IMPLICATIONS OF BIFUNGITES FROM THE UPPER DEVONIAN OF WEST VIRGINIA, USA

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Abstract

Recent highway construction in east-central West Virginia, USA, has exposed kilometre-long outcrops of Upper Devonian strata. Within these siliciclastic sediments are the records of numerous small-scale transgressive-regressive episodes associated with the deposition of the Acadian Clastic Wedge. In particular, strata of the Blizzard Member of the Foreknobs Formation (formerly Clemson) have been under investigation for the past two years. Excavation has brought to light well-preserved, marine body fossils; bedding-surface exposures of sedimentary structures; and numerous trace fossils.

The trace fossils in the Blizzard are restricted to two zones separated by 60.3 metres of strata. The upper trace fossil zone is 19.8 metres thick with a prolific assemblage of trace fossils dominated by Bifungites, Avencicolites, and a variety of horizontal traces. The lower zone is only a few metres in thickness, is marked by “diffuse” upper and lower boundaries, and contains the same trace fossil assemblage but fewer trace fossils are present and Avencicolites is more abundant than Bifungites. These assemblages appear to belong to a “mixed” Sholohov and Cruziana ichnocoenosis, both characteristic of relatively high-energy, shallow-marine environments but of different water depths. The associated sediments are fine-to very fine-grained siliciclastics with ripple-scale crossbedding. The upper trace fossil zone is nearly devoid of body fossils, a few, centimetre-thick shell lags are found in the lower zone.

Examination of numerous Bifungites expressed either as epipodal molds, hypichnial casts, or clay-filled endichnia causes us to speculate that some Bifungites ichnospecies may be preservational artifacts related to the grain size and consistency of the enclosing sediment. The formation of the arrow-shaped protrusions of Bifungites is not associated with feeding. It may represent an attempt by the tracemaker to suspend its body above waterlogged sediment at the bottom of the u-tube by increasing its surface area. Another possible explanation for this behavior is that the arrow-shaped portion of the trace may have allowed the tracemaker to “hold on” to the enclosing sediment with one end of its body when faced with a predator attempting to extract it from the burrow.

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General Upper Devonian Stratigraphy

The Upper Devonian clastic wedge of the central Appalachian Basin comprises the Brallier Formation, the tetsnand shale group, and the Hampshire Formation. The Brallier consists of deeper water, inter-beded sandstone and shale with minor fine-grained sandstone. The Greensand Group overlies the Brallier and represents an overall “shallowing upward” marine sequence of sandstones and shales. Finally, the Hampshire Formation caps this clastic wedge and consists of fluvial-deltaic and subaerially exposed sandstones, siltstones, and shales.

Within the Foreknobs Formation of the Greenland Gap Group, several episodes of regression and transgression are inferred (Thennison, 1996).

Acknowledgements

Paleoenvironmental Implications

Two zones with abundant trace fossils are present in the Blizzard Member of the Foreknobs Formation at Elkana, WV. The lower trace fossil zone, centered at mile marker 80 + 352’, on the outcrop panorama shown below, is only a few metres thick and is constrained by discrete upper and lower contacts with enclosing sediments. The lithology within this zone consists of interbedded shale, siltstone, and very fine- to fine-grained quartz sandstone with ripple-scale cross laminations and centimetre-thick shell lags consisting primarily of atyidi brachipods. The trace fossils in this zone are dominated by Avencicolites, followed in abundance by Bifungites and horizontal traces. The upper trace fossil zone, located between mile markers 80 + 072’ and 79 + 980’ on the outcrop panorama, is 19.8 metres thick and contains a prolific assemblage of trace fossils dominated by Bifungites. Lithology and physical sedimentary structures are similar to the lower zone but brachiopod shell lags are absent.

This combination of lithology, sedimentary structures, and trace fossils seems to indicate a relatively high-energy, shallow-marine depositional setting. The assemblage of trace fossils in both the lower and upper zones contains elements of both the Sholohov and Cruziana ichnocoenosis of Fry and Pemberton (1985). The presence of various horizontal traces in both zones suggests a closer affinity to the Cruziana ichnocoenosis but perhaps in shallower subtidal depth setting.
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Bifungites - Discussion

Perhaps most interesting of all the trace fossils at the Elkins outcrop are the numerous examples of Bifungites in all stages of preservation including: epichnial molds, hypichnial casts, and clay-filled endichnia. Specimens of Bifungites at the Elkins outcrop are of the “arrowhead” variety possibly attributable to the ichnospecies Bifungites fezzanensis, Narbonne, 1981. Again, the various expressions of this trace fossil, ranging from sharp arrow shapes resembling something drawn by a very good drafts-person to vague, only roughly arrow-shaped impressions at each end of a horizontal tube, are made possible by the variety of siliciclastic sediment types present. Coarser grain sizes result in correspondingly less distinct and less well-preserved traces. The large number of Bifungites present allows us to speculate that some of the identified ichnospecies assigned to this ichnogroup may, in fact, be preservational artifacts dependent on the nature of the preserving sediment for their distinctive shapes.

Speculation on the origin of Bifungites has ranged from faucid or colonial animal (Deco, 1940) to the filling of the top of a U-shaped burrow inhabited by a small arthropod (Dubois and Lessertiaus, 1965) to special preservation of “protrusive” U-shaped feeding burrow (Seilacher, 1955 and 1969). We note the following common features of all specimens at the Elkins outcrop: 1) each specimen is associated with a dolomite-like U-tube and is positioned (or superimposed) horizontally within a few millimeters of the bottom of the tube; 2) the bottom of the U-tubes are preserved within a different type of sediment than the two limbs of the tubes; 3) the sediment in which the U-tubes “bottom out” may have been less cohesive or more “water-logged” than the overlying layer; 4) examples of Bifungites lie at the interface between the two types of sediment in 2) and 3).

References Cited

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Discussion - Continued

Two modes of preservation of Bifungites encountered at the Elkins outcrop. On the left is a convex hyporelief, on the right is a concave epirelief. Examples of epirelief preservation are considerably less abundant. Coin is 30 mm in diameter.

This is another example of Bifungites preserved as a convex hyporelief. Note the bluntness of the ends of the “barbs” of the arrow-shaped trace. Specimen is 3 cm in length.

We agree, in part, with Seilacher’s assessment of Bifungites as a modification of a U-shaped burrow. However, if the formation of the arrow portion of the trace was associated with feeding there would be no reason to stop with a single, arrow-shaped “excursion” nor would there be any reason for “barbs” of the arrow to always point towards the center of the associated U-tube. We suggest that: 1) Bifungites is associated with the tracemaker’s attempt to maintain circulation through a poorly formed U-tube or 2) that Bifungites is associated with the tracemaker’s attempt to avoid being extracted from the U-tube by a predator.

In the first scenario, the bars of Bifungites represent open cavities into which the tracemaker (an annelid?) could insert anterior or posterior (or both) appendages. Thus “informed” against the overlying sedimentary layer, the tracemaker could push its dorsal surface into the underlying sediment to maintain an open tube. Movement by the tracemaker’s legs would create circulation in the “improper” U-tube.

In the second scenario, anterior or posterior appendages were also inserted into the bars of Bifungites. But, in this scenario, the tracemaker would resort to this behavior only when a predator penetrated one of the limbs of the U-tube, attempting to grasp the tracemaker to extract it from the burrow. The tracemaker could resist by bracing its terminal appendages against the enclosing sediment.