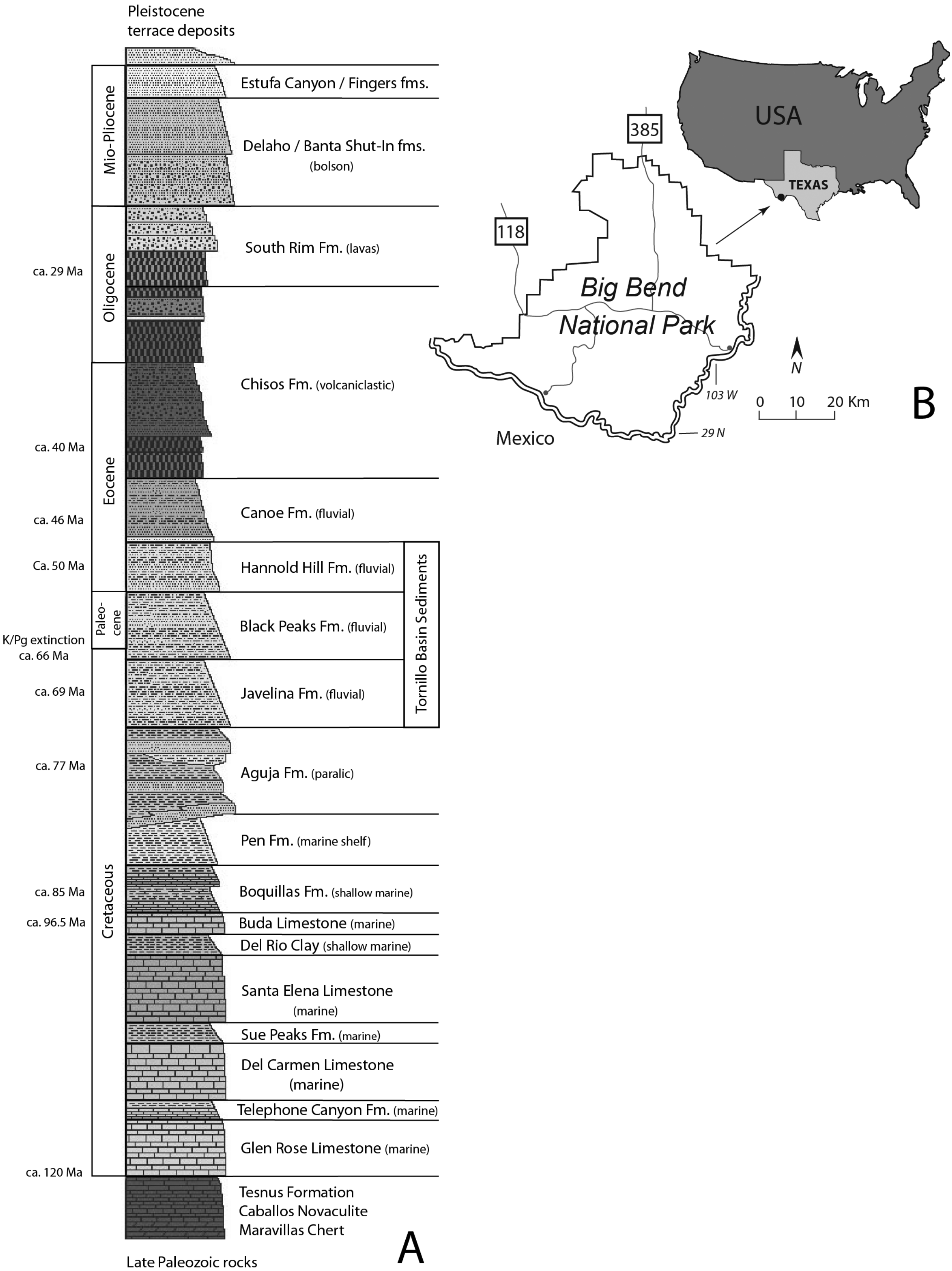


**Figure 1.** Generalized stratigraphic column (**A**) exposed within Big Bend National Park, Texas, USA (**B**). Approximate absolute stratigraphic ages are based upon biostratigraphic and radiometric information from multiple sources (Maxwell et al. 1967; Lehman et al. 2006; Befus et al. 2008; Tiedemann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

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. 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 make-up 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 inter-tongue 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-year-long 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 fine-grained 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 paleo-forests (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 an-

**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 |

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| | | GR | TC | DC | SE | DR | BO | PN | AG | JV | BP | HH | CN | |
| **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 |

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| **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 |

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| **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 = •**<br>**UNPUBLISHED NEW TAXON = Δ**<br>**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** | | |
| | | **FORMATIONS** | | | | | | | | | | | | |
| **MISCELLANEOUS** | **Unidentified log fragments** | **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.).

cient 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 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 structure (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 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

**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** | | | | | | | | | | | | | | |
| PLANKTONIC CREATURES | ***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 |
| | ***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 aissan*a** | | | | | | | | 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) | | | | | | | | | | | | | | |
| PLANKTONIC CREATURES | ***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 |
| | ***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 | FORMATIONS | | | | | | | | | | | | REFERENCES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | GR | TC | DC | SP | SE | DR | BU | BO | PN | AG | JV | BP | |
| **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 |

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| | | FORMATIONS | | | | | | | | | | | | |
| **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 brewsterensi*s** | | | | | | | | 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 |

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| **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*** | | | | | | | | | | 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 |

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| **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 |
| CLAMS, OYSTERS, MUSSELS | ***Lingula subspatulata*** | | | | | | | | | | X | | | Eley 1938 |
| | ***Liopistha bella*** | | | | | | | | | | X | | | Eley 1938 |
| | ***Lopha*** **sp.** | | | | | | | | | X | | | | Lehman 1985 |
| | ***Lophia subovata*** | | | | X | | | | | | | | | Maxwell et al. 1967 |
| | ***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 |

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| **BIVALVIA** (Continued) | | | | | | | | | | | | | | |
| CLAMS, OYSTERS, MUSSELS | ***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 |
| | ***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** | | | | | | | | | | | | | | |
| SNAILS, WHELKS | ***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 |
| | ***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 |

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| **GASTROPODA** (Continued) | | | | | | | | | | | | | | |
| SNAILS, WHELKS | ***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 |
| | ***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** | | | | | | | | | | | | | | |
| AMMONITES, NAUTILOIDS | ***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 |
| | ***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 |

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| **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 |

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| **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 |
| | **HOLOTYPE = •**<br>**UNPUBLISHED NEW TAXON = Δ**<br>**UNNAMED NEW TAXON = +** | **GR** Glen Rose Limestone | **TC** Telephone Canyon Formation | **DC** Del Carmen Limestone | **SP** Sue Peaks Formation | **SE** Santa Elena Limestone | **DR** Del Rio Clay | **BU** Buda Limestone | **BO** Boquillas Formation | **PN** Pen Formation | **AG** Aguja Formation | **JV** Javelina Formation | **BP** Black Peaks Formation | |
| | | | LOWER CRETACEOUS | | | | | | UPPER CRETACEOUS | | | | | |

| 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).

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

**Table 3.** Vertebrate fossils.

| CLASS | TAXON | COMMON NAME | FORMATIONS | | | | | | | | | | | REFERENCES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | BO | PN | AG | JV | KBP | PgBP | HH | CN | CH | DE | BS | |
| **CHONDRICHTHEYS** | | | | | | | | | | | | | | |
| CARTILAGINOUS FISHES | ***Anomotodon augustidens*** | Shark | | | X | | | | | | | | | Lehman 1985 |
| | ***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** | | | | | | | | | | | | | | |
| Boney FISHES | **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 |
| | **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 | BO | PN | AG | JV | KBP | PgBP | HH | CN | CH | DE | BS | REFERENCES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | FORMATIONS | | | | | | | | | | | |
| **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 |

TURTLES, LIZARDS, CROCODYLIANS, PTEROSAURS, DINOSAURS

| CLASS | TAXON | COMMON NAME | FORMATIONS | | | | | | | | | | | REFERENCES |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | BO | PN | AG | JV | KBP | PgBP | HH | CN | CH | DE | BS | |
| **REPTILIA** (Continued) | | | | | | | | | | | | | | |
| | **?*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 |

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| **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. *Saurornitholestes*** | 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 |

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| **MAMMALIA** (Continued) | | | | | | | | | | | | | | |
| | ***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 |
| PRIMITIVE AND ADVNCED MAMMALS | ***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 |

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| **MAMMALIA** (Continued) | | | | | | | | | | | | | | |
| PRIMITIVE AND ADVNCED 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* •** | Trituberculate | | | 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 ADVNCED 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 = •**<br>**UNPUBLISHED NEW TAXON = Δ**<br>**UNNAMED NEW TAXON = +** | | **Boquillas Formation** | **Pen Formatrion** | **Aguja Formation** | **Javelina Formation** | **Cretaceous (K) Black Peaks Formation** | **Paleogene Black Peaks Formation** | **Hannold Hill Formation** | **Canoe Formation** | **Chisos Formation** | **Delaho Formation** | **Banta Shut-in Formation** | |
| | | | **UPPER CRETACEOUS (K)** | | | | | **PALEOGENE (Pg)** | | | | **NEOGENE** | | |
| | | | **FORMATIONS** | | | | | | | | | | | |

| CLASS | TAXON | COMMON NAME | FORMATIONS | REFERENCES |
|---|---|---|---|---|
| **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).

(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).

# Acknowledgements

The author is indebted to their colleagues at the Division of Science and Resource Management at Big Bend National Park (especially D. Corrick) for their friendship and support regarding this project as well as the earlier, more comprehensive inventory completed in 2015 – like this account, that work was also a labor of love. I thank M. Brown and J.C. Sagebiel of the Texas Vertebrate Paleontology Laboratory at the Jackson School Museum of Earth Sciences at The University of Texas at Austin for their longtime support of the author's paleontological endeavors and curation of many of the specimens reported herein. T. Lehman and T. Shiller II have provided very useful stratigraphic interpretations and entertaining insights over many paleontological excursions throughout the Big Bend of West Texas. J. Wick is offered an especially kind word of appreciation for supporting the paleontological and geological adventures of the author. The author thanks T. Shiller II and T. Adams for critical reviews that improved the manuscript.

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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