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The graphoglyptid trace fossil *Spirorhaphe involuta* (de Stefani, 1895) from eastern Jamaica

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Abstract — The spiral graphoglyptid trace fossil *Spirorhaphe involuta* (de Stefani, 1895) occurs in deep-water turbidites of the Maastrichtian - Lower Eocene Richmond Formation exposed in Dry River in eastern Jamaica. This is the first report of the ichnogenus from Jamaica, and the Caribbean region. The same location also yields examples of the ichnotaxa *Helminthorhaphe flexuosa* Uchman and *Helminthopsis hieroglyphica* Heer.

INTRODUCTION

FUCHS (1895, p. 394) introduced "Graphoglypten" as a term for a group of trace fossils subsequently found to be characteristic of successions interpreted as flysch, i.e., syn-tectonic deep water turbidites (Seilacher, 1977). As discussed by Miller (1991), the descriptor graphoglyptid has become more or less synonymous with geometrically intricate trace fossils that occur in rock sequences interpreted as deep-sea turbidite successions. Many enigmas remain to be resolved with respect to graphoglyptids, such as their function, affinities and evolutionary history.

Graphoglyptids include networks (e.g., *Paleodictyon* Meneghini), radial structures (e.g., *Lorenzinia* de Gabelli), loose but continuous meanders (e.g., *Cosmorhaphe* Fuchs), uni- and biramous meanders (e.g., *Urohelminthoida* Sacco) and spirals (e.g., *Spirophycus* Häntzschel) (see Książkiewicz, 1970, 1977; Miller, 1991; Uchman, 1995). In Dry River in eastern Jamaica we encounted the spiral graphoglyptid *Spirorhaphe involuta* (de Stefani, 1895). This genus has not been recorded previously from Jamaica, nor for that matter from anywhere else in the Caribbean. Despite an intensive search, only a single example was discovered. Additional ichnotaxa occur at the site, namely the graphoglyptid *Helminthorhaphe flexuosa* Uchman and the simple meandering burrow *Helminthopsis hieroglyphica* Heer. Although both of these ichnotaxa have been recorded previously from the Richmond Formation in Jamaica (Pickerill *et al*., 1992, 1993), the specimens documented in these reports proved uncollectible. Three examples of the former and one of the latter were collected and, along with *S. involuta*, are deposited in the Geology Museum, University of West Indies (UWIGM), with registration numbers UWIGM 1997.3 (*S. involuta*), UWIGM 1997.4-6 (*H. flexuosa*) and UWIGM 1997.7 (*H. hieroglyphica*).

LOCATION AND STRATIGRAPHY

The site is located in eastern Jamaica on the east bank of the Dry River, a small, north-flowing tributary of the Rio Grande, immediately to the west of Comfort Castle, parish of Portland (Fig. 1; NGR 31131557; Jamaica 1:50,000 (metric edition) topographic map 14, "Port Antonio"). It is reached by a track that joins the main road at Comfort Castle. The exposure, in steep river cliffs, comprises several tens of metres of thin-bedded, fine- to medium-grained deep-water sandstones, interpreted as deep-water turbidites, interbedded with shales (Fig. 2A), and overlain by thick bedded conglomerates interpreted as probable debris flow deposits.

As discussed by Pickerill and Donovan (1991), there is controversy with respect to the nomenclature of these strata. Some authors assign them to the Richmond Formation (e.g., Scott, 1987) or the Moore Town Formation (e.g., Jiang and Robinson, 1987; Mooretown Formation {*sic*}, Robinson and Jiang, 1990). In this contribution we follow the former nomenclature (Fig. 1). The Richmond Formation is largely Paleocene to Lower Eocene (Jiang and Robinson, 1987), although Scott

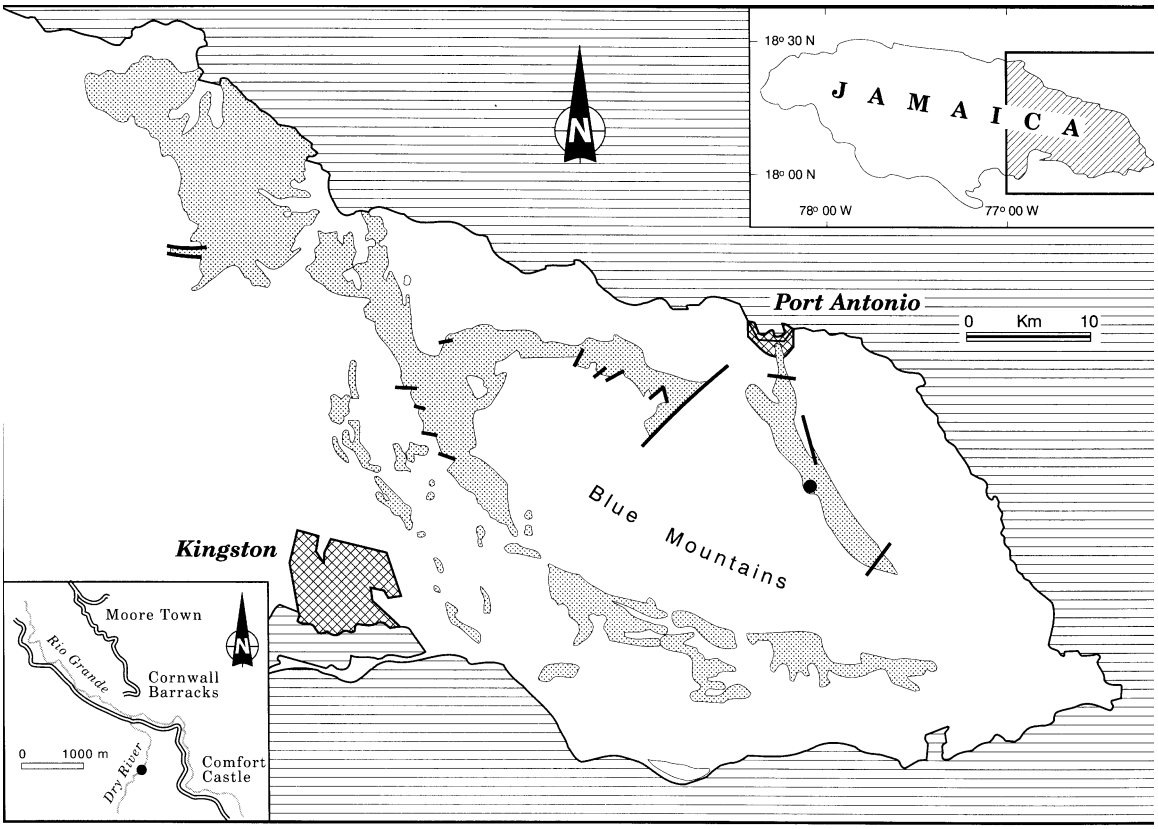

Figure 1. Simplified geological map of eastern Jamaica showing outcrop of the Richmond Formation (stippled). The Dry River location is indicated by a solid black dot; the inset (bottom left) shows the location in more detail.

(1987) demonstrated that the succession in the Rio Grande valley extended down into the Maastrichtian (Upper Cretaceous).

SYSTEMATIC PALICHNOLOGY

Ichnogenus *Spirorhaphe* Fuchs, 1895

Spirorhaphe involuta (de Stefani, 1895)

Fig. 2B

Diagnosis. Tightly spiralled horizontal trail which coils inwards, loops back, and coils outwards alongside the inward-coiling trail.

Geological range. Ordovician-Recent.

Material. Specimen UWIGM 1997.3.

Description. The specimen is preserved in positive hyporelief on the sole of a 40 mm-thick, fine- to medium-grained sandstone layer. It is a thin ridge, 1.8-2.0 mm wide, that forms a spiral coil. The individual whorls are broadly parallel or sub-parallel and they form a centrally-positioned return loop. The four whorls on the left side of the specimen (illustrated in Figure 2B) terminate before the edge of the slab, presumably having originally extended upward into the original sediment. The ridges are smooth, and the sediment between them is undisturbed. The entire specimen covers a surface area of approximately 50 by 52 mm.

Remarks. *S. involuta* can be differentiated from the other two ichnospecies of *Spirorhaphe*, *S. azteca* Seilacher and *S. graeca* Seilacher, by the presence of the central loop. This loop reflects the behaviour of the unknown producing organism which employed a two-way spiraling system (Seilacher, 1977), although Seilacher's (1977) hypothetical model is based on multiple levels of spiralling and is difficult to apply to two-dimensional specimens preserved in the rock record. *S. azteca* and *S. graeca* both consist of one-way spirals with no central loop developed and are easily distinguished from *S. involuta*.

Most previously illustrated examples of *S. involuta* (for example, Häntzschel, 1975, p. W105, fig. 65, 1a, b; Seilacher, 1977, p. 293, fig. 2a, p. 298, fig. 3k, p. 303, fig. 5a; Książkiewicz, 1977, p. 145, fig. 30b-d, p1. 18, 1-2; Ekdale and Berger, 1978, fig. 10; Ekdale, 1980, fig. 1A-B; Ekdale *et al.*, 1984, fig. 8A; McCann and Pickerill, 1988, p. 338, fig. 5-7; Crimes and Fedonkin, 1994, p. 80, fig. 6C; Crimes and McCall, 1995, p. 247, fig. 7E-F, p. 249, fig. 8A-C) exhibit more concentric whorls than the four developed on the specimen described here. However, the holotype (de Stefani, 1895, pl. 14, fig. 1; reproduced in Książkiewicz, 1977, p. 145, fig. 30a) shows only four

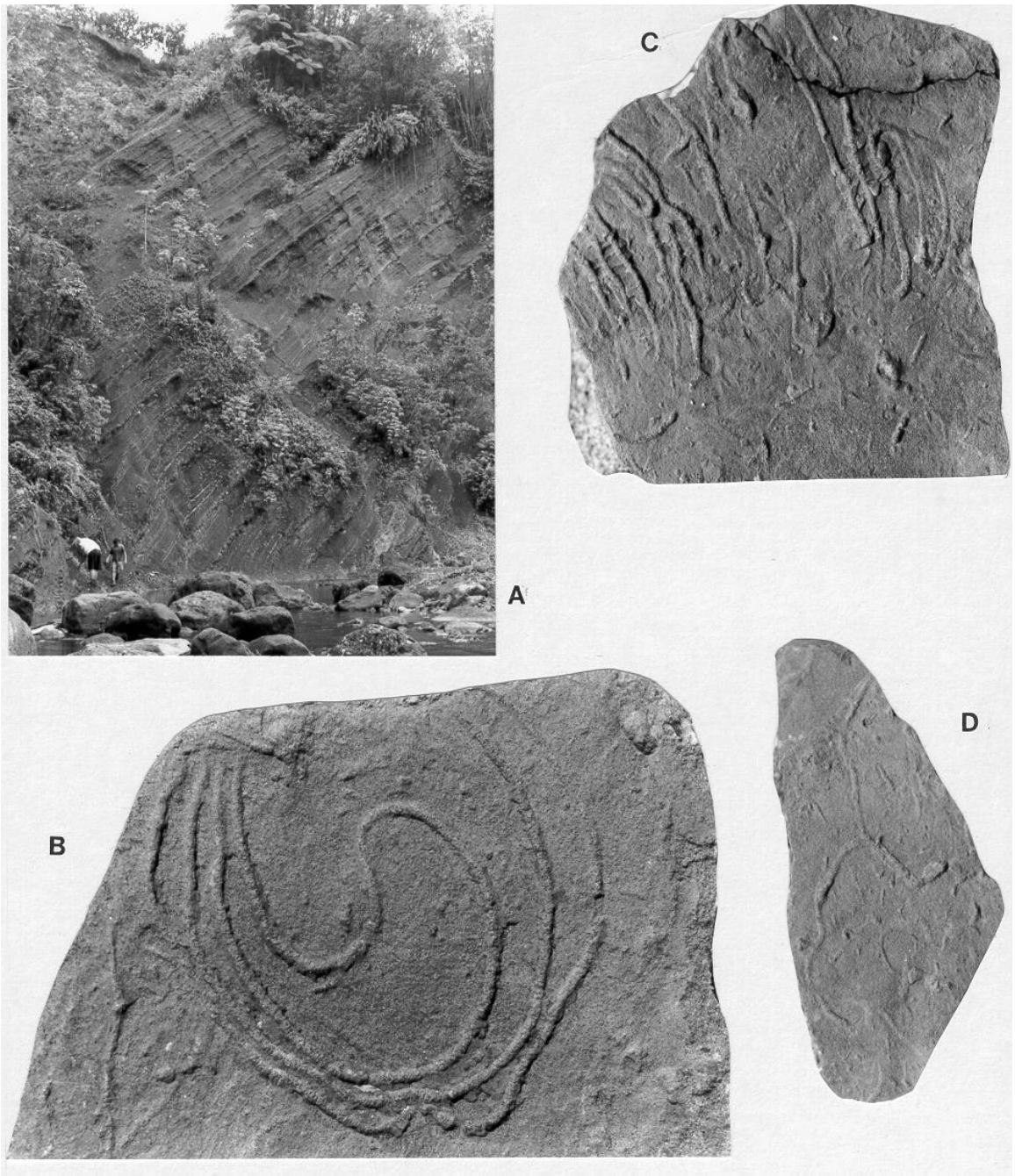

Figure 2. A, Thin-bedded turbidites and inter-turbidite shales of the Richmond Formation at Dry River. People (bottom left) for scale. B, *Spirorhaphe involuta* (de Stefani, 1895) preserved on a sandstone sole, UWIGM 1997.3, × 1.5. C, *Helminthorhaphe flexuosa* Uchman, preserved on a sandstone sole, UWIGM 1997.4, × 1. D, Two intersecting specimens of *Helminthopsis hieroglyphica* Heer preserved on a sandstone sole, UWIGM 1997.7, × 0.8. All illustrated ichnofossils occur in positive hyporelief.

whorls and is virtually identical in overall size and morphology to the Jamaican specimen.

Seilacher (1977), Książkiewicz (1977) and Crimes and McCall (1995) discussed *S. involuta* in some detail. Although the first known occurrences are in the Ordovician (Pickerill, 1980), the ichnospcies typically occurs in strata of Mesozoic and younger age in strata interpreted as deep-water flysch.

CONCLUDING REMARKS

The Richmond Formation crops out over a considerable area of Jamaica (Fig. 1). It comprises a

variety of facies interpreted to have been deposited in diverse shallow- and deep-marine environments (Wescott and Ethridge, 1983). Pickerill *et al*., (1993) drew attention to the fact that graphoglyptid trace fossils were surprisingly uncommon in deep-water facies of the Richmond Formation. Indeed, of sixteen ichnotaxa reported, only three graphoglyptids were represented, namely, *Cosmorhaphe* cf. *gracilis* Książkiewicz, *Paleodictyon*? isp. and *Helminthoida crassa* Schafhäutl. The latter ichnospecies, *H. crassa*, has been subsequently incorporated within *Helminthorhape flexuosa* Uchman, 1995, a taxonomic decision with which we concur. *H. flexuosa* has been reported previously from the Richmond Formation (Pickerill *et al*., 1993, p. 63, fig. 2b). The new material is better preserved (Fig. 2C). The only other ichnotaxon discovered at the site, *Helminthopsis hieroglyphica* is also figured (Fig. 2D).

In addition to this being the first record of *Spirorhaphe* from Jamaica, it adds to the overall diversity of ichnotaxa, particularly graphoglyptids, known from deep-water facies of the Richmond Formation.

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REFERENCES

Crimes, T.P. & Fedonkin, M.A. 1994. Evolution and dispersal of deepsea traces. *Palaios*, **9**, 74-83.

Crimes, T.P. & McCall, G.J.H. 1995. A diverse ichnofauna from Eocene-Miocene rocks of the Makran Range (S.E. Iran). *Ichnos*, **3**, 231-258.

Ekdale, A.A. 1980. Graphoglyptid burrows in modern deep-sea sediment. *Science*, **207**, 304-306.

Ekdale, A.A. & Berger, W.H. 1978. Deep-sea ichnofacies: modern organism traces on and in pelagic carbonates of the western equatorial Pacific. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **23**, 263-278.

Ekdale, A.A., Muller, L.N. & Novak, M.T. 1984. Quantitative ichnology of modern pelagic deposits in the abyssal Atlantic. *Palaeogeography, Palaeoclimatology, Palaeoecology*, **45**, 189-223.

Fuchs, T. 1895. Studien über Fucoiden and Hieroglyphen. *Akademie der Wissenschaften zu Wien, mathematisch-naturwissenschaftliche Klasse, Denkschriften*, **62**, 369-448.

Häntzschel, W. 1975. Trace fossils and Problematica: in Teichert, C. (ed.), *Treatise on Invertebrate Paleontology, Part W, Miscellanea, Supplement I*, W1-W269. Geological Society of America and University of Kansas Press, Boulder, Colorado, Lawrence, Kansas.

Jiang, M.-J. & Robinson, E. 1987. Calcareous nanofossils and larger foraminifera in Jamaican rocks of Cretaceous to Early Eocene age: in Ahmad, R. (ed.), *Special Issue of the Geological Society of Jamaica, Proceedings of a workshop on the status of Jamaican Geology*, 24-51.

Książkiewicz, M. 1970. Observations on the ichnofauna of the Polish Carpathians: in Crimes, T.P. & Harper, J.C. (eds.), *Trace fossils, Geological Journal Special Issue*, **3**, 283-322. Seel House Press, Liverpool.

Książkiewicz, M. 1977. Trace fossils in the flysch of the Polish Carpathians. *Palaeontologicia Polonica*, **36**, 208 pp., 29 pls.

McCann, T. & Pickerill, R.K. 1988. Flysch trace fossils from the Cretaceous Kodiak Formation of Alaska. *Journal of Paleontology*, **62**, 330-348.

Miller, W. III. 1991. Paleoecology of graphoglyptids. *Ichnos*, **1**, 305-312.

Pickerill, R.K. 1980. Phanerozoic flysch trace fossil diversity - observations based on an Ordovician flysch ichnofauna from the Aroostook-Matapedia Carbonate belt of northern New Brunswick. *Canadian Journal of Earth Sciences*, **17**, 1259-1270.

Pickerill, R.K. & Donovan, S.K. 1991. Observations on the ichnology of the Richmond Formation of eastern Jamaica. *Journal of the Geological Society of Jamaica*, **28**, 19-35.

Pickerill, R.K., Donovan, S.K. & Dixon, H.L. 1992. The Richmond Formation of eastern Jamaica revisited - further ichnological observations. *Caribbean Journal of Sciences*, **28**, 89-98.

Pickerill, R.K., Donovan, S.K., Doyle, E.N. & Dixon, H.L. 1993. Ichnology of the Paleogene Richmond Formation of eastern Jamaica - the final chapter? *Atlantic Geology*, **29**, 61-67.

Robinson, E. & Jiang, M.-J. 1990. Eocene calcareous nannofossils from western Portland and the ages of the Richmond and Mooretown Formations of Jamaica. *Journal of the Geological Society of Jamaica*, **27**, 17-25.

Scott, W. 1987. Age and provenance of the Richmond Formation of the Rio Grande Valley, eastern Jamaica; in Ahmad, R. (ed.), *Special Issue of the Geological Society of Jamaica, Proceedings of a workshop on the status of Jamaican Geology*, 52-68.

Seilacher, A. 1977. Pattern analysis of *Paleodictyon* and related trace fossils: in Crimes, T.P. & Harper, J.C. (eds.), *Trace fossils 2, Geological Journal Special Issue*, **9**, 289-334. Seel House Press, Liverpool.

Stefani, C. de. 1895. Aperçu géologique et description paléontologique de l'île de Karpathos: in Stefani, C. de, Forsyth Major, C.J. & Barbey, W., Karpathos. *Étude géologique, paléontologique et botanique*, 1-28, G. Bridel, Lausanne.

Uchman, A. 1995. Taxonomy and palaeoecology of flysch trace fossils: The Marnosa-Arenacea Formation and associated facies (Miocene, Northern Apennines, Italy). *Beringeria*, **15**, 1-115.

Westcott, W.A. & Ethridge, F.G. 1983. Eocene fan delta-submarine fan deposition in the Wagwater Trough, east-central Jamaica. *Sedimentology*, **30**, 235-247.