TRACKWAY OF A GIANT ARTHROPLEURA FROM THE UPPER PENNSYLVANIAN OF EL COBRE CANYON, NEW MEXICO

Article · January 2005

CITATIONS
16

READS
565

5 authors, including:

Spencer G. Lucas
New Mexico Museum of Natural History and Science
1,442 PUBLICATIONS **15,282** CITATIONS
SEE PROFILE

Allan J Lerner
New Mexico Museum of Natural History and Science
39 PUBLICATIONS **393** CITATIONS
SEE PROFILE

Joseph T. Hannibal
Cleveland Museum of Natural History
44 PUBLICATIONS **183** CITATIONS
SEE PROFILE

Adrian P. Hunt
316 PUBLICATIONS **5,904** CITATIONS
SEE PROFILE

New Mexico Geological Society, 56th Field Conference Guidebook, Geology of the Chama Basin, 2005, p. 279-282.

TRACKWAY OF A GIANT *ARTHROPLEURA* FROM THE UPPER PENNSYLVANIAN OF EL COBRE CANYON, NEW MEXICO

SPENCER G. LUCAS[1], ALLAN J LERNER[1], JOSEPH T. HANNIBAL[2], ADRIAN P. HUNT[1], AND JOERG W. SCHNEIDER[3]

[1]New Mexico Museum of Natural History and Science, 1801 Mountain Road N.W., Albuquerque, NM 87104

[2]Cleveland Museum of Natural History, 1 Wade Oval Drive, Cleveland, Ohio 44106

[3] Freiberg University of Mining and Technology, Institute of Geology, Department of Palaeontology, Bernhard-von-Cotta street 2, D-09596 Freiberg GERMANY

Abstract.—We document a giant terrestrial arthropod trackway assigned to *Diplichnites cuithensis* Briggs, Rolfe and Brannan, 1979 from the nonmarine redbeds of the Cutler Group (Late Pennsylvanian, Missourian?) in El Cobre Canyon, New Mexico, a classic Pennsylvanian-Permian vertebrate fossil locality. The El Cobre trackway is the first occurrence of *D. cuithensis* in the American Southwest, and, with a width of 38 cm, the largest known trackway of *D. cuithensis*. The tracks are attributable to *Arthropleura*, a gigantic terrestrial myriapod-like arthropod. The Late Pennsylvanian age and paleoenvironmental setting of the El Cobre trackway is consistent with most other records of *D. cuithensis*.

INTRODUCTION

El Cobre Canyon in northern New Mexico (Fig. 1) has been known to paleontologists since 1858 when J. S. Newberry visited the copper mines developed in Upper Triassic strata along the canyon walls (Newberry, 1876). Most of the paleontological fame of the canyon rests on the fossil vertebrates from strata of the Pennsylvanian-Permian Cutler Group exposed in the canyon floor (e.g., Vaughn, 1963; Fracasso, 1980; Berman, 1993). These Cutler Group strata also yield a paleoflora (Hunt and Lucas, 1992) and a little studied trace-fossil assemblage. Here, we document an unusual element of this trace fossil assemblage, a locomotion trace of the giant terrestrial myriapod-like arthropod *Arthropleura*. In this paper, NMMNH refers to the New Mexico Museum of Natural History and Science, Albuquerque.

PROVENANCE

The trackway reported here was collected at NMMNH locality 6037 near the fossil plant locality first reported by Fracasso (1980) and documented by Hunt and Lucas (1992). The trackway (now catalogued as NMMNH P-45287) is on the top surface of a bed of fine- to medium-grained, small-scale cross bedded to ripple-laminated, micaceous arkosic channel sandstone in the lower part of the El Cobre Canyon Formation of the Cutler Group (see Lucas and Krainer, this volume). This bed is between grayish-red, fossil-plant-bearing muddy siltstone beds (Hunt and Lucas, 1992). A few meters away, a smaller, less well-preserved trackway of similar morphology is on the same bedding plane as the trackway described here. Both trackways are heading nearly due west. Fossil pollen, plants and vertebrates suggest a Late Pennsylvanian (Missourian?) age (see Lucas and Krainer, this volume).

DESCRIPTION AND IDENTIFICATION

The trackway at NMMNH locality 6037 (Fig. 2) is preserved in concave epirelief and consists of two track rows of mostly crescentric imprints that are oriented perpendicular to the midline and extend over a distance of about 210 cm. Each track row is missing a mid-length section ~ 50 cm long due to erosion. External trackway width is 32-38 cm. Imprints are 5-7 cm wide and up to 2 cm deep. Spacing between imprints varies between 2.5 and 4 cm. The trackway is heading N80°W, and there are about 18-20 imprints per 100 cm.

The individual imprints are mostly crescent shaped, but include hemispherical impressions, complex lobate shapes and simple, rounded impressions. We regard most of these shape differences as being due to erosion, the fact that the trackway clearly is an undertrack and the variablity of imprints made by repetitive, overlapping footprints of more than one appendage.

We assign the trackway to *Diplichnites cuithensis* Briggs, Rolfe and Brannan. Briggs et al. (1979) diagnosed that taxon as a very large *Diplichnites* with rare trifid tracks shallowing toward the trail axis. Their emended diagnosis of *Diplichnites* reads: "morphologically simple trail, up to 36 cm wide, consisting of two parallel series of tracks (each up to 9 cm wide); individual tracks elongate roughly normal to trail axis, spaced closely and

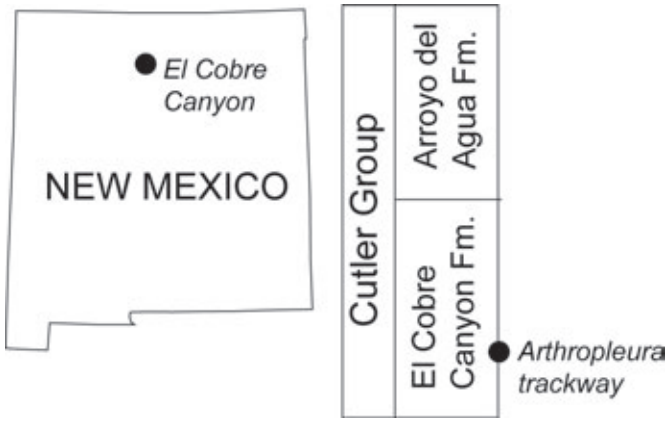

FIGURE 1. Index map and generalized lithostratigraphy showing the location of El Cobre Canyon and the *Arthropleura* trackway locality, NMMNH 6037.

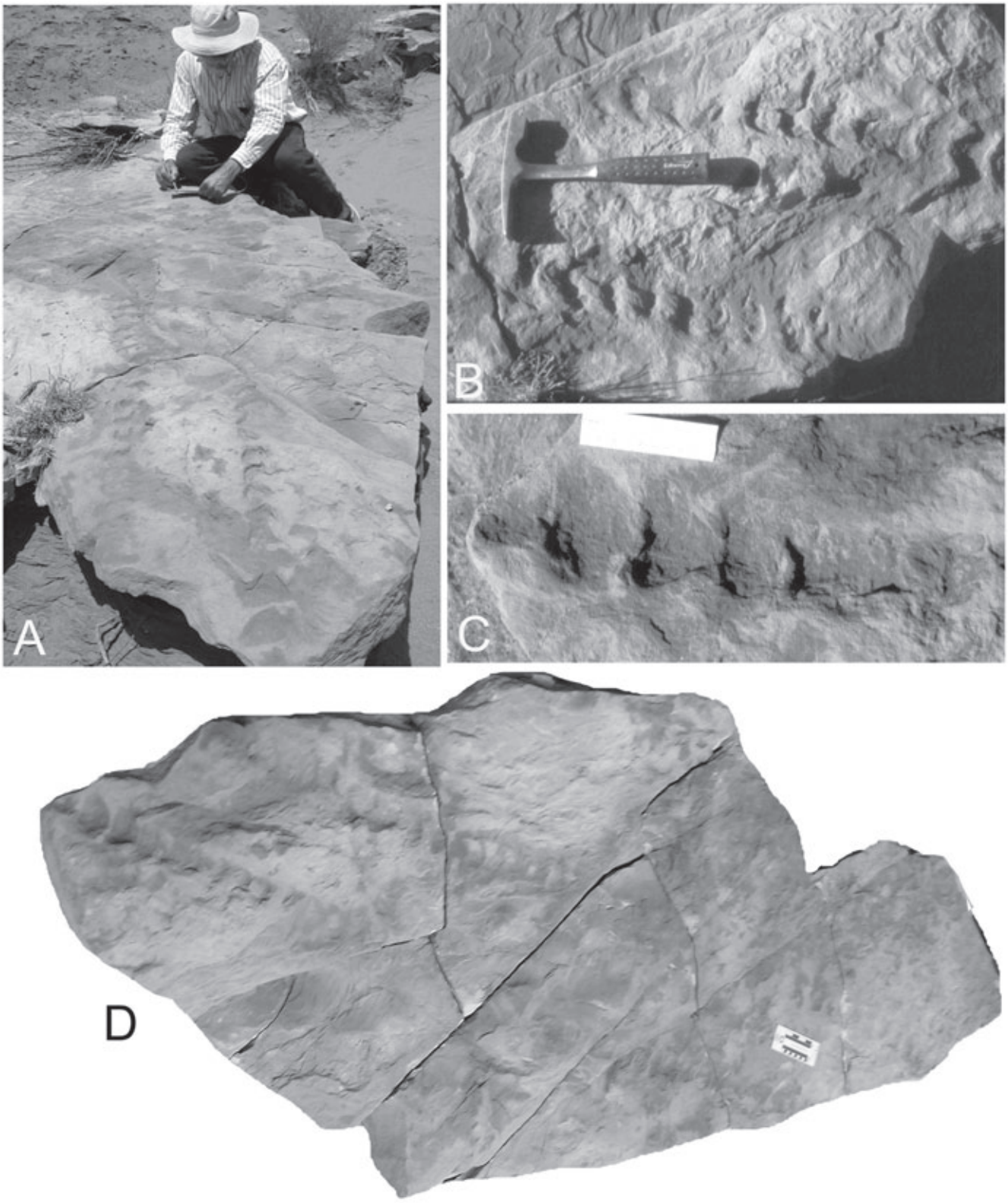

FIGURE 2. Selected photographs of the trackway of a giant *Arthropleura*, *Diplichnites cuithensis*, at NMMNH locality 6037. A, Overview of trackway. B-C, Details of trackway. D, View of trackway in the Museum (NMMNH P-45287).

regularly, at up to about one per cm" (Briggs et al., 1979, p. 289). The trackway from El Cobre Canyon fits well with this diagnosis except that the trifid tracks toward the rail axis are not preserved. The El Cobre trackway resembles illustrated specimens of giant *Diplichnites* (e.g., Briggs et al., 1979, 1984; Briggs and Rolfe, 1983; Almond, 1985; Wright et al., 1995).

Indeed, the El Cobre Canyon trackway of *D. cuithensis* is the largest known trackway of that ichnospecies. With a width of about 38 cm, it is larger than the famous Arran, Scotland record, which is 36 cm wide (Briggs et al., 1979) and those found at Gardner Creek, New Brunswick, which are also about 36 cm wide (Briggs et al., 1984). Note that Pearson (1992, p. 129) claimed a possible occurrence with a width of 46 cm, but his certain trackways are only 21-24 cm wide. Schneider and Werneburg (1998) reconstructed a 2 m long *Arthropleura* based on a leg from the Lower Permian Manebach Formation, Thuringia, Germany, as well as on well-preserved ventral body remains from the Döhlen Formation in Saxony, Germany. The trackway made by an individual of this size should have been about 40-50 cm wide.

DISCUSSION

Diplichnites cuithensis is generally considered to be the trackway of the giant myriapod-like arthropod *Arthropleura* (Fig. 3). Arthropleurids are the largest terrestrial invertebrates known (Schneider and Werneburg, 1998). Using the criteria of Wilson (2003), the crescentic nature of the imprints of the El Cobre trackway indicates that the arthropleurid making the trackway was moving rapidly.

The El Cobre Canyon record of *D. cuithensis* is its first published record from New Mexico and its first documentation in the American Southwest (Hunt et al., 2004). *Arthropleura* trackways, sometimes assigned to the ichnospecies *D. cuithensis* or *D. aenigma* Dawson, 1873, are well known from the Carboniferous of eastern Canada (New Brunswick and Nova Scotia: Ferguson, 1966, 1975; Rolfe, 1979; Briggs et al., 1984; Archer et al., 1995), and in the USA *D. cuithensis* has been reported from Kansas (Mángano et al., 2000). A large (15 cm wide by 3 m long) trackway from the Casselman Formation (Conemaugh; Stephanian equivalent), in Cambria County, Pennsylvania described by Marks et al. (1998) may well also have been made by *Arthropleura*. Mass occurrences of 2-5 cm wide trackways of juvenile arthropleurids were reported as *Diplichnites minimus* by Walter and Gaitzsch (1988) from Permocarboniferous tuffites of the Flechtingen high in central Germany.

Trackways assigned to eoarthropleurids range back in age to at least the Late Silurian (Wright et al., 1995) and the Early Devonian (Gevers et al., 1971; Braddy and Milner, 1988; Smith et al., 2003). Trackways made by *Arthropleura* are Visean to Stephanian (Late Pennsylvanian) in age (e.g., Pearson, 1992; Briggs, 1986; Walter and Gaitzsch 1988; Archer et al., 1995). The age of the El Cobre Canyon occurrence of *Diplichnites cuithensis* thus is consistent with the other occurrences.

Body fossils of *Arthropleura* are Visean to Early Permian in age (Briggs and Almond, 1984; Schneider and Barthel 1997, Rößler and Schneider 1997, Schneider and Werneburg, 1998) and in North America have been reported from Nova Scotia, Illinois, Ohio and western Pennsylvania (Richardson, 1956, 1959; Copeland, 1957; Rolfe, 1979; McComas and Mapes, 1985; Hannibal, 1997a, b). There are additional, undescribed specimens of *Arthropleura* from east-central Pennsylvania in the collections of the United States National Museum of Natural History.

Sedimentological studies indicate that the depositional environment of the El Cobre Canyon Formation was that of a low sinuosity river system with locally vegetated interfluves and floodplain surfaces (Fracasso, 1987; Eberth and Miall, 1991; Krainer and Lucas, 2001). This environment belongs to the so-called "wet red bed" facies characterized by common *Scoyenia* burrows, ferric soils with hematitic concretions as well as immature calcisols and calcareous rhizoconcretions. Other records of *Diplichnites cuithensis* and of *Arthropleura* suggest that these giant myriapod-like animals preferred river floodplain environments with an open, mesophilic vegetation (Walter and Gaitzsch, 1988; Schneider and Barthel, 1997). The El Cobre Canyon occurrence of *D. cuithensis* is in rocks representative of such an environment, and thus paleoecologically consistent with earlier records.

The preservation of the trail as relatively deep undertracks at the surface of a fluvial channel sandstone contradicts the latest interpretation of Kraus and Brauckmann (2003) of *Arthropleura* as a thin-skinned caterpillar-like animal, stabilized only by means of antagonistic hydraulics of body fluids. This interpretation is obviously based on an incorrect over-interpretation of resorbed and therefore thin molting remains of *Arthropleura.* Instead, the exoskeleton of this giant must have been strongly sclerotized in order to make deeply impressed trackways such as those from El Cobre Canyon.

FIGURE 3. Reconstruction of *Arthropleura* and its trackway (from Rolfe, 1979).

ACKNOWLEDGMENTS

The sharp eyes of David S. Berman spotted the trackway reported here. Larry Rinehart, Josh Smith and others assisted in the field. Ronny Rössler and Kate Zeigler made helpful comments on an earlier version of the manuscript.

REFERENCES

Almond, J. E., 1985, Les arthropleurides du Stephanian de Montceau-les-Mines, France: Bulletin de la Societe d'Histoire Naturelle Autun, v. 115, p. 59-60.

Archer, A. W., Calder, J. H., Gibling, M. R., Naylor, R. D., Reid, D. R. and Wrightman, W. G., 1995, Invertebrate trace fossils and agglutinated Foraminifera as indicators of marine influence within the classic Carboniferous section at Joggins, Nova Scotia: Canadian Journal of Earth Sciences, v. 32, p. 2027-2039.

Berman, D. S., 1993, Lower Permian vertebrate localities of New Mexico and their assemblages: New Mexico Museum of Natural History and Science, Bulletin 2, p. 11-21.

Braddy, S. J. and Milner, A. R. C., 1988, A large arthropod trackway from the Gaspé Sandstone Group (Middle Devonian) of eastern Canada: Canadian Journal of Earth Sciences, v. 35, p. 1116-1122.

Brauckmann, C., Gröning, E. and Thiele-Bourcier, M., 1997, Kopf- und Schwanz-Region von *Arthropleura armata* Jordan, 1854 (Arthropoda; Ober-Karbon): Geologica et Palaeontologica, v. 31, p. 179-192.

Briggs, D. E. G., 1986, Walking trails of the giant arthropod *Arthropleura* (traces d'*Arthropleura* geants): Bulletin de la Société d'Histoire Naturelle d'Autun, v. 117, p. 141-148.

Briggs, D. E. G. and Almond, J. E., 1984, The arthropleurids from the Stephanian (Late Carboniferous) of Montceau-les-Mines; in Poplin, C. and Heyler, D., eds., Quand le Massif Central etait sous l'equateur: Un ecosysteme Carbonifere a Montceau-les-Mines: Memoires de la Section des Sciences 12, Editions du Comite des Travaux Historiques et Scientifiques, Paris.

Briggs, D. E. G. and Rolfe, W. D. I., 1983, A giant arthropod trackway from the Lower Mississippian of Pennsylvania: Journal of Paleontology, v. 57, p. 377-390.

Briggs, D. E. G., Plint, A. G. and Pickerill, R. K., 1984, *Arthropleura* trails from the Westphalian of eastern Canada: Palaeontology, v. 27, p. 843-855.

Briggs, D. E. G., Rolfe, W. D. I. and Brannan, J., 1979, A giant myriapod trail from the Namurian of Arran, Scotland: Palaeontology, v. 22, p. 273-291.

Copeland, M. J., 1957, The arthropod fauna of the Upper Carboniferous rocks of the Maritime Provinces: Geological Survey of Canada, Memoir 286, 110 p.

Eberth, D. A. and Miall, A. D., 1991, Stratigraphy, sedimentology and evolution of a vertebrate-bearing, braided to anastomosed fluvial system, Cutler Formation (Permian-Pennsylvanian), north-central New Mexico: Sedimentary Geology, v. 72, p. 225-252.

Ferguson, L., 1966, The recovery of some large track-bearing slabs from Joggins, Nova Scotia: Maritime Sediments, v. 2, p. 128-130.

Ferguson, L., 1975, The Joggins section: Maritime Sediments, v. 11, p. 69-76.

Fracasso, M. A., 1980, Age of the Permo-Carboniferous Cutler Formation vertebrate fauna from El Cobre Canyon, New Mexico: Journal of Paleontology, v. 54, p. 1237-1244.

Fracasso, M. A., 1987, Fluvial deposition and paleoenvironment of the Cutler Formation red beds, El Cobre Canyon, New Mexico: New Mexico Geology, v. 9, p. 14-18.

Gevers, T. W., Frakes, L. A., Edwards, L. N. and Marzolf, J. E., 1971, Trace fossils in the Lower Beacon sediments (Devonian) Darwin Mountains, Southern Victoria Land, Antarctica: Journal of Paleontology, v. 45, p. 81-94.

Hahn, G., Hahn, R. and Brauckmann, C., 1986, Zur Kenntnis von *Arthropleura* (Myriapoda; Ober Karbon); Geologica et Palaeontologica, v. 20, p. 125-137.

Hannibal, J. T., 1997a, Myriapods and arthropleurids; *in* Shabica, C. W. and Hay, A. A., eds., Richardson's guide to the fossil fauna of Mazon Creek: Chicago, Northeastern Illinois University, p. 172-183.

Hannibal, J. T., 1997b, Remains of *Arthropleura*, a gigantic myriapod arthropod, from the Pennsylvanian of Ohio and Pennsylvania: Kirtlandia, no. 50, p. 1-9.

Hunt, A. P. and Lucas, S. G., 1992, The paleoflora of the lower Cutler Formation (Pennsylvanian, Desmoinesian?) in El Cobre Canyon, New Mexico, and its biochronological significance: New Mexico Geological Society, 43rd Field Conference Guidebook, p. 145-150.

Hunt, A. P., Lucas, S. G., Lerner, A. J and Hannibal, J. T., 2004, The giant *Arthropleura* trackway *Diplichnites cuithensis* from the Cutler Group (Upper Pennsylvanian) of New Mexico: Geological Society of America, Abstracts with Programs, v. 36, no. 5, p. 66.

Krainer, K. and Lucas, S. G., 2001, Pennsylvanian-Permian depositional break in the Cutler Formation, El Cobre Canyon, New Mexico: Geological Society of America, Abstracts with Programs, v. 33, no. 5, p. A5-A6.

Kraus, O. and Brauckmann, C., 2003, Fossil giants and surviving dwarfs. Arthropleurida and Pselaphognatha (Atelocerata, Diplopoda): Characters, phylogenic relationships and construction: Verhandlugen Naturwissenschaltliche Verein Hamburg Neue Folge, v. 40, p. 5-50.

Mángano, M. G., Buatois, L. A., West, R. R., & Maples, C. G., 2002, Ichnology of a Pennsylvanian equatorial tidal flat--the Stull Shale Member at Waverly, eastern Kansas: Kansas Geological Survey, Bulletin 245, p. 1-133.

Marks, W. J., Marks, R. I. and Pompa, A. M., 1998, Problematic tracks in the Casselman Formation of Cambria County: Pennsylvania Geology, v. 29, no. 2-3, p. 2-6.

McComas, G. A. and Mapes, R. H., 1988. Fauna associated with the Pennsylvanian floral zones of the 7-11 Mine, Columbia County, northeastern Ohio: Ohio Journal of Science, v. 88, p. 53-55.

Newberry, J. S., 1876, Geological report; in Macomb, J. N., ed., Report of the exploring expedition from Santa Fe…in 1859: Washington, D. C., U. S. Army Engineer Department, p. 9-118.

Pearson, P. N., 1992, Walking traces of the giant myriapod *Arthropleura* from the Strathclyde Group (Lower Carboniferous) of Fife: Scottish Journal of Geology, v. 28, p. 127-133.

Richardson, E. S., 1956, Trilobitomorpha: Arthropleurida: Fieldiana Geology, v. 12, p. 69-76.

Richardson, E. S., 1959, Trilobitomorpha: Arthropleurida II: Fieldiana Geology, v. 12, p. 79-82.

Rolfe, W. D. I., 1979, Aspects of the Carboniferous terrestrial arthropod community: IX International Carboniferous Congress, v. 5, p. 303-316.

Rössler and Schneider, J. W., 1997, Eine bemerkenswerte Paläobiocoenose im Unterkarbon Mitteleuropas – Fossilführung und Paläoenvironment der Hainichen-Subgruppe (Erzgebirge-Becken): Veröffentlichungen Museum für Naturkunde Chemnitz, v. 20, p. 5-44.

Ryan, R. J., 1986, Fossil myriapod trails in the Permo-Carboniferous strata of northern Nova Scotia, Canada: Maritime Sediments and Atlantic Geology, v. 22, p. 151-161.

Schneider, J. W., and Barthel, M., 1997, Eine Taphocoenose mit *Arthropleura* (Arthropoda) aus dem Rotliegend (Unterperm) des Döhlen-Becken (Elbe-Zone, Sachsen): Freiberger Forschungshefte C, v. 466, p. 183-223.

Schneider, J. W., and Werneburg, R., 1998, *Arthropleura* und Diplopoda (Arthropoda) aus dem Unter-Rotliegend (Unter-Perm, Assel) des Thüringer Waldes (Südwest-Saale-Senke): Veröffentlichungen Naturhistorisches Museum Schleusingen, v. 13, p. 19-36.

Smith, A., Braddy, S. B., Marriott, S. and Briggs, D. E., 2003, Arthropod trackways from the Early Devonian of South Wales: A functional analysis of producers and their behavior. Geological Magazine, v. 140, p. 63-72.

Vaughn, P. P., 1963, The age and locality of the late Paleozoic vertebrates from El Cobre Canyon, Rio Arriba County, New Mexico: Journal of Paleontology, v. 37, p. 283-286.

Walter, H., and Gaitzsch, B. 1988. Beiträge zur Ichnologie limnisch–terrestrischer Sedimentationsräääume Teil II: Diplichnites minimus n. ichnosp. aus dem Permosiles des Flechtinger Höhenzuges: Freiberger Forschungshefte Reihe C, v. 427, p. 73-84.

Wilson, H. M., 2003, Functional morphology of locomotion in the giant Paleozoic millipede Arthropleura: insights from trace fossils and kinematics of locomotion in extant millipedes. Geological Society of America Abstracts with Programs, v. 35, no. 6, p. 538.

Wright, J. L., Quinn, L., Briggs, D. E. G. and Williams, S. H., 1995, A subaerial arthropod trackway from the Upper Silurian Clam Bank Formation of Newfoundland: Canadian Journal of Earth Sciences, v. 32, p. 304-313.