Overview of the geology, paleontology, and geoscience education opportunities of the University of Tennessee at Martin Coon Creek Science Center for visitors, researchers, and docents

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Research Article

Overview of the geology, paleontology, and geoscience education opportunities of the University of Tennessee at Martin Coon Creek Science Center for visitors, researchers, and docents

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ABSTRACT

The Coon Creek Formation is an internationally recognized Upper Cretaceous (Campanian, 76 million-years-old) marine clastic lagerstätten deposit with over 500 identified species of nearly perfectly preserved invertebrates, vertebrates, plants, and trace fossils with original shell geochemistry and paleoecological fidelity preserved. The type-locality and type-section, located in rural McNairy County, Tennessee, was preserved for research and education in 1988 when the Memphis Pink Palace Museum constructed a 232-acre geoscience education facility on the site, now run as the University of Tennessee at Martin Coon Creek Science Center. Visitors to the site participate in a wide variety of geoscience education programming and citizen science research that is based upon open-ended inquiry methodology. On the occasion of the 46th Biennial Convention, hosted at the site by the Eta Alpha Chapter of Sigma Gamma Epsilon (SGE), this paper summarizes the overall geologic setting, general paleontology, geoscience education history, and opportunities of the site for SGE field trip participants, potential researchers, visitors, and potential interns. Additionally, this paper highlights some of the numerous geoscience education programs for docents and research opportunities available for geology students who wish to participate in ongoing research at the site.

KEYWORDS

Coon Creek, Lagerstätte, Cretaceous, Campanian, Fossils, SGE, Eta Alpha, Geoscience Education

INTRODUCTION

The Coon Creek Formation is an Upper Cretaceous (76 million-years-old) clastic lithologic unit that is now considered a lagerstätten, or “mother-load” fossil site (Gibson and Dunagan, 2003; Gibson, 2011). The formation’s lagerstätten status was earned due to its remarkable abundance and species diversity of preserved fossils and the exceptional state of mostly unaltered and uncompacted fossil shell preservation (e.g., Adams, 1994; Noble, 1996; Zepp, 1999; Gibson, 2011). The faunal list is growing, but to date over 500 species of fossil taxa have been identified. The biodiversity includes nearly all major phyla of marine invertebrates, numerous vertebrates (especially fish, turtles, swimming reptiles, and one flying reptile), along with rare plant remains (both marine and terrestrial plants). The Coon Creek Science Center, built on the site of the “old Dave Weeks fossil farm,” is a 232-acre facility that is home to the Coon Creek Formation type locality and type measured section. The late Harvard University evolutionary biologist and paleontologist Stephen J. Gould commented to Pink Palace Museum Director...
Doug Noble at the grand opening of the Coon Creek Science Center in 1988 that “…while Coon Creek is not well known, I believe it is one of the ten or twelve most important fossil sites in North America” (Noble, email communication to Ron Brister, December 17, 2002; Brister, 2016). In 1988, the Coon Creek Science Center (hereafter CCSC) was opened by the Memphis Family of Museums and Pink Palace Museum so that the fossil riches of the site could be preserved and made available for education as well as scientific research (Brister, 2016). The University of Tennessee at Martin (hereafter, UT Martin) contracted to take control of the 232-acre facility in late 2019, just prior to the COVID-19 pandemic, and the site was renamed the University of Tennessee at Martin Coon Creek Science Center (hereafter UTMCCSC). UT Martin used the pandemic shutdown to refurbish and upgrade the site and expand educational programing and research. While there are several published summaries about the history of the discovery and scientific investigations of the Cretaceous fossils in the Coon Creek Formation (e.g., Wade, 1926; Brister, 1994; 2016; Wingard, 2016), until now little has been written concerning the educational programing and impact of the Coon Creek Science Center since 1988, nor has the non-Cretaceous geology of the site been summarized.

The Eta Alpha Chapter of Sigma Gamma Epsilon (SGE), which has been instrumental in the redevelopment and programing at the site since 2017, when negotiations with the Pink Palace Museum for the UT Martin to administer the site began in earnest, is delighted to be able to host the 46th Biennial Convention of the SGE at the site. This paper summarizes the overall geologic setting, general paleontology, geoscience education history, and opportunities of the site for SGE field trip participants, visitors, visiting researchers, and potential interns. Additionally, this paper highlights some of the numerous research opportunities available for geology students who wish to participate in ongoing research at the site.

SITE HISTORY

The type locality for the Coon Creek Formation was originally known as the “Old Dave Weeks Place” in the literature, named after the Weeks family who purchased the property in 1867. In 1888, Dave Weeks purchased the property from his mother (his father had passed away in 1867) for $125, at which point additional acreage was purchased to bring the size of the farm to approximately 250 acres (Brister, 2016). Weeks began to develop it as a subsistence farm concentrating on cotton and corn crops (Wade, 1926; Brister, 1994; Wingard, 2016). Dave Weeks died in 1941 and the farm passed to his brother Tad Weeks. In 1953, the property was purchased by the A.Z. Smith family who built the current house on the site of the Weeks cabin, added a barn (torn down in 2019) and a mailbox identifying the property as “The Fossil Farm.” The Smiths charged visitors by the carload to collect from “the fossil beds” (Brister, 2016). The “old Dave Weeks” house, which was near where the current caretaker house built by the Smiths in 1975 now stands, was abandoned at some point after 1941, but was still standing on the site in the 1970s (Russell and Parks, 1975). It was during the 1970s that the Pink Palace Museum in Memphis began regular collecting trips to The Fossil Farm and began showcasing the fossils in its natural history exhibit in Memphis.

By the late 1980s, the aging Smith family desired to sell the property, but in a way that preserved the fossil deposit for future study. The Pink Palace purchased the site in 1988 for $200,000 and the Coon Creek Science Center (CCSC) was constructed and opened that year (Brister, 2016) and was known by that name until 2019. In the early 1990’s, the University of Tennessee at Martin entered into a relationship with the science center and Pink Palace Museum in which UT Martin served as the coordinator for scientific research and post-secondary education programs on the site by providing paleontological and geological expertise, while the Pink Palace and Coon Creek staff focused on K-12 programs and public programs, especially for the Memphis-Shelby County populous (Gibson, 2011). In late 2019, UT Martin assumed primary control of the facility through a long-term (40-year) lease-agreement and the site was renamed The University of Tennessee at Martin Coon Creek Science Center (UTMCCSC). The Pink Palace Museum underwent reorganization at this time to become the Museum of Science and History (MoSH). MoSH retains ownership of the Coon Creek property itself and serves as the repository for scientifically significant fossils and artifacts collected on the site.

HISTORY OF GEOLOGIC STUDY

The history of geologic study at Coon Creek is filled with luminaries in geology and this history is included into programing for visitors to the site. The Coon Creek Formation takes its name from the modern 2nd-order creek that has eroded into the upper part of the formation at the type locality (Wade, 1926). Coon Creek flows north into White Oak Creek, which then flows east into the Tennessee River.
Fossils from what is now called the Coon Creek Formation, but not collected directly off of the “Old Dave Weeks” place, were first described by Tennessee’s first State Geologist, Gerard Troost (Troost, 1840; Corgan and Gibson, 1991; Gibson and Corgan, 1992), who described fossils being found in the glauconite-rich “green sands” in the region. Troost had embarked on a 29-day trip by horseback and train to West Tennessee from Nashville on October 24, 1833 (Gibson and Corgan, 1992). While conversing with local farmers during his excursion, Troost learned of a water well being dug that had revealed numerous shells and added a side trip to the site to investigate the find. Troost mistakenly identified the fossils as large individuals of the genus Gryphaea; however, the fossils Troost saw were more likely the large, coiled oyster Exogyra (Gibson and Corgan, 1992). The following day he was traveling in what was then Perry County and encountered more marl fossils that included the oyster Ostrea.

Several other prominent Tennessee geologists added to the knowledge of this “green sand marl.” Nelson Saylor (1866) depicted the “green sand marl” as the base of the Cretaceous system on his “An Outline Geological Map of Tennessee,” but it was the second State Geologist of Tennessee James M. Safford (1869) who organized the fossiliferous Cretaceous strata of West Tennessee into a meaningful stratigraphic framework (Wade, 1926). Safford described the “Green Sand or Shell Bed formation” from Hardin, McNairy, and Henderson counties in his seminal “Geology of Tennessee” in 1869. He recognized the green coloring in the sand as coming from the abundant occurrence of the mineral glauconite, also noting that the mineral provided an excellent fertilizer for the area. Safford published a page-long list of the taxa he collected from the “marl” exposed at several localities, but his collection did not come from the location that would become the future type-section. Safford’s fossils were identified by the prominent paleontologists Timothy Abbott Conrad and William More Gabb. Safford (1869) accurately described the most seminal feature of the formation writing, “it abounds in fossils” and that it “is pre-eminently [sic] the shell-bed of the post-Paleozoic beds of West Tennessee.”

The Cretaceous of West Tennessee strata continued to be studied by stratigraphers seeking to trace these beds regionally for economic reasons. In 1906, State Geologist and Vanderbilt University professor L.C. Glenn published an extensive study of the outcropping Cretaceous strata in West Tennessee in which he summarized the distribution and quality of groundwater in the strata. Safford’s 1869 stratigraphic assessment was revised by the influential U.S. Geological Survey stratigrapher and paleontologist Lloyd W. Stephenson when he established the “Ripley Sand Member,” later to become the Coon Creek Formation, as a northward thinning stratigraphic “tongue” in Tennessee within the Ripley Formation (Stephenson, 1914; Stephenson and Monroe, 1940). The Ripley Formation had been named by E.W. Hilgard (1860) for exposures near Ripley, Mississippi and Coon Creek Formation equivalent stratigraphy is still called Ripley Formation outside of Tennessee.

The fauna of the Coon Creek Formation owes part of its pedigree to paleobotanist E.W Berry (1919) who had been working to identify the fossil plants from all West Tennessee deposits, later correlating them with strata along the East Coast. It was Berry who introduced Vanderbilt University geology graduate Bruce Wade, from nearby Trenton, Tennessee, to the exquisitely preserved invertebrate fossils being collected in the region and Wade began his study of the fossils as his PhD dissertation topic at Johns Hopkins University. After publishing over a dozen shorter papers on the Coon Creek Formation from 1917-1922 (e.g., Wade, 1917), his work culminated in his now seminal U.S. Geological Survey Professional Paper 137 “The Fauna of the Ripley Formation on Coon Creek, Tennessee” in 1926 (Wade, 1926; Brister, 1994; Brister, 2016; Wingard, 2016), which is still considered the primary taxonomic guide for most invertebrate fossil groups from the Coon Creek Formation. For a detailed biography of Bruce Wade and comprehensive list of Wade’s publications, the reader is referred to Brister (1994).

The Coon Creek tongue was elevated to formational status in Tennessee by Russell in 1966 as part of the publication of the 1966 Geologic Map of Tennessee (Hardeman et al., 1966) based upon the fact that in Tennessee the Coon Creek Formation sediments differ significantly from the typical Ripley sediments of Mississippi. While the site was known to and visited by many geologists in the years after Wade’s work, there was little paleontological work of significance until 1950, when Norman Sohl, who would later to become president of the Paleontological Society, began fieldwork toward his dissertation from the University of Illinois at Urbana-Champaign under the eminent paleontologist Bernhard Kummel (Wingard, 2016). Norm Sohl’s choice to work on Cretaceous gastropods at Coon Creek was influenced by the U.S. National Museum (Smithsonian Institution) paleontologist Ralph Imlay and U.S. Geological Survey paleontologist John Reeside, with encouragement of U.S.
Geological Survey stratigrapher L.W. Stephenson (Wingard, 2016), thus beginning a long association between the Coon Creek site and the U.S. National Museum (Smithsonian Institution) and the U.S. Geological Survey that continues to this day. Sohl’s thesis (1951) and dissertation (1954) were published as U.S. Geological Survey Professional Papers (Sohl, 1960; 1964a; 1964b), remaining the sole resource on Cretaceous gastropods of the region until Bandel and Dockery (2016).

There are numerous early studies that focused on the biostratigraphy of the Coon Creek Formation. Stephenson (1914) established the biozonation that was used by Wade (1926) utilizing the large oyster *Exogyra* which he used to correlate the Coon Creek Formation (within the *E. costata* biozone, and the included *E. cancellata* subzone) throughout the Gulf coast and upwards along the Atlantic coast. The earliest microfossil studies on the Coon Creek Formation were conducted by Berry and Kelley (1929), Cushman (1931), Berryhill (1955), and Granata (1960). Mosasaurs were known from the Coon Creek Formation since the identifications by C.W. Gilmore published in Wade (1926). Whetstone (1977) identified the first plesiosaur remains from the Coon Creek Formation and turtles were reported by Collins (1951). Bishop (e.g., 1983; 1985; 1991; 2016) described the decapods from the Coon Creek, which has become one of the formation’s most well-known fossils and highly sought after by collectors. There were a few additional studies that included Coon Creek fauna, such as the work of cephalopod studies of Cobban and Kennedy (1993) and Larson (2016).

Perhaps the earliest paleoecological study was conducted by Moore (1974) in an unpublished, but often cited, M.S. thesis from The University of Tennessee, Knoxville, in which Moore updated much of the bivalve taxonomy from Wade’s original work. At the nearby Thompson Farm locality, Dunagan and Gibson (1993) documented *in situ* assemblages mixed with assemblages that showed varying degrees of local reworking attributed to bioturbation (probably mostly by echinoids), which also represents the earliest ichnofossil study from the Coon Creek Formation. Shell repair (Vermeij and Dudley, 1982) and drilling predation studies (e.g., Kelley and Hansen, 1996; Kelley et al., 2001; Kittel et al., 1981) have been the focus of many paleoecological investigations, mostly using museum collections from Coon Creek. Griffin and Gibson (1998), Jones and Gibson (2000a; 2000b), Rhenberg (2007), and Gibson (2023) focused on biotic interactions and taphonomic characteristics preserved in the Coon Creek fauna.

In 2002, UT Martin geologists hosted a special session of invited scientific papers that were presented at the Southeastern Section of the Geological Society of America annual meeting held in Memphis, which was the first scientific symposium devoted to the Coon Creek Formation. It was co-sponsored by the Southeastern Section of the Paleontological Society and the Southeastern Section of the National Association of Geoscience Teachers and included a field trip to visit the site. At this time, the site was recognized as a “lagerstätten deposit” (“motherload deposit”), which is generally considered the highest level of classification for fossil deposits, due to its abundance of pristinely preserved fossils and faithful recording of paleoecological conditions. The papers from this symposium were compiled and published as Alabama Museum of Natural History Bulletin 33, volumes 1 and 2 (Ehret et al., 2016a; 2016b) representing the most comprehensive study of the Coon Creek fauna since Wade’s (1926) original work. These compiled bulletins opened with a summary of the stratigraphy (Ebersole, 2016) and history of the site (Brister, 2016; Wingard, 2016) and included taxonomic studies of plants (Dilcher, 2016), fish otoliths (Stringer, 2016), bryozoans (McKinney and Taylor, 2016), echinoids (Ciampaglio and Phillips, 2016), pterosaurs (Harrell et al., 2016), and palynology (Baghai-Riding et al., 2016), and gastropods (Bandel and Dockery, 2016).

More recently, Vrazo and others (2018) applied carbon isotopes to demonstrate that the decapods in the Coon Creek Formation utilized terrestrial plant-based organic matter as primary in their diet, thus demonstrating the usefulness of stable isotopes to understanding the Coon Creek fauna. Byl and others (2021; 2023), Cunningham and others (2022), and Gibson and others (2022) have reported on the presence of microcystin and saxitoxins, the toxins that cause red tides in modern oceans, preserved within the shells of the Coon Creek fauna. Kovalski and others (2022) and Kovalski (2024) evaluated stable isotopes (e.g., δ18O, Mg/Ca, Ba/Ca, Sr/Ca, and δ13C) to conclude from the bivalve *Pterotrionia thoracica* to infer paleoenvironmental geochemical parameters within the Coon Creek ecosystem. These studies, made possible due to the amazing geochemical preservation of the Coon Creek lagerstätten fauna, may offer a mechanism for the periodic kill events that resulted in several mosasaur skeletons found on the site (Byl et al., 2023). Self-Trail and others (2024), used calcareous microfossils (benthic and planktic foraminifera, calcareous nanofossils, and ostracods) and palynomorphs.
(pollen, spores, algal remains, and dinoflagellates) to refine the geologic age of the Coon Creek type locality to the late Campanian (76.0-76.8 Ma) and having been deposited in inner to middle neritic water depths (0-56 m [0-180 ft]). Prior to this study, the Coon Creek Formation was reported as either Campanian or Maastrichtian in age.

LOCATION AND REGIONAL GEOLOGIC SETTING

The visitor’s geoscience education experience begins with their drive to the UTMCCSC. The UTMCCSC is situated within the West Tennessee Uplands physiographic province which is characterized by gently rolling hills deeply incised with steep-walled narrow creeks, such as Coon Creek (Fenneman, 1938; Floyd, 1990). The overall climate is humid to subtropical.

The Coon Creek Formation is exposed as part of a north-south trending outcrop belt within the Mississippi Embayment in western Tennessee and eastern Mississippi (Figure 1). Regionally the outcrop belt is traceable around the Gulf Coast northward up the Atlantic Coastal Plain (Figure 1A).

Paleogeographically, Coon Creek sediments were deposited within a large, partially enclosed, and sheltered bay that formed along the southern margin of the Late Cretaceous Interior Seaway within the landmass of Appalachia. The bay and its sediments were the result of continued infilling the Late Neoproterozoic-age Reelfoot Rift System, famous for the New Madrid Seismic Zone, and associated Paleozoic and Mesozoic subsidence activity, and associated with the Cretaceous position of the Bermuda hot spot (Cox and VanArsdale, 2002, and references cited therein), although there is no record of volcanic activity within the Coon Creek Formation sediments. The embayment was proximal to, and connected to, the Cretaceous Interior Seaway system to the west and the Atlantic Ocean to the east and represents the sea level high stand that bisected Cretaceous North America into two landmasses, Appalachia to the east and Laramidia to the west.

The Coon Creek Formation is clastic dominated, composed of gray to dark-green, micaeous, glauconitic, quartz sand that is locally highly fossiliferous. Moore (1974), Russell and Parks (1975), Dunagan and Gibson (1993), and Self-Trail and others (2024) interpret the Coon Creek to represent a series of clastic coastal to offshore marine environments tracking the initiation of a regional sea level regression. Depositional lithofacies of the Coon Creek Formation grade laterally and vertically into the McNairy Sand (Figure 2) consisting of non-glaucconitic quartz sand, sandstone, and clay (Russell and Parks, 1975) representing

Figure 1: Regional setting and location of the Coon Creek Formation and the University of Tennessee at Martin Coon Creek Science Center (UTMCCSC). (A) is the Upper Cretaceous outcrop distribution in the southeast showing location of the Coon Creek type-locality (CC) and the University of Tennessee at Martin (Star). (B) is a close-up map showing north-south oriented Cretaceous outcrop belt (in green) within the West Tennessee Uplands physiographic province and the location of UTMCCSC (yellow circle X) in McNairy County, just south of Enville, Tennessee.
barrier sand bars and beach environments prograding across the area during regression. The underlying Demopolis and Sardis formations represent an open marine transgressive highstand sequence prior to Coon Creek time. These units consist of glauconitic sand (Sardis Formation) that grade upwards and laterally into sandy- and silty-marl with localized argillaceous chalk (Demopolis Formation). The Coon Creek thus occupies the critical hinge position in the transgressive-regressive sequence sea level shift.

**GEOLOGIC FEATURES AT THE SITE USED FOR VISITOR PROGRAMING**

**Geomorphology of the UTMCCSC**

In addition to programs focused on the fossil deposit, UTMCCSC offers programming related to basic geologic processes, especially processes highlighted in public education Earth science classes and University-level introductory geology courses. Fluvial and mass wasting processes are integral to understanding the fossil exposures of Coon Creek. Figure 3 is a site map of the UTMCCSC with locations of geomorphic features related to modern physical geology used in geoscience education programming. Often overlooked by visitors who are focused on finding fossils, but of great educational value, are the interacting modern geologic processes and landforms that can be viewed by visitors on their way to the fossil exposures. It is important to point out these processes at the beginning of a visitor’s experience, especially on the walk to the fossil deposit, so that they understand why there is such a mix of modern and ancient geologic features visible simultaneously and have a better grasp of the effects of temporal and spatial scales in the historical geology of the Coon Creek site. Visitors often confuse the ancient Coon Creek Formation with the modern Coon Creek fluvial system as being part of the same geologic process occurring at the same time and confusion can result in understanding how the modern terrestrial Coon Creek geologic system that they see on their visit relates to the ancient ocean Coon Creek ecosystem that they are reconstructing with the fossils and sediments.

At the UTMCCSC, fluvial processes (along with anthropogenic drainage changes) have resulted in a geomorphic expression of a series of five narrow elongate floodplains separated by short east-flowing shallow tributaries that have been informally named for prominent geologists associated with the Coon Creek Formation (Figure 3). The most southern branch (Weeks Branch) begins adjacent to the caretaker’s house and is the most significant as it drains an artificial farm pond (Safford Pond) built by the Weeks family and has deeply incised the modern floodplain, requiring the construction of a foot bridge by the UT Martin Engineering program students and another foot bridge built by local Eagle Scouts. The perennial Weeks Branch is the shortest of the cross-drainages at 200 meters (660 feet) long, steeply incised, with a nearly straight channel until it reaches the floodplain where it makes one wide meander offset before emptying into Coon Creek. Weeks Branch has the highest rate of incising as evidenced by being 1.5 meters (4.9 feet) deep at mid-course, next to the Fossil Cleaning Pavilion, and up to 3 meters (10 feet) deep with a 1.3 meter (4.3 feet) tall waterfall at the confluence with Coon Creek. The waterfall at the confluence of Coon Creek and Sohl Branch (Figure 4) is used to explain to visitors how temporary baselevel cutting works as a fluvial process and how modern landforms are the result of depositional and erosive geologic process that interplay over varying geologic time scales.

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**Figure 2:** Regional stratigraphy of West Tennessee with *Exogyra* bivalve oyster biozones discussed in the text.
Four artificial ponds have been built on the property by damming the upper reaches of drainages. Three of these ponds occur on the western hill slope and one occurs on the eastern edge of the property in the next valley to the east of Coon Creek. Safford Pond (Figure 3), constructed in the 1950s, occurs near the site of an old brick kiln operated by the Weeks family in the late 1800s, and is used for limnology studies by visiting groups, especially pond water geochemistry and food

Figure 3: Site map of the UT Martin Coon Creek Science Center showing important geomorphic, geologic, and infrastructure features (Not drawn to scale). MH&C area is shown in more detail in the inset and is the area with cabins, restrooms, showers, first-aid. Inset Map shows details of the buildings in the MH&C – black rectangle with dots = Mess Hall, Numbered boxes are cabins and buildings: 1 = Evergreen cabin (UT Martin Research cabin), 2 = Dogwood, 3 = Cypress, 4 = Birch, 5 = Aspen (Intern's cabin), 6 = Lively Paleontology Lab, 7 = Fossil Prep Pavilion. FP = Floodplains (listed numerically). Area of Creek Walk Program outlined by dashed box.
web concepts. Troost Pond is named after Gerard Troost and occurs near the cabin complex. Three other cross-drainages, Sohl Branch (named for U.S. Geological Survey paleontologist Norman Sohl), Wade Branch (named for geologist Bruce Wade), and Russell Branch (named for Mississippi State geologist Ernest Russell) are less incised into the floodplain. None of these cross-drainages have artificial ponds at their headwaters. Each of the cross-drainage branches develop waterfalls with splash pools at the base of the waterfall that often concentrates more resistant fossils such as bone, teeth, and large fossil oysters as a lag, like the splash pool at Sohl Branch that produces the largest numbers of fossils as a pool lag gravel after extensive rains.

Although not obvious from the topographic map (Leapwood 7.5-minute topographic quadrangle) for the site due to the 20 foot contour interval, there is a distinct widening of intermittent stream channels at the topographic level of the floodplain floor for Coon Creek (Figure 5). Best visible in winter when the leaves have dropped from the trees, the steeper and shorter cross-drainages on the east side of Coon Creek display marked widening of their respective valleys at the stratigraphic level where the more clay-rich lower fossiliferous horizon of the Coon Creek Formation is encountered. This is the same stratigraphic level for the temporary baselevel waterfall development discussed above. Downcutting slowed relative to enhanced lateral erosion to widen the cross-channel floors and reduce the steepness of their V-profile. It should be noted that the level at which lateral cutting increases coincides with the stratigraphic level within the Coon Creek Formation that clay content increases, and groundwater percolation slows within the sediment, showing a positive feedback relationship between clay content and erosion characteristics. The east cross-drainages are much steeper in gradient and shorter in length than the west cross-drainages, so the enhanced widening of these drainages is all the more unusual when compared to the western branches.

**Modern Geology: Coon Creek Fluvial Processes**

The modern north-flowing Coon Creek channel is confined to the east side of the floodplain with tall, steep,
east walls (up to 20 meters [66 feet]). As the UTMCCSC occurs near the headwaters for Coon Creek, the course of the channel is relatively straight with only moderate meandering. Within the channel itself, point bar and slip-off slope development is subdued due to the deep, narrow, V-shaped cross-section; however, there are typical meander channel features visible along the channel that are good for educating visitors on fluvial processes and geomorphic landforms typically discussed in a physical geology course (e.g., point bar deposition, graded bedding, cut bank erosion, thalweg development, grain size sorting, etc.). Levee development along the incised channels is subdued, less than 0.5 meters (1.6 feet) tall.

Coon Creek has become deeply incised by over 100 years of farming practices that lacked conservation methods and was characterized by controlling the channelization. The primary concern for the Weeks family in the early days was to drain the narrow floodplains quickly for crops and to curtail channel migration into the planting area. The only area along the creek where Coon Creek meanders westward enough to expose a floodplain on the east side of the creek is the extreme northern edge of the property (FP 5 in Figure 3) where the remains of plow furrows from the 1940s are visible on the floodplain within a small grove of trees that have reclaimed the floodplain (these are becoming less visible as time passes). Further to the north, the Coon Creek valley widens considerably as it approaches the confluence with White Oak Creek and the channel develops a wider meander pattern into the valley with better development of wider floodplain on both sides of the creek.

As noted, the modern Coon Creek is itself a young geomorphic feature of partly anthropogenic origin. According to Sohl (1954), Dave Weeks dug a drainage furrow for a field he had in cultivation along what is now the east side of the Coon Creek valley, establishing the current channel. Within a mere 20 years, meandering processes ceased, and erosion had deepened the drainage channel to ~5 meters (16 feet) total cutbank highwall relief, thus locking-in the current drainage

Figure 5: Photo looking east from the floodplain during a winter snow showing widening of the east-side cross-drainage valleys at the level of the floodplain and the temporary base level created at the contact with the clay-rich Coon Creek Formation (Photo Credit: M.A. Gibson).
track. Continued incising of Coon Creek has rapidly exposed the steep-faced fossiliferous strata which can be traced under the floodplain to the west. The average downcutting rate is calculated at 3.05 cm/yr (1.20 in/yr) between the years of 1988 and 2024 (see discussion below).

The fossiliferous mounds used by the UTMCCSC for fossil collecting by visitors are constructed by trenching through the floodplain “overburden” into fresh fossiliferous Coon Creek material under the floodplain (Figure 6). The floodplain overburden sediment averages 3-5 meters (10-16 feet) thick. The floodplain overburden sediments overlying the fossiliferous Coon Creek horizon are silt- and clay-dominated and contain several gravel channels cross-sections with reworked ferruginous sandstone (ferricrete) channel lags mixed with weathered and reworked Coon Creek sands and clays, much like sediments within the modern creek. These channels represent the paleodrainages of “earlier Coon Creeks” that meandered across the floodplain prior to meander restriction established by Weeks when he dug the current drainage pathway on the east side of the floodplain (Sohl, 1951). The fertile floodplain that Dave Weeks farmed is the surface upon which the current soil horizons have formed and is now the grassed-over field across which visitors walk to reach the creek exposures for fossil collecting (FP 1 and FP 2 in Figure 3).

Modern Coon Creek is actively transporting clay and sand reworked from the surrounding hillside and hilltops and material eroding from several stratigraphic units. Iron-cemented siltstone and sandstone, or “ferricrete” clasts, are major components of the modern creek sediment (see alluvial fan in Figure 4). Ferruginous sandstone lag gravels are found in the modern Coon Creek and in the paleochannels indicating that this has been a common occurrence for an extended period of time. Paleochannels and slope deposits resembling the modern creek sediments occur in the upper portions of the cutbank exposures along the creek in three separate areas on the property that probably represent earlier (higher elevation) fluvial events in the history of the Coon Creek valley. Reworked Coon Creek fossils are often found in the modern creek sediments but not in the modern floodplain deposits, reflecting that the incising into the Coon Creek Formation is a relatively recent occurrence.

There are two types of ferricrete within the channel sediments (both modern and paleochannels). Resistant, dark red-brown, coarse, sandy, unfossiliferous, cemented (hard) ferricrete is derived from the hilltops and higher

Figure 6: Photo showing trenching of a fossil mound on the floodplain for visitor digging. Mounds are used for small as ADA compliance for very small children and others not able to participate in the Creek Walk Program and for providing bulk sample buckets for shipping to schools for remote programming. Gray pile on left is Coon Creek matrix, floodplain sediments are piled on the right (Photo Credit: M.A. Gibson).
elevations, probably cementation of the overlying McNairy Sand. The second type of ferricrete consists of less resistant and more limonitic clasts that are fossiliferous, especially with molds of pelecypods and gastropods. These limonitic clasts often occur as large boulders (up to several meters in diameter) that mass waste from within the upper Coon Creek Formation from a prominent ledge along the cutbank and then breakdown into smaller clasts moved by the creek.

It should be noted that fragmented, reworked, and corroding fossil shells, teeth, and bone from the Coon Creek Formation are also being transported and redeposited as clasts within the modern Coon Creek. This type of reworking can lead to the formation of remanié deposits (Craig and Hallam, 1963), which occurs when older fossils (Cretaceous Coon Creek Formation) are reworked into younger sediments (modern Coon Creek) and redeposited. A similar potential remanié deposit occurs in the creek sediments at the northern edge of the property and beyond where Paleogene age fossiliferous gravels were introduced and used to build a temporary road and culvert for logging purposes resulted in the fossil gravels mixing with the Cretaceous fossils and being redeposited within modern Coon Creek sediments.

Burrows within the Coon Creek Formation are sometimes infilled with sand that cements to form resistant structures that erode into the modern creek as large clasts. Purported Cretaceous-age coprolites and infilled burrows are encountered within the actively reworking Coon Creek sediments of Coon Creek. Some in situ burrows can be seen differentially eroding into high relief within the creek bed by hydraulic sculpting around the slightly hardened burrows. Crustacean fossils, especially the claws of the ghost shrimp Microstylus, are common as concretionary gravel clasts within the modern creek sediments.

Creek walkers looking for the Cretaceous-age fossiliferous horizons are often first confronted with the sheer abundance of the reworked ferricrete-rich fluvial gravel that comprises the modern creek channel and underlies the floodplain surface. However, close comparison reveals that this sediment contrasts markedly from the sediments of the ancient Coon Creek Formation itself. Typically, visitors confuse the ferricrete clasts as fossils, which leads to predictable discussions about the origin of mimetoliths and pseudoformations.

Cross-sections of earlier subrecent Coon Creek paleochannels are visible in several areas of the creek highwall exposure at differing elevations, and contain the physical sedimentological features of the modern Coon Creek. As noted, this ferricrete gravel originated by iron-oxide cementation of percolating groundwater in the McNairy Sand overlying the Coon Creek Formation and is more resistant than the Coon Creek sands and clays. The timing of the cementation is older than the formation of the paleochannels and represents the now exposed result of earlier groundwater processes that occurred post-Cretaceous deposition, but prior to (Paleogene-Neogene) formation of the modern geomorphic landscape. While much of the ferricrete occurs as clasts in the soils topping the hilltops, it also works its way down from the surrounding hilltops to accumulate as lag gravel within the modern stream, as it did for the paleochannels. The visitor is thus treated to a glimpse of what will eventually happen to the modern Coon Creek, thus allowing them to “read forward” into geologic time and the processes of the geologic cycle that are the result of “landscape evolution.” These geologic lessons are easily transferable to other areas of the West Tennessee Uplands.

Modern Geology: Environmental Lessons

Environmental geology lessons are an important part of the educational mission of UTMCCSC. As noted earlier, when the Weeks family purchased land that Coon Creek ran through in 1867, the then unnamed Coon Creek was just a small drainage ditch with few fossils exposed (Sohl, 1951). Weeks deepened and widened the drainage by hand shovel to carry away rainwater from his newly developed bottomland. Within 20 years or so, meandering had ceased and erosion had deepened the drainage, exposing the fossils that had laid buried for over 70 million years. As an interesting sidenote popular with visitors, Weeks would grind the fossilized shells into a meal that he could feed to his chickens, providing calcium to strengthen their eggs.

How do we know that over a meter of downcutting has occurred along Coon Creek in the area of the type-section across from the first floodplain since 1988? This was determined by measuring the base of a set of stairs constructed at creek level in 1988 to its current position on the side of the channel in 2024. That stop along the Creek Walk Program for visiting colleges is one of the most illustrative in demonstrating the impact that human activity can have, even as it relates to small-scale, localized subsistence farming. Erosion processes are easily understood when they are fresh and occur suddenly; however, slower erosion that revectates as it proceeds is less obvious to observers unless
there is some obvious marker, like our stairs, to serve as a visual aide to seeing the impact.

Modern Geology: The Role of Ice

On the Leapwood 7.5-minute topographic quadrangle, Coon Creek is mapped as a perennial stream; however, it acts more as an intermittent stream and has significant periods of time with only a trickle of water moving sluggishly from pool to pool downstream, especially during the dryer months of the year. The creek is often dry for several weeks at a time, except for isolated pools of water fed by springs in the creek wall. Local relief along Coon Creek can be as much as 30 meters (98 feet) to the top of adjacent hills with over 15 meters (49 feet) of exposed cutbank on the east side of the creek locally. Incising by water action alone does not appear to be capable of creating this amount of relief in the time that the creek has been in existence.

A fortuitous winter ice storm that stranded the author on the site for a few days led to the discovery that ice plays a major role in the incising and erosion of Coon Creek. During the winter months, the moist outer surface sediments of the channel walls (up to 10 centimeters [3.9 inches] deep into the bank) often freezes and can produce extensive patches of needle ice (Figure 7). This ice formation in the outer few centimeters results in expansion during freezing and nearly vertical separation fractures under the frozen slabs. The slabs of coherent sediment exfoliate from the outcrop and spall-off into the channel as subsequent thawing occurs. Repeated freeze-thaw cycles result in localized mass wasting surfaces cutting under the rooted zone (Figure 8) that steepen the outcrop walls and results in numerous treefalls. As the UTMCSC is situated near the headwaters of Coon Creek, heavy winter and early spring rains flush through the channel and contribute to the quick incising of the creek. Seasonal small-scale mass wasting processes are underappreciated as a fluvial process, but it is well-illustrated during winter Creek Walk Programs at the UTMCSC. Additionally, these features offer an opportunity for the visitor to learn about the sometimes episodic nature of some “hidden” geologic processes and the role that seasonality and time play in geology to produce features that appear at odds to the more obviously daily processes.

Modern Geology: Landscape Evolution

Drawing attention to the above geomorphic processes and features allows docents to introduce the concept of “landscape evolution” over geologic time scales of decades through centuries to millenia, through differential erosion processes, to be presented to visitors. Additionally, groundwater processes that, mostly, are hidden to the average visitor and difficult to understand, are readily visible within the stratigraphy of the walls of Coon Creek. Evidence of differential erosion rates are visible in the geomorphology of the tributaries entering Coon Creek and the temporary baselevel of the floodplain itself.

The upper stratigraphy at the site is more-sandy and percolates groundwater well, while the clay-rich lower stratigraphy is better sealed from percolating groundwater. Differences in groundwater content and percolation can be seen as a visitor takes a hike on the nature trail, which traverses all of the geomorphic regions on the site. As noted above, the result is that the creeks incising the surrounding hills slow their downward cutting upon reaching the clay-rich horizon and begin to cut laterally, thus widening the stream profile at the contact with the clay-rich portion (Figure 5). Numerous springs occur along the creek bank where the more porous and permeable floodplain sediments sitting on top of the Coon Creek Formation meets the less permeable and lower porosity clay-rich Coon Creek Formation sediments and groundwater begins to flow laterally. These sites on the Creek Walk Program serve as places to explain geologic processes related to groundwater movement (e.g., water tables and perched water tables, porosity-permeability relationships, and sediment characteristics) to visitors.
Several chalybeate horizons (Figures 8 and 9) are visible on the creek walls as iron-stained surfaces that accentuate the stratigraphy (specifically the location of contacts and minor perched water table surfaces) and relative percolation rates, again providing opportunities to see the relationship between processes of ancient geologic history and modern geomorphic expression.

**Modern Geology: Uplands and Soils**

Hill tops at the UTMCCSC have second- and third-generation forests. The original hardwood forest on the property was harvested in the 1870s when the Weeks family...
Figure 9: Photo of type-section showing Coon Creek Formation internal stratigraphy and large-scale slump overhang produced by undercutting of the rooted horizon. Horizon 4 ledge passes under the slump overhang. Recently fallen limonite and ferricrete talus blocks from Horizon 4 occur at the base of the debris slope, partially blocking the Coon Creek channel (Photo Credit: M.A. Gibson).
acquired the property and the site was then modified for use as farmland. When the A.Z. Smith family acquired the site in the late 1950s, all farming ceased and a mix of hardwoods and pine recovered the hill tops; however, the Memphis Museum harvested most of the hardwoods from the uplands in 2011, except for the southwest portion of the property that houses the UTMCCSC and Caretaker’s House. The floodplains were kept barren of trees for the most part. Currently the upland is planted with fast-growing pine for later harvesting upon maturity of the trees.

Precipitation runoff during the tree harvesting, and for a few years afterward, caused some problems with increased runoff sedimentation into Coon Creek until the growth of the pines could stabilize the slopes. The soils developing on the site belong to the “Iu” (Iuka) along Coon Creek and “LuE” (Luftee) soil systems on hill tops (Brown, 1997). Overall, soils are classified as strongly acidic, fine, sandy loams that are occasionally flooded, moderately well-drained and permeable, with moderate available water capacity, and displaying a seasonal, high water table.

In 2020, a 4-kilometer-long (2.5 mile) hiking trail was cut on the property that begins at Weeks Branch near the Fossil Cleaning Pavilion and meanders north through the planted pine forest to the UTMCCSC property line on Hardin Graveyard Road, where it then turns east to cross Coon Creek. After steeply climbing to the top of the eastern upland, the trail turns south along the eastern edge of the property following the hill ridgeline, until it turns west to descend and re-cross Coon Creek at the entrance site of the beginning of the Creek Walk Program on the second floodplain just south of the confluence with Wade Branch. The trail is used for forestry and wildlife programming and for viewing the origin of the ferricrete that is so prevalent as gravel in Coon Creek.

As previously noted, erosion and mass wasting processes have produced steep, nearly vertical, walls in the Coon Creek banks. The channel shows significant undercutting of the rooted horizon on both sides of the creek (Figure 9). The type-section outcropping on the first floodplain has a significant overhang that extends nearly 0.4 meters (1.3 feet) outward from the steep face of the hill and is held together by a thick root mat from the tree and shrubs that used to be on the surface. The overhang shows significant sagging due to the undercutting and the beginning of separation cracks near the channel wall. This feature serves as another geologic process discussion stop for visitors where modern mass wasting processes (e.g., slides and falls versus creep, etc.) are emphasized. Many smaller, and less dangerous, overhangs occur along the Coon Creek channel illustrating the meandering nature of the fluvial system and starkly contrasting cutbank erosion processes with point bar depositional process (e.g., Figure 4). Fallen and curved trunks of trees in various growth stages on the overhangs along the creek are used to demonstrate the slow nature of these processes to visitors (Figure 4). Additionally, these trees can be used to introduce dendrochronology and dendrogeomorphic processes (e.g., Stotts et al., 2014) to visitors by comparing tree ages with degree of trunk curvature and tree falls.

Anthropogenic Impacts: Environmental Action Research

Does the digging for fossils along the creek by visitors and researchers impact the ecology of Coon Creek as would be expected due to the volume of visitors and the enhanced erosion produced by digging tools? Most of the active digging on the creek for the past 20 years has been confined to a 200 meter (660 foot) stretch along the middle section of the creek where an access slope was cut through the Coon Creek levee berm in 1988 when a mosasaur skeleton was found at a meander bend in the creek (Figure 3). Approved groups and scientific studies are allowed along the other areas of the creek, but only on a limited and controlled basis. We can document enhanced erosion of the creek channel banks, along with increased sedimentation rate within the channel, within this portion of the creek. This is evidenced by: (1) a wider channel profile; (2) slightly wider stream meander development; (3) more abundant, larger, and deeper overhangs on cutbanks; (4) numerous holes left behind by digging tools; (5) steeper waterfalls and splash pools; and (6) larger point bars with more fine-grained Coon Creek matrix sediment relative to ferricrete co-occurring within the high-visitation portion of the creek.

Does the fossil digging activity degrade the geochemical quality of Coon Creek waters. Part of the UTMCCSC “action research” programing is to have some visitor groups conduct water quality studies (using the same kits that they would use in most introductory environmental geology courses) along the creek, which includes identifying and counting riparian fauna, at various times of the year and comparing with nearby creeks. Additionally, studies have been conducted before, during, and at various times after individual digging programs to identify short-term impacts. There are no significant differences in the geochemistry profile of Coon Creek.
Creek and nearby creeks with the sole exception of fecal coliform bacteria, which is lower in Coon Creek than in nearby creeks. This is attributed to the UTMCCSC sitting near the headwaters of Coon Creek with limited cattle grazing in the uplands surrounding the Center or on the property itself. Much of the land to the east of the UTMCCSC belongs to a hunting club.

There are several recurring results noted by these “citizen science,” place-based, action projects that have been conducted over the years. As would be expected: (1) water clarity decreases and turbidity increases during and just after digging events along the active reach, and to a lesser degree downstream, of Coon Creek; (2) the physical profile in this reach of the creek is becoming wider than adjacent creek channel reaches; (3) meanders in this reach are slightly wider; (4) there is a greater volume of reworked fine-grained sediment within the digging reach, and just downstream of it; and finally, (5) in Coon Creek the numerous small-hole excavations that are dug by visitors influence channel bottom shape and result in the bedload sediments moving through these “potholes” to remain turbid the longest (with average small pothole, based upon the size of fossil excavated, is usually no more than 20 cm [7.9 in] in diameter) and with potholes remaining visible for a couple of weeks during the dryer season until erosion sculpts the edges and sediment infills the small depocenter created by the digging. The recovery time of the most in-stream turbidity to water clarity is short, usually minutes to a few hours and generally is less than the turbidity that occurs during heavy runoff periods produced by rain.

In summary, undoubtedly, digging for fossils on the creek has an anthropogenic physical impact; however, there is no evidence of large-scale or long-term negative impact over the history of excavations at Coon Creek.

SEDIMENTOLOGY AND STRATIGRAPHY OF THE COON CREEK TYPE SECTION

Russell and Parks (1975) and Russell and Keady (1983) delineated two traceable lithofacies within the Coon Creek Formation, the boundary between them often marked by phosphatic concretions and platy ferruginous sandstone layers. The lower Coon Creek lithofacies is a massive-beded, glauconitic, fossiliferous bluish to green clayey-sand and sandy-clay that tends to weather brown and locally contains carbonate concretion horizons. Only this lower Coon Creek lithofacies is exposed along the creek exposures of the UTMCCSC fossil site (Figure 10; Self-Trail et al., 2024). Comparison of the UTMCCSC fossil site with the nearby Thompson Farm exposure (Dunagan et al., 1992; 1993; Dunagan and Gibson, 1993) indicated that some lateral variation in lithofacies exists locally and regionally. Dunagan and Gibson (1993) attribute this variation to some degree to be original patchy sediment characteristics of the sea floor being preserved due to lack of reworking.

The upper Coon Creek lithofacies consists of red siderite concretion beds interbedded with dark gray to red micaceous silty-shale (Russell and Parks, 1975) and was termed the “ferruginous clay member” (limonite/siderite) by Wade (1926). This lithofacies is best exposed in the Selmer region to the south and northward along Bible Hill in Decatur County. The upper lithofacies is generally invertebrate-poor, but locally vertebrate-rich.

At the UTMCCSC, four distinct fossiliferous horizons (Figure 10) can be visually delineated within the Coon Creek type-section lithofacies (Ebersole, 2016; Self-Trail et al., 2024). Surface weathering of each horizon accentuates the visibility of that horizon for the visitor, and serves to focus meaningful discussions of stratigraphy to visitors. Docents point out that modern weathering processes are superimposed upon the original stratigraphy, yet are also influenced by that stratigraphy, so as, to produce a distinct zonation visible on the outcrop surface. The lowermost Horizon A is unweathered, fossiliferous, dark gray, glauconitic, micaceous clayey-sand and sandy-clay of the “classic” Coon Creek. This horizon is generally confined to the exposures near creek level upwards approximately 3-5 meters (10-16 feet). While it appears moist on the surface, digging just a few centimeters results in sediment that is clay-rich and nearly dry, not percolating water readily. This is one of the primary factors that enhances the pristine fossil preservation of the Coon Creek invertebrate fauna as there is little percolating moisture for dissolution, nor has there been throughout most of the burial history.

Overlying Horizon B is a tan, oxidized, mottled clay and clayey-sand that was extensively bioturbated, mostly by echinoids as echinoid traces are abundant. Shelly fossils are leached from this horizon. Stratigraphically upward, Horizon C is a weathered limonitic fourth horizon rich in molds and casts of invertebrates and iron-cemented sandstone. Horizon C appears to represent a highly leached and possibly condensed shell bed. The upper few decimeters of Horizon C are clay-rich and leached of fossil material with the exception...
of rare bivalve and gastropod molds or “ghosts” visible on weathered surfaces. The remaining upper exposure above Horizon D grades into the tan, mottled, ferruginous, and rooted soils horizons that are developed in the Coon Creek Formation sediments and that are devoid of any of their original sedimentary features. These upper soil horizons are usually only visible under the cutbank overhang at the top of the highest exposed sections along the creek (Figures 9 and 10). Nowhere on the property is the contact with the overlying McNairy Sand visible in outcrop.

This stratigraphic zonation, which so clearly shows a weathering (diagenetic) overprint prograding downward into unweathered Coon Creek Formation, is used in geoscience education lessons on weathering processes to illustrate the dynamic nature of weathering in the region. It demonstrates to visitors the complex combination of original

Figure 10: Lithology and fossil content of the type-section of the Coon Creek Formation showing stratigraphic and fossiliferous horizons within the Coon Creek Formation. Photo taken to left (north) from outcrop in Figure 9 (modified from Ebersole, 2016).
stratigraphic characteristics and weathering enhancement, with zones accentuated by differences in shell preservation, grain size characteristics, clay content, and groundwater regime. Often particular zones, especially Horizon B, can be delineated and correlated locally by the seasonal growth of moss and algae on the outcrop surface (Figure 9).

PALEONTOLOGY AT THE COON CREEK SCIENCE CENTER

Brief Overview of Biota Preserved at the CCSC Fossil Site

A detailed discussion of the vast invertebrate fauna of the Coon Creek Formation, even if restricted to the UTMCCSC fossil site, is beyond the scope of this summary. The primary reference, indeed, the acknowledged taxonomic “bible” for the Coon Creek fauna, remains Wade (1926); however, much of that taxonomy is now out-of-date and there have been revisions of faunal elements since that time disseminated in the paleontological literature. The UTMCCSC provides a generalized field identification sheet for the most conspicuous fossil taxa encountered by visitors to the site. The Mess Hall (Figure 11) and Clinton W. Lively Paleontology Lab (Figure 12) contain collections of identified and labeled specimens that are available for visitors to help with taxonomic identifications.

Although mostly recognized for its invertebrates, the Coon Creek biota also contains a significant component of vertebrate remains including the sabre-tooth fish *Enchodus* (Hudson and Gibson, 2024) and a possible squirrelfish (Gibson et al., 2018), sharks, mosasaurs, plesiosaurs, and turtles (e.g., Wade, 1926; Collins, 1951; Russell, 1967; Whetstone, 1977). Stringer (2001; 2016) provide exhaustive treatments of fish otoliths (ear bones), noting ten fish taxa represented by only by their otoliths. Gilmore (in Wade, 1926) figured several mosasaur bones and fish remains (including otoliths). Since 1990, skeletal remains of at least two additional mosasaurs have been uncovered at the UTMCCSC fossil site (Evans and Gibson, 2021) along with one gastrolith and a few teeth of a suspected plesiosaur.

Terrestrial and marine plant fragments have been recovered from the Coon Creek fossil site, although plants are better known from other units (e.g., Berry, 1919; 1925; 1928). Most of the macrofossil terrestrial plant input into the Coon Creek marine ecosystem is represented by plant lignite. For a more recent review of the flora associated with the UTMCCSC fossil site and equivalents, see Dilcher (2016).

As noted in the paragraph on micropaleontology, pollen is a common component within Coon Creek sediments. Trace fossils from the Coon Creek Formation in general and the UTMCCSC fossil site have received little attention but offer potential for deciphering microenvironments and sedimentation parameters within the Coon Creek Formation. Moore (1974) discussed trace fossils within his sedimentology discussion; Dunagan and Gibson (1993) and Dunagan and others (1993) discussed trace fossil

Figure 11: Photo of the Mess Hall educational displays (Photo Credit: M.A. Gibson).
distribution, primarily produced by echinoids, at the nearby Thompson Farm exposure and were the first to apply ichnofossil analysis to the Coon Creek Formation. In addition to burrow type trace fossils within the Coon Creek sediments, or as inclusions within the sediment, many of the fossil shells have been bored by predatory naticid gastropods (e.g., Kelley and Hansen, 1996; Kelley et al., 2001) and shell repair from predation (Vermeij and Dudley, 1982). Borings made by the sponge Cliona, belonging to the ichnogenus Entobia, were discussed by Griffin and Gibson (1998), Jones and Gibson (2000a; 2000b), and Gibson and Dunagan (2003).

Diagenesis and Fossil Exposure

A distinctive feature of the Coon Creek fossil site is the lack of any significant diagenetic overprinting on the sediments or in the preserved fauna within the lower Coon Creek lithofacies. The clay-rich lower horizons of the Coon Creek Formation exposed at the UTMCCSC are well-sealed from percolating groundwater, which protects the fossils from altering until complete exhumation in the modern and associated atmospheric exposure. Calcareous shells (original aragonite and calcite) of fossils are unaltered and most of the aragonitic ammonoid cephalopods still contain their iridescent nacre. The glauconitic, micaceous, clayey-sands and sandy-clays are only lightly indurated by clay coatings on the sand grains and not by any post-burial cementation of quartz or carbonate cements, at least not to any great degree. Limited thin section study has failed to reveal the presence of cement overgrowths on fossils or sand grains. The slight degree to lack of induration makes it possible to easily remove fossils from the matrix with simple tools such as dental picks. Sediment is easily removed from the fossils with a light touch and water and the sediment can even be carved into display stands for the fossils (Figure 13).

The only partially indurated nature of the matrix is one of the factors that makes collecting fossils enjoyable to visitors.
Docents guide visitors on preparation techniques using dental picks, awls, and aspirator bottles of water (Figure 14). The matrix separates from the sediment easily and fossils can be completely extracted for further cleaning, or can be only partially extracted. Partially extracted fossils are encouraged so that a portion of the original sea floor lithology remains with the fossil and becomes part of the lessons for visitors. Removal of the entombing sediment removes part of the scientific context needed for proper interpretation of a fossil and reconstructing the original paleoenvironment of deposition. To illustrate paleoautecology of taxa from the Coon Creek Formation, shells are often partially excavated from their sediments, but oriented in living position relative to their substrate position to allow visitors to better visual animal-sediment relationships in what would have been the living Cretaceous ecosystem of the Coon Creek Formation (Figure 15).

Additionally, the matrix contains abundant microfossils (e.g., fish otoliths, foraminifera, pollen, ostracods, etc.) as well as minerals necessary for a complete picture of the environment (e.g., glauconite, muscovite). The UTMCCSC has several slightly more advanced programs for exploring micropaleontology using the Coon Creek matrix. It is noted that the Coon Creek sediments are highly micaceous, which is one line of evidence that the paleoenvironment of the Coon Creek ecosystem was not too distant from a shoreline and within a protected region as mica does not survive long in a marine setting.

Some features attributed to localized early diagenesis are present, indicating some sluggish fluid migration and active sediment geochemistry, although there have been no studies to date to determine the timing or nature of fluid – sediment interactions. The most prominent of these features are the likely early diagenetic carbonate concretion zones traceable along the creek exposure (Figure 16). Large (up to 4 meters [13 feet] length by 0.9 meters [3 feet] in diameter) concretions occur along as many as four distinct horizons along the creek bed exposure. The calcareous concretions are well indurated, rounded in form, and always have their greatest dimension horizontal. The concretions produce prominent ledges and protective overhangs and localized rapids or waterfalls along the creek bed.

**Figure 13:** Photograph of a block of Coon Creek sediment partially prepared by Pink Palace preparatory Roy Young. The lack of cementation while retaining cohesion allows the sediment to be carved using away using small picks to expose the fossils and produce display stands. Notice the abundance of well-preserved bivalves, gastropods, and cephalopod fossils visible in a small area (Photo Credit: M.A. Gibson).
Internally, the concretions are fine-grained, clayey-and silty-limestone, with the clastic component matching the surrounding sediment lithology. The concretions lack internal zonation, but contain an invertebrate fauna of diminutive bivalves, shell hash pods, and especially aragonitic fossils such as the bivalve *Inoceramus* and scaphites, some of which are quite large. At present the origin of these concretions is not understood; however, the concretions are thought to represent early diagenetic processes of carbonate formation at shallow depth within the Cretaceous seafloor. It should be noted that the source of the carbonate forming the concretions is not from dissolution of the enclosing or surrounding macrofauna as these fossils are well-preserved within and around the concretions. Microbial action associated with burial within the sediment is suspected as the nucleating mechanism. The concretions are common in the modern creek bed sediments, making-up the largest clast component, and popular with collectors because they are fossiliferous and contain well-preserved aragonitic shell material and steinkerns after being exposed to dissolution in the creek.

Sandwiched between the highly fossiliferous shell-producing lower horizons one and two of the UTMCCSC fossil site exposure and below burrowed Horizon B (Figure 10) and the extensively weathered interval near the top of the section is the red to tan, oxidized, “bioporous” Horizon C. Fossil molds and rare casts are abundant, with many of the now dissolved shells quite large and unbroken. The molds

Figure 14: Photo of students in the Fossil Prep Pavilion, the last stop of the Creek Walk Program where much of the docent interpretation of fossils occurs with visitors. (A) An overnight group of college students working with dental tools under supervision of instructors and interns. (B) Typical Public Day group in the Fossil Prep Pavilion with Dr. Gibson (standing) providing interpretation information on this particular find of fossils for the day (Photo Credit: M.A. Gibson).
often touch one another indicating that this horizon was originally a clast-supported sediment prior to dissolution of the fauna. This part of the stratigraphy displays varying degrees of induration owing to its porous nature and its weathering characteristics differ significantly from the underlying “classic Coon Creek.” In some areas it occurs as a slight ledge-former and produces blocks of “fossiliferous ferricrete.” In other areas, this layer is not well indurated, or perhaps became leached more recently, to produce a soft iron-stained clayey-sand with limonitic fossil molds. As noted earlier, this Horizon D is providing some of the ferricrete that comprises so much of the sediment load of Coon Creek. Horizon D is thought to be a shell-bed lag deposit related to the regressive nature of the upper Coon Creek, likely representing a sediment-starved interval. Alternatively, this could be an actual thick winnowed shell-bed from one or more storm events. Further study of this horizon is needed.

**Taphonomic and Paleoecological Studies**

The biota preserved at the UTMCCSC fossil site is considered a lagerstätten deposit because of its abundance and diverse well-preserved marine invertebrates, but a diverse assemblage of marine vertebrates and rare plant fragments (marine and terrestrial) enhance its status. Taxonomically, the invertebrate component is dominated by marine gastropods and pelecypods; however, cnidarians, echinoderms, annelids, porifera, ectoprocts, and arthropods are also preserved. This cross-kingdom diversity is one of the characteristics that establishes the importance of the Coon Creek biota to understanding the dynamics of Late Cretaceous sea level changes of the southeastern tip of the Cretaceous Interior Seaway and the adjacent early Atlantic.

The Coon Creek Formation is a lagerstätten with characteristics of being both a “concentration lagerstätten” (due to the abundance and diversity of fossils) and a “conservation lagerstätten” (*sensu*, Seilacher et al., 1985; Gibson and Dunagan, 2003). Not only are original shell mineralogies intact (i.e., konservät lagerstätten; Seilacher et al., 1985), but the biota has not suffered taphonomically from effects of compaction or other structural geology processes. Accordingly, delicate ornamentation, such as the long spines of gastropods, the wing-like apertural flares of shells of *Petrocerella*, and more weakly calcified forms, such as carapaces of *Avitelmessus* crabs, are preserved unbroken, articulated, and uncrushed. One specimen of the crab *Dakoticancer overanus* was described as still retaining color markings (Kesling and Reimann, 1957). The unaltered nature of the fossils provides...
several important opportunities for future study. Taxonomic studies have been and will continue to be a dominant focus of research in the Coon Creek biota; however, advances in stable isotope geochemistry techniques, only recently applied to the Coon Creek fauna, are unlocking the Coon Creek fauna potential to as a source of information concerning sea water geochemistry, such as salinity and temperature (e.g., Vrazo et al., 2018; Kovalski et al., 2022; Kovalski, 2024; Self-Trail et al., 2024).

There have been few focused paleoecological studies of the Coon Creek biota as a whole (e.g., paleocommunity studies, paleobiogeography, etc.), beyond generalized regional environmental implications of the marine fauna, thus this remains a promising area of future study. Two studies are notable, however, for their focus on “specimen-level” and “outcrop level” paleoecology, especially animal-sediment relationships. Dunagan and Gibson (1993) studied fossil zonation at the Thompson Farm exposure of the Coon Creek Formation, exposed approximately 5 km (3.1 mi) northwest of the UTMCCSC fossil site. They noted that the Coon Creek fauna is distinctly zoned vertically, contains an abundant ichnofauna, and preserves remnants of the original distributional patchiness of organisms inhabiting the sea floor. Moore (1974) recognized four animal-sediment/substrate relationships that he traced regionally: matrix-supported isolated individuals within the glauconitic sands (with varying degrees of minor reworking), horizontal lenses of shell valves, “pods” of fossil shells (“giblet pods”), and fossil-bearing concretions.

Where they occur, horizontal fossil lenses usually are dominated by one or two species, are more common within the lower glauconitic lithofacies exposed near creek level, and may contain the more exotic elements of the biota (e.g., accumulations of pelagic or vagrant ammonites) or concentrations resembling shell beds or lags. Some of the beds may represent taphonomic accumulations while others appear to be thanatocoenoses. For example, a bed concentrated with ammonite shells occurs approximately 0.2 meters (0.7 feet) above creek level in the same area as most of the post-1988 mosasaur finds. In the same geographic location, just at and below creek level, a bed rich in reworked and concentrated Pterotrignia (Scabrotrignia)
thoracica bivalves occurs near a bed consisting almost exclusively of Inoceramus shells. In the Pterotrigonia bed, many of the shells are either articulated, although not in inferred living position, suggesting some minor reworking (physical or bioturbation).

Overall, the Coon Creek fauna represents a diverse array of benthic shallow marine habitats with infaunal, epifaunal, sessile, vagrant, pelagic, benthic, and sclerobiotic habits. Most bivalves are infaunal deposit and suspension feeders; however, abundant mobile predatory gastropods and ammonites are also well represented as well as scavenging and predatory decapods. Shallow to deep burrows are often preserved. Often in-living-position deeper burrows are found. This abundance and diversity of ecological types indicates that additional detailed study of biotic interactions preserved within the Coon Creek biota would be fruitful.

HISTORICAL, CULTURAL, AND ARCHAEOLOGICAL RESOURCES

The UTMCCSC has a historical and geoarchaeological record that is becoming part of the research and programing for the site. Native American lithic points produced by are found in both the creek bed itself, which are derived from the fields surrounding the headwaters of Coon Creek to the south, and weathering out of Coon Creek’s floodplain sediments. The latter are interpreted to have points that were lost during hunting by the Indigenous inhabitants, buried, and later exhumed during field plowing by the Weeks’ as they were buried shallowly and within the plow zone of the floodplain. During the rainy 2002 GSA fieldtrip, a particularly important white quartzite point 15 cm (5.9 in) long was located on floodplain two (Figure 17). White quartzite, a metamorphic rock, is not indigenous to West Tennessee, even in transported gravel deposits, so this point was clearly a trade item. It was placed on display in the Mess Hall; however, the point was stolen from the display case during one of the periods that the site was shut down. Most of the points found are Sykes or White Springs culture points, which dates to the Middle Archaic Period, 4-5 Ky (Emma Hughes, personal communication, 2024).

As noted, the UTMCCSC sits on the original Weeks farmstead, which was active in the late 1800s. Geoarchaeological programing has not been fully developed at UTMCCSC yet, but geoarchaeological excavation opportunities for visitors in the future are planned. The Weeks family operated a brick kiln on the site, locating just north of the house along the Weeks Branch drainage using clays derived from the Coon Creek Formation sediments. Little remains of the kiln today; however, brick and other artifacts litter the ground surface. Floodplain three (Figure 3) contains the remains of 13 black, organic-rich, soil mounds that were stockpiled on the western side of the floodplain during the Weeks years of farming, presumably to add organics to the floodplain soils; however, the soils were never applied to the fields. The site origin of the black soils is not known, but the Black Belt Prairie soil province is nearby to the south. Sediment input to the site opens the research avenue of investigating “legacy sediments” both in the creek and on the surrounding floodplains (e.g., Wade et al., 2020).
The UTMCCSC is situated in a region with historical significance. Two Civil War sites are within a short drive of the site and the center has produced programming that includes the topic of military geology. The Battle of Shiloh occurred on April 6-7, 1862, and is only 20 km (12 mi) south of the UTMCCSC within the same outcrop belt. The role that the local geology played in this battle is well-known (e.g., Kemmerly, 2014; 2016). Military geology is a popular topic with visitors to the area and they are keenly interested in the connections between geology and Civil War history.

Closer to the UTMCCSC, only nine kilometers (5.6 miles) to the north, is the small community of Jacks Creek. Jacks Creek supplied recruits to Confederate General Nathan Bedford Forrest’s newly formed 13th Cavalry in September of 1863. On December 23, 1863, a surprise skirmish took place when some of Bedford’s troops encountered part of a Union column moving northwest from Corinth, Mississippi (e.g., Dyer, 1942). Mapping of the region by UTMCCSC geologists indicates that the local geology played a significant role in this skirmish as the skirmish occurred because the Confederate troops were bogged down in a local swampy area that was the result of water standing on a perched water table on the clay-rich sediments of the Coon Creek Formation.

Although not related to geology directly, UTMCCSC visitors are also piqued when they learn that the UTMCCSC is located only 2 kilometers (1.2 miles) to the east of the birthplace of Buford Pusser of the Walking Tall movie fame from the 1970s (for details of these murders, see Morris, 1995; Broughton and Kirby, 2018; Baldwin and Baldwin, 2021 and references cited within). It is known that Pusser visited the Coon Creek fossil site as a youth (Dwana Pusser, personal communication to Michael Gibson, 2005). One potentially fruitful line of research that relates to local hydrogeology may involve the numerous whisky-still operations that Pusser was famous for uncovering and destroying.

**THE UTMCCSC GEOSCIENCE EDUCATION MISSION**

The scientific importance of the Coon Creek lagerstätten is well-established and clearly the site is worthy of preservation. What makes the UTMCCSC unique is that it is a type-section and lagerstätten deposit that is available to the public, as well as researchers, for education and personal collection. The UTMCCSC is unique among fossil sites because visitors can freely collect from the lagerstätten deposit and are provided geoscience educational programming tailored to the fossils the visitor actually collect. Each visitor is participating in citizen science and action research during their visit. Docents practice actualistic approaches, including open-ended inquiry-based pedagogy, to geoscience education using all aspects of the Coon Creek Formation, both modern and ancient (e.g., Gibson and Brister, 2002; Hudson and Gibson, 2023).

Geoscience education and programing at the UTMCCSC has evolved since its opening in 1988. At that time, there was a focus on summer programing and nature camps for grade school age children. Programing was akin to traditional summer nature camps with focus outdoor activities related to modern plants and animals, stars, and the playing of games, but was different from most summer camps in that it included significant fossil programing. These camps were organized and run by a live-in camp director, the late Bobby King, and a staff of local, self-trained naturalists (mostly nearby teachers or staff from the Pink Palace Museum in Memphis). Camp participants lived in the cabins on the site for various periods of time with catered meals provided by the staff of the camps. Child development was emphasized in the campus as well. Programing included crafts, skits, and singing. Several Coon Creek Camp songs were written.

By the middle 1990s, the summer camp model was not economically tenable for the Pink Palace to maintain. The decision was made for CCSC programing to shift away from running summer camps to providing short few hour-long to single day-long experiences that concentrated solely on the fossils. Access to the CCSC was by reservation through the Memphis Museum offices only (no drive-up visitation), limited to a couple of hours with a specified fossil program, and all overnight programing ceased to be run by the Pink Palace Museum. At this point, any fossils that were found by the visitor could be confiscated by the staff if they were deemed important. Bobby King left the CCSC and the caretaker’s house was vacated. Two local residents that were self-trained on the Coon Creek fossils, Vicky Goodrum and Pat Broadbent, were employed to serve as program docents and caretakers of the site. Essentially, as the years passed, visitation dropped off dramatically, as did access to the site by amateurs, local residents, and even researchers. The CCSC was winterized from November through March each year with no programing. Only UT Martin faculty had access to the site to run their own research and programing during these months. The rural location of the site resulted in deteriorating roads and interrupted services, which
contributed to the decline of the facilities and resulted in several instances of break-ins and vandalism.

Because the Pink Palace did not have PhD level geoscience-trained staff, faculty from The University of Tennessee at Martin became involved in the paleontology research and geoscience education programing as part of a collaboration that continues today. Funded by external grants, K-12 teachers utilized the UTMCCSC to participate in Tennessee- and National Science Standards-based programing and extended stay camps for Tennessee teachers primarily. From 1989 until the COVID-19 pandemic began, a series of GeoCamps and GeoTreks, funded by Eisenhower Title II grants and National Science Foundation funding, were run by faculty from UT Martin and UT Knoxville in collaboration with the Tennessee Earth Science Teachers (TEST) and the Tennessee Higher Education Commission (THEC). TEST was the association of Tennessee earth science teachers and higher education faculty that formed to promote Earth science education in Tennessee (e.g., Byerly and Gibson, 1999; Gibson and Brister, 2002). TEST was responsible for authoring, validating, and training teachers on Earth science content of the Tennessee Science Standards (Watson and Gibson, 2006).

UT Martin became the primary authority for access to the site for scientific studies by professional paleontologists and to be present to host overnight university geology class visits. Only university classes were granted overnight privileges under supervision of UT Martin faculty. During this time period, Vicky Goodrum and Pat Broadbent continued to run Pink Palace programing for the Memphis – Shelby County school children and occasional public visitation, but visitation continued to drop off markedly. UT Martin’s role in running programing at the site continued to expand throughout the years from 2000 through 2019. The CCSC continued to be a financial strain on the Pink Palace Museum, especially with declining visitation and limited program topics. With the exception of a few university paleontology class visits, and some small, faithfully recurring, local group visits, the CCSC was essentially mothballed for much of the year, and remained that way for more than a decade. During this time, maintenance lapsed, and the facilities continued to degrade. UT Martin maintained a research cabin (Evergreen Cabin) on the site and continued to maintain the Mess Hall collections for university visits and researchers.

Driven by the severe economic downturn of 2007-2009, in 2009 the geology program at UT Martin underwent a reorganization. The Department of Geology, Geography, and Physics, which had been in the College of Engineering and Natural Sciences, was broken-up and geology was moved into the College of Agriculture and Applied Science to become part of the newly renamed Department of Agriculture, Geosciences, and Natural Resources. At the same time, the Dean of the college, Dr. Jerry Gresham, recognized the agricultural education value of the CCSC and opened negotiations with the Pink Palace Museum to take-over the CCSC property as an agricultural site. For the next decade, numerous proposals were developed between UT Martin, the Pink Palace Museum, Memphis Museums Inc., the local governments of McNairy County and Hardin County, the cities of Selmer and Adamsville, and even several State of Tennessee agencies in attempts to find the most adventitious arrangement that would allow UT Martin to become the primary steward of CCSC, allow the Pink Palace to remain involved, obtain adequate funding to run the site, keep the site open and available to the public, and most importantly, conserve and preserve the fossil resources on the site. Negotiations were complex, fraught with problems, and there were many policy and jurisdictional hurdles to tackle, which led to many false starts and failed proposals.

In 2018, the Pink Palace Museum and its properties underwent a reorganization that paved the way for a breakthrough in negotiations. The director of the Pink Palace Museum was removed by the advisory board and a new director took over the reigns of the museum and its properties, which included the CCSC. Under the new director, the Pink Palace Museum reorganized into the Museum of Science and History (MoSH). Under the new administrative leadership, MoSH immediately agreed on a 40-year-long lease of the CCSC to the geology program within the Department of Agriculture, Geosciences, and Natural Resources at UT Martin and granted UT Martin full stewardship of the site (MoSH retained ownership of the land and facilities).

At the same time, the Kenneth V. Bordeau Paleontology Endowment was established at UT Martin through an inheritance gift from the Bordeau estate. The Bordeau Paleontology Endowment would provide funding for the paleontology-related programing and maintenance of the fossil collections of UT Martin. Kenneth V. Bordeau (1923-2011), a micropaleontologist, had been one of the original “founding fathers,” and the first paleontologist faculty, of the geology program at UT Martin, which was established in 1972 (Gibson, in preparation). UT Martin paleontologist Dr. Michael A. Gibson became the director of the newly renamed Department of Geology, Geography, and Geosciences.
UT Martin Coon Creek Science Center (UTMCCSC), which was placed under the direct supervision of UT Martin’s Selmer Center in nearby Selmer, Tennessee. The director of the Selmer Center, Alan Youngerman, himself with a geologist’s background, became the primary administrator for the UTMCCSC. Year-round access, new programing and expanded hours of operation were developed to support the mission of the UTMCCSC and a student intern program was instituted to provide trained docents for research and programing.

COVID-19 Pandemic

The COVID-19 Pandemic postponed the planned 2019 opening of the UTMCCSC, but did not stop work at the site, following pandemic protocols, which was allowed during the pandemic because of the remoteness of the site. Renovations began immediately with grounds equipment supplied by the agriculture program at UT Martin and new maintenance facilities added from funding by the Bordeau Paleontology Endowment.

In 2021, with the lifting of the COVID-19 pandemic shutdown, the UTMCCSC resumed operations, now with the added benefit of a paleontology laboratory that was moved onto the site during the pandemic to replace an old barn that housed a small laboratory and which had been torn down when it became unsafe (Figure 3). In 2024, funding was provided through private donations for programing at the UTMCCSC and the paleontology laboratory was dedicated in memory of that donor as the Clinton W. Lively Paleontology Lab. More facilities continue to be added. As noted earlier, a 4-km-long (2.5 mi) nature trail was also cut, along with installation of weather station facilities, and an astronomy telescope with associated programing for both.

UT Martin geology graduate and paleontologist Josh Ratliff, was hired to become the site caretaker and he and his family live on-site in the Smith house, now called the Caretaker’s House (Figure 3). Ratliff also taught geology courses at the UT Martin Selmer and Parsons centers. The UTMCCSC was officially dedicated as a UT site within the UT System on April 30, 2021, by UT System President Randy Boyd and UT Martin Chancellor Keith Carver. Since opening, the UTMCCSC has expanded programing and paleontology research to include pond ecology, forestry, agriculture, geoarchaeology, and more (Hudson et al., 2023). The site has had over 5,400 visitors since the dedication. The Eta Alpha Chapter of Sigma Gamma Epsilon, along with the Alpha Chapter of Sigma Gamma Epsilon, has had over 5,400 visitors since the dedication. The Eta Alpha Chapter members of SGE at UT Martin have been involved in all activities at the site including programing and maintenance. The chapter often conducts its outreach programs and chapter initiatives at the site. In 2023, Gibson retired after 35 years of teaching at UT Martin and 27 years as Eta Alpha Chapter advisor. Josh Ratliff became the second director of the UTMCCSC.

Expanded K-16 Educational Opportunities at the UTMCCSC

The UTMCCSC is a geoscience education facility and there are many opportunities for students and teachers to participate in ongoing STEM programing and research at the UTMCCSC. Eta Alpha Chapter members of SGE at UT Martin took the initiative to collaborate with STEM educators across Tennessee to spearhead the drive to establish an official state fossil for Tennessee in 1998 (Gibson et al., 1997; Gibson and Martin, 1998; Bacon et al., 1997; White and Gibson, 1997a; 1997b; Martin and Gibson, 1999; Brusatte, 2003). After researching fossil candidates and running a year-long polling drive of K-12 and university educators across Tennessee, the Coon Creek bivalve Pterotrigonia thoracica (Figure 15) was identified as the winning candidate and, in 1998, the Tennessee Legislature passed House Joint Resolution 552, sponsored by Senator Roy Herron and Representative Mark Maddox, as the Official State Fossil of Tennessee, making Tennessee the 38th state to designate a state fossil. Recently this species was taxonomically revised and the species assigned to the new genus Tennessiella by Cooper (2016).

The Tennessee Earth Science Teachers (TEST) is an organization of teachers from across Tennessee that began in the early 1990s and was instrumental in developing and distributing hands-on, inquiry-based K-16 curricula, including teacher training, across Tennessee (e.g., Byerly and Gibson, 1999; Gibson and Brister, 2002; Gibson, 2018). TEST has been a continuous user of the Coon Creek site and its fossils for decades. Much of the programing uses the state fossil, “Ptero,” as a vehicle for the training STEM educators on use of the National Science Standards and State of Tennessee Science Framework, demonstrating the educational potential of Coon Creek in both formal and informal education settings. Several of the interns at the UTMCCSC are also local STEM teachers and they have run teacher-led training workshops using the Coon Creek fossils as their focus at the annual Tennessee Science Teachers Association (TSTA) meetings.

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Public Days and Creek Walk Program

The UTMCCSC is open for visitation by reservations through the UT Martin Selmer Center. Organized group visits can be arranged for most any time, including most weekends, as long as docents can be on hand to provide programs. Each third weekend of the month is designated as Community Days, and the facility is open to anyone (e.g., amateur collectors, families, tourists, etc.) by making a reservation to guarantee a slot for a Creek Walk Program.

There are many programs available for visitors to the UTMCCSC; however, the most popular program, for which all docents are trained to be able to deliver, is the Creek Walk Program, which typically run about three-four hours long and accommodates up to thirty visitors. The program is open-ended, inquiry-based in terms of pedagogy and personalized to the visitors. Upon arrival at the UTMCCSC, visitor meet in the Mess Hall to handle billing and receive an orientation by their docents for the program (Figure 18). This is an opportunity for the docents to get to know the visitors, learn a little about their knowledge background and goals for the day, and provide them an opportunity to peruse the displays of fossils and history lessons in the Mess Hall for later use. A short lecture on the history of the UTMCCSC site is presented by the docents. After gearing-up (all necessary implements are supplied by the UTMCCSC, but visitors may bring their own collecting gear), visitors are guided to the creek entrance. Along the walk, many of the basic geologic features and processes described in this paper are introduced to the visitor.

Figure 18: Photograph of a Community Day group beginning their Creek Walk Program in the Mess Hall where they are provided with historical background to the site and a safety lesson. Informational and fossil identity displays are visible on the wall around the room (Photo Credit: M.A. Gibson).
Once in the creek (Figure 3, Figure 19), there is an orientation to the stratigraphy of the Coon Creek Formation, common fossils, and a demonstration on how to excavate fossils and field-wrap them to protect them from damage. A one to two-hour period is allowed for the visitors to wander within the designated creek area and collect freely. No large-scale digging is allowed, except by the docent. Docents shadow visitors, being sure to mingle and provide help and information as needed. Exactly which fossils will be discovered cannot be predicted, so all discussions are tailored to the precise fossils, and geologic phenomena, being encountered by the visitors (Figure 20). It is necessary for docents to be versant on the ecological details of a wide variety of taxa and geologic concepts.

After visitors have collected their fossils and protected them in the field setting, the visiting group then returns to the Mess Hall area, specifically to the Fossil Preparation Pavilion, to begin the process of exposing and caring for their fossils (e.g., see Figure 14). First, visitors are instructed on the best techniques to remove the sediment matrix and “carve” the sediment for the presentation of a fossil and how to repair delicate or broken specimens (e.g., see Figure 15). Docents interact with each visitor as they work sharing additional insights into the individual fossils that the visitor has collected, but also expounding on discussion items that have arisen during the programming. Lessons on reconstructing life histories of individual species and fossil individuals, along with larger-scale lessons related to global change and conservation are introduced to the visitors while they work on their fossils. Docents then make sure that all fossils are identified and prepared for travel.

The visitors to the program were previously introduced to their role as citizen scientists. In this way, should any of them have discovered fossils that the docents deemed important for further study or conservation, the visitor is offered the opportunity to donate the specimen (always with a trade of another fossil, usually from a Paleozoic formation nearby) and to visit the paleontology laboratory to help catalog and curate their specimen. The visitor can fill-out the specimen card with their name entered as “collector” along with their contact information. Any published results that involve their specimen is sent to the visitor upon publication. The program ends with a question-and-answer period during clean-up and preparation for leaving. Creek Walk Programs can be tailored to specific types of experiences using any

Figure 19: Public Day Creek Walk. (A) Photograph of a Public Day group beginning their Creek Walk and hunting for fossils under supervision of the docents. (B) Group of visitors with bags of fossils. Docents walk among the visitors providing individualized lessons on the discovery of each visitor modeling open-ended inquiry pedagogy for instruction. It is at this stage that scientifically significant fossils are identified for additional preparation at the Fossil Prep Pavilion or Paleontology Lab, specific instruction about this fossil’s significance is determined for presenting later to the visiting group, and voluntary donation to the UTMCCSC by the visitor is initially discussed (Photo Credit: M.A. Gibson).
of the concepts presented in this paper; however, the fossil program is the most popular. Overnight and day-long visitors, especially organized groups, such as SGE (Figure 21), receive more in-depth coverage with additional topics tailored toward their education and experience level. All programing includes personalized instruction on the fossils that each visitor finds.

**SUMMARY**

The UTMCCSC was built on the site of the type-locality and type-section for the Upper Cretaceous Coon Creek Formation lagerstätten, thus ensuring the site and its fossil riches will be preserved intact and available to the public. The Coon Creek Formation is internationally recognized for its high biodiversity (more than identified 500 species), high abundance (1 m³ [35 ft³] of sediment contains as much as 200 fossil individuals), pristine preservation (many of

*Figure 20: (A) Articulated and in-living-position Crassatella bivalve in-place before excavating. Once digging commenced, it was determined that this was one specimen in a cluster of Crassatella (B) (Photo Credit: M.A. Gibson).*
The invertebrates are unaltered to the point of preserving the original mother-of-pearl luster and color pattern and allowing meaningful geochemical study), lack of compaction of the sediment (resulting in no distortion of the fossils), leading to ease of extraction (the sediment allows fossils to be separated from matrix using only simple hand tools), that demonstrates paleoecological fidelity (many of the species are preserved complete, with delicate ornamentation intact, and in-living-position, suggesting rapid burial with little disturbance later).

Traditionally, the field research conducted on the Coon Creek Formation was limited to the relatively few scholars disseminating the information in scientific journals only available to professionals. Non-professional visitors collected fossils and took them home, their information to be lost to the scientific community until the construction of the Coon Creek Science Center in 1988. Traditional K-12 (and collegiate) students and highly-motivated life-long learners rarely have hands-on access to this kind of resource or are allowed to participate in original STEM field research. Museums – long considered the “university of the masses” – have always been leaders in the realm of life-long learning, by passively (look, don’t touch) using objects (the “real thing”) to interpret and bridge the gap between abstract science and observable, concrete, and relevant concepts. The UTMCCSC was established to bring the experience of first-hand field research to any visitor.

The UTMCCSC fossil site is scientifically valuable and accessible to learners from elementary school age to post-doctoral status. It is one of the few internationally significant fossil sites to invite both the layperson and the scholar to engage in observation, excavation, and study of well-preserved fossils of great antiquity. As put forth by its mission statement, the University of Tennessee at Martin Coon Creek Science Center educates and engages responsible citizens to lead and serve in a diverse world through education, conservation, stewardship, and research. Our mission at the UT Martin Coon Creek Science Center is to: (1) promote conservation and stewardship of the Coon Creek fossil site and its resources through education and research; (2) study and document the paleobiological, geological, ecological, and human history preserved at the Coon Creek Science Center and the surrounding region; (3) stimulate visitor interest and educate the public about ancient life, ecosystems, and the geologic history preserved in West Tennessee; (4) expose visitors to the processes of modern science and scientific methods as practiced at the UT Martin Coon Creek Science Center; and (5) provide opportunities to students and the public to participate in “citizen science.”

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