Shipworms and Crabs:
Ichnology of a Cretaceous Lagoon

Justin N. Brundin, Ryan F. Morgan
Tarleton State University
Stephenville, Texas USA

TarletonScience

- - Abstract - -

An assortment of trace fossils were examined within an exposure of the Glen Rose Formation in Coryell County, Texas, along Cow House Creek. These ichnofossils vary in abundance and variety, providing insight into a complex and thriving ecosystem. *Teredolites isp.* burrows were found *in situ* , penetrating into a carbonized tree log. The carbonized log was deposited within a limestone , with layers of sand and chalk interspersed, formed in shallow waters near shore. This interpretation is supported by other associated ichnofossils and invertebrate fossils emplaced within the same beds, including a variety of bivalves, ammonites, and small rudist patch reef structures. An associated plant fragment was similarly carbonized but is much smaller and lacking in evident traces. Additional trace fossils include *Thalassinoides isp.* in layers upwards of 20cm thick throughout the exposure, several paired sets of *Brontopodus isp.* in the uppermost layer, as well as two sand lined, flattened, horizontally oriented *Psilonichnus isp. (?)* burrows that have been preserved intact, lacking infill.

- - Objective - -

Tracks along Cow House Creek have been known for almost 40 years, but access has been limited (Raley 2014). Recently the primary track site within Joe Hanna Ranch has been made open for study by the trust overseeing the utilization of the land for educational purposes. This site has proven to be rich in a variety of ichnofossils providing an opportunity for a glimpse into the ecology of lagoon environments in the early Western Interior Seaway of Texas, specifically during the deposition of the Glen Rose Formation.

The Glen Rose Formation has long been known as a source of well-preserved vertebrate trackways (Wedel & Cifelli 2005). The study of these ichnofossils has done much to increase our understanding of vertebrate behavior. Compared to *Brontopodus isp.* Farlow et al. (1989), *Eubrontes isp.* Hitchcock (1845), and other vertebrate ichnogenera, invertebrate traces have remained relatively unstudied, despite their excellent preservation. This provides an opportunity to better understand the behavior of some invertebrate groups whose traces have been preserved.

- - Geologic Setting - -

The location of this study is along the banks of Cow House Creek in Coryell County, Texas, USA approximately 19.3km SW of the city of Gatesville. The outcrop is part of the Glen Rose Formation, a formation within the Trinity Group (Stricklin et al. 1971). It is characterized by massive, ledge forming limestone beds which are primarily composed of coccolithophoran lime mudstone with shell fragments, with interbeds of calcareous clay and lenses of chalk present. The presence of thin cross bedding at the site suggests an intertidal to subtidal flat in lower beds, while ichnofossils support the upper beds association with a lagoon environment.

Other notable ichnofossils sites within the Glen Rose Formation include the large track site at Dinosaur Valley State Park near the town of Glen Rose, Texas (Shuler 1917). Numerous other smaller trackways have been found across this geographically wide ranging formation (Dattilo et al 2014).

- - *Teredolites*, Log Transport & Burial - -

Teredolites isp. Leymerie (1842) are elongate, club shaped burrows, associated with woodgrounds (Bromley et al. 1984). These structures have been identified as dwelling and feeding traces made by wood-boring bivalves, more commonly known as “shipworms.” Two pieces of wood were discovered at the site which had undergone coalification. The largest piece appears to be a continuous log deposited into the bed horizontally for an unknown depth. This log is the only substrate for *Teredolites* found at the site.

Teredolites burrows can be found penetrating the log from all sides. It is of note that the top burrows seem to be more mature due to their large size. It is proposed that while this log was floating, initial burrowing and colonization was begun by shipworms. After transport, the log came to rest on the floor of the lagoon, effectively smothering the burrowers on the bottom of the log, but allowing for the short-term continued growth of the burrows on top. Eventually the burrowers on top were either smothered or abandoned the burrows due to sedimentation and burial. This is reflective of *in situ* logs in which borers are only found perpendicular to the wood surface, exposed to the water column, thereby allowing for respiration (Gingras et al. 2004)

Future study would require the removal and dissection of this log to see if relative size of burrows is consistent along the top and bottom, to look for remaining shelly parts within burrows to test suffocation versus abandonment, and to compare with modern analogs for growth rate. All of these could provide valuable insight into log transport in shallow seas, colonization of wood substrates by shipworms, mobility when stressed, and fine scale sedimentation rate analysis.

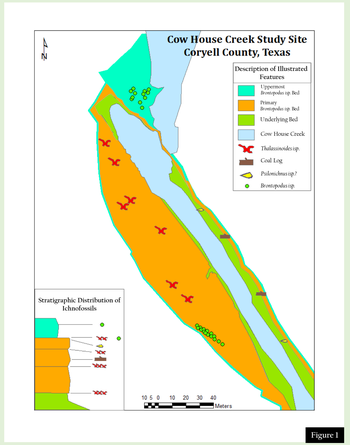

Figure 1

Figure 2

Figure 3

- - Horizontal *Psilonichnus*? - -

Two burrows were discovered preserved intact in the primary *Brontopodus* bed (see Fig. 3) that were horizontally oriented, sand lined, and flattened. Based on photographs and a lack of similar structures in other ichnogenera, it was thought to be *Psilonichnus* Fürsich (1981). However, some conflicting features put this ichnogenus assignment into question. First, the burrows are horizontal instead of the definitive vertical orientation of *Psilonichnus*. Second, these burrows are flattened along the horizontal axis whereas normal diagnosis requires cylindrical or twisting shafts (Frey et al., 1984). Finally, these burrows have a more sandy lining than the surrounding rock, suggesting a lining. While explanations for these anomalies might include compression during lithification, or infill after abandonment, the pristine preservation of nearby *Thalassinoides* Ehrenberg (1944) and Teredolites suggest the correct ichnogenus has yet to be identified or perhaps described.

- - Sauropod Trackways - -

The trackways at this site occur in two beds (see Fig. 1), with the lower presenting the best preservation. They have been assigned to the ichnogenus *Brontopodus* based on their geometry and size. The longest continuous trackway is in the lower bed and is over 19m long, but may continue under the non-eroded bed and bank on the western side. Tracks are very large, with the largest track measuring over a meter in diameter. The only currently know sauropod that could produce tracks of these dimensions during the lower Albian would be a *Sauroposcidon*, which has been put forward as trace maker for other Glen Rose Formation trackways (Wedel & Cifelli 2005).

Conspicuously missing from both beds on Cow House Creek are tridactyl tracks of any kind. This is a marked difference from other track sites that have tridactyls of various sizes alongside the larger sauropod tracks (Raley 2014). Further erosion and exposure of the track baring beds may expose tridactyls if they exist. Lack of tracks could be explained with two potential scenarios. The first would be that the water was too deep for smaller bipedal dinosaurs at the time tracks were lain. These smaller dinosaurs would have a hard time touching the bottom while maintaining their head above the water, given a deep enough tide. A lack of preserved toe kicks suggest that if there were swimming bipedal dinosaurs, they were not touching the bottom (Romilio et al. 2013). The second, and more likely, is that the carbonate muds had already undergone a great deal of hardening and to some extent, lithification. The presence of rudist patch reefs further supports the idea that this was already a firm-to-hardground when these *Brontopodus* tracks were laid, some right through these rudists patches. This leads to the hypothesis that other tridactyl track makers were in fact walking around as is seen in other sites, but *Sauroposcidon* was the only animal with enough weight to break through the hard shell overlaying the carbonate mud.

- - Future Work - -

Future work will focus on the following three areas:

1. Refining the size and speed of the *Brontopodus* track maker.
2. Attempting to better understand colonization of *Teredolites*.
3. Identifying or assigning the tentative *Psilonichnus* burrows to a proper ichnogenus.

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