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SOME TRACE FOSSILS FROM CLINTON RED SANDSTONE (EARLY SILURIAN) FROM HARRISBURG AREA, PENNSYLVANIA, AND THEIR ENVIRONMENTAL SIGNIFICANCE.

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ABSTRACT

The outcrops of hematite cemented sandstone facies of Clinton Group are exposed along Susquehanna river north of Harrisburg in Pennsylvania. These sandstones are devoid of body fossils. Only two ichnogenera *Skolithos* Haldeman and *Arthrophycus* Hall have been previously reported. Four new ichnogenera herein described are *Cruziana* d'Orbigny, *Rusophycus* Hall, *Lockeia* James, and *Planolites* Nicholson. One new form ichnoforma A is also described, but formal name is not given since its biogenic origin is doubtful. These sandstones of Clinton Group are interpreted to be deposited in *Skolithos* and *Cruziana* facies indicating a littoral to sublittoral (down to the level of effective wave base) environment.

INTRODUCTION

The rocks of Clinton Group are mainly shales, but changes to sandstones in the eastern part of Pennsylvania. The important lithological units are ferruginous sandstones, siltstones and grey shales around Harrisburg area in the Blue Mountains. Large scale ripple marks and cross beddings are common primary sedimentary structures. In addition to them some small scale ripple marks of oscillatory currents alongwith interference type are common in thinner beds. The geology of different lithofacies of Clinton Group has been discussed in detail by Hunter (1970).

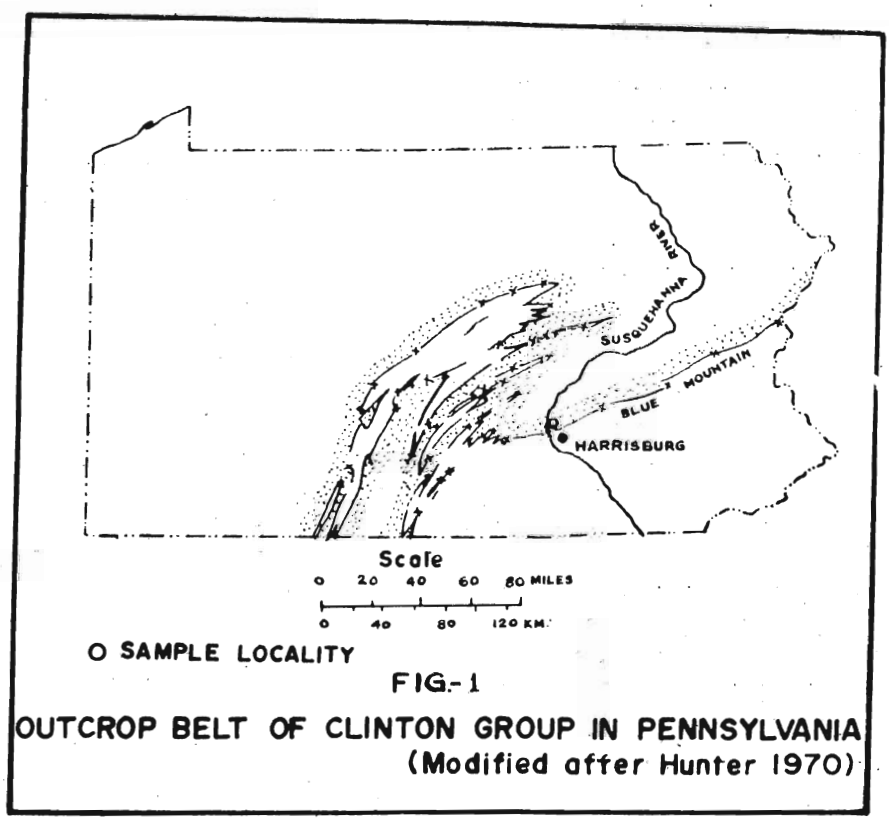

Fig. 1. Outcrop belt of Clinton Group in Pennsylvania.

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Yeakel (1962) discussed the presence of *Skolithos* and *Arthrophycus* in this rock unit. Hunter (1970) also mentions the occurrence of various types of tracks and trails. The other fossil record includes the presence of thin and arcuate fragments probably of *Lingula*. Seilacher (1967) considers that Clinton Group was deposited in *Cruziana* facies.

Locality : The present assemblage of ichnofauna is described from the hematite cemented sandstone facies of Clinton Group. These fossils were collected at a locality about five miles north of Harrisburg along the Susquehanna river (Figure-1). These were collected in April 1973 from the debris of rock fall at the base of the outcrop.

SYSTEMATIC DESCRIPTION

All the specimens are kept in the Palynology Laboratory, Geology Department, Michigan State University.

Ichnogenus *Rusophycus* Hall 1852

Rusophycus sp.

(Pl. I—2, Fig. 2B)

The specimen is segmented into two rows which are joined by a median line. There are about 12 segments clearly visible. The anterior end is semicircular, but the posterior end tapers into a point. It is 4 centimeters long and 8 millimeters wide. *Rusophycus* is the resting of Trilobites.

Discussion : Crimes (1970) considered that the various forms of this ichnogenus cannot be satisfactorily divided into ichnospecies. He classified various forms into groups. The present species belongs to his Form B group.

Material : One well preserved specimen.

Ichnogenus *Cruziana* d'Orbigny 1842

Cruziana sp.

(Pl. I—1, Fig. 2A)

It is a bilobate convex hyporelief, 12 centimeters long, 12 millimeters wide, and about 2 millimeters high. It shows deeply impressed and sharply separated 'V' shaped markings which meet medially to give the 'V' angle 100 degrees. It is considered to be a crawling trace of Trilobites.

Discussion : Cruziana sp. looks similar to *Cruziana quadrata* of Seilacher (1970), but the latter species is much more wide and its width ranges from 4.0 to 6.5 centimeters. The present species belongs to the *Cruziana quadrata* group established by Seilacher (1970).

Material : One well preserved specimen.

Ichnogenus *Lockeia* James 1877

Lockeia sp.

(Pl. II—1, Fig. 2E)

These are small, oblong to cylindrical bodies, preserved as convex hyporelief. Generally these are cylindrical rather than oblong, 12 to 14 millimeters wide and 1 to 2 millimeters high, with smooth surface. They lie horizontally parallel to the bedding plane without any preferred orientation.

Discussion : This ichnogenus is similar to another ichnogenus *Pelecypodichnus* Seilacher (1953), which has been interpreted to be the resting trace of small bivalves. Osgood (1970) considers that *Lockeia* were made by some rigid and semirigid bodies and represent the burrowing activity of pelecypods.

Material : One well preserved specimen.

Ichnogenus *Planolites* Nicholson 1873

Planolites sp.

(Pl. II—2, Fig. 2F)

These are cylindrical to subcylindrical, unbranched, curved or straight, smooth walled tubes. These tubes are filled with sediment of different lithology than that of host rock. Generally these tubes lie horizontally in the bedding plane, or at times diagonal to it. Sometimes these tubes are found as convex hyporelief on the bedding plane. Their diameter ranges from 3 to 5 millimeters, and at times these get flattened by compaction.

Discussion : Crimes (1970) has demonstrated that this ichnogenus is independent of facies. Most probably it does not have much environmental significance. As far as its mode of formation is concerned, Hallam (1970) considers it to be worm burrow. Osgood (1970) considers it to be excretion of worms, which results in the lithological difference between these tubes and the host rock.

Material : Three well preserved specimens.

Ichnogenus *Skolithos* Haldeman 1840

Skolithos sp.

(Pl. I—1, and Pl. II—3, Fig. 2C)

They are unbranched, tubular penetrations found vertical to the bedding plane of the rock. The diameter of the present specimens range from 4 millimeters to 12 millimeters. There are four such burrows present in one of the specimens which has an area of 11.5×9.5 centimeters.

Discussion : There have been many interpretations in past about its mode of formation, which ranges from stem of some marine plant to the annelid burrows. Crimes (1970) considers *Skolithos* to be facies dependent, and *Skolithos* facies represents littoral zone. Fenton and Fenton (1934) proposed that phoronids build tubes of similar shape, size, and structure on the coastal sands. This interpretation is also indicative of the littoral zone.

Material : Three well preserved specimens.

Ichnogenus *Arthrophycus* Hall 1852

Arthrophycus sp.

(Pl. II—4, Fig. 2D)

These are straight, unbranched tubes found on the sole of the bedded sandstones. They are found in random clusters and often cut across each other. They are 2 to 6 centimeters long, and 2 to 5 millimeters wide, with smooth surface.

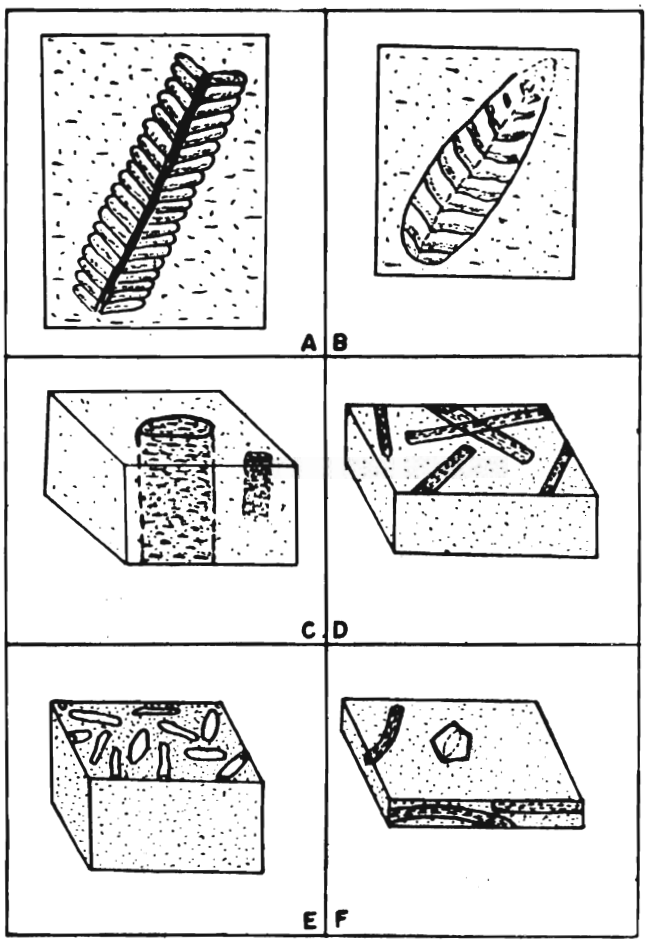
Discussion : The origin of *Arthrophycus* is uncertain. Sarle (1906) considered it to be animal burrows.

Material : One well preserved specimen.

Ichnoforma A

(Pl. II—2, Fig. 2F)

It is convex relief of pentagonal shape on the bedding plane, and has two ridges running from one end to the other with maximum separation at the highest point of the convex relief. Its cast shows all these structures. It is 8 millimeters long, 6 millimeters wide, and 2 millimeters high. Its biogenic origin is doubtful.



F:g.2. DIAGRAMMATIC SKETCH OF CLINTON TRACE FOSSILS

Fig. 2. Diagrammatic sketches of Clinton trace fossils.
A. *Cruziana* sp.
B, *Rusophycus* sp.
C. *Skolithos* sp.
D. *Arthrophycus* sp.
E. *Lockeia* sp.
F. *Planolites* sp. and Ichnoforma A.

Material : One well preserved specimen which also has specimens of *Planolites.*

DEPOSITIONAL ENVIRONMENT

A nearshore shallow marine environment was suggested by Craig (1952) on the basis of probable presence of the genus *Lingula,* and other sparse fauna. Hunter (1970) considers that this facies in parts represents tidal flat deposits and other parts were probably deposited in shallow marine waters below low tide line.

The present assemblage of ichnofauna includes *Cruziana, Rusophycus, Arthrophycus, Lockeia, Skolithos* and *Planolites.* According to Crimes (1970) the ichnogenus *Planolites* is facies independent. *Arthrophycus* and *Lockeia* could represent a nearshore shallow marine and also onshore tidal flat environment. The presence of *Cruziana* and *Rusophycus* are important because they definitely indicate marine environment since they reflect movement of Trilobites.

The present assemblage of ichnofauna represents *Skolithos* and *Cruziana* facies of Seilacher (1967) indicating a littoral to sublittoral environment of deposition. This is further substantiated by the presence of primary sedimentary structures like large and small ripple marks.

CONCLUSION

(*a*) Four new ichnogenera *Cruziana, Rusophycus, Planolites* and *Lockeia* are for the first time reported and described from the hematite cemented sandstone facies of Clinton Group.

(*b*) A new ichnoforma A is also described.

(*c*) The rocks belonging to this facies are interpreted to be deposited in littoral to sublittoral (down to the effective wave base level) zone of deposition.

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EXPLANATION OF PLATES

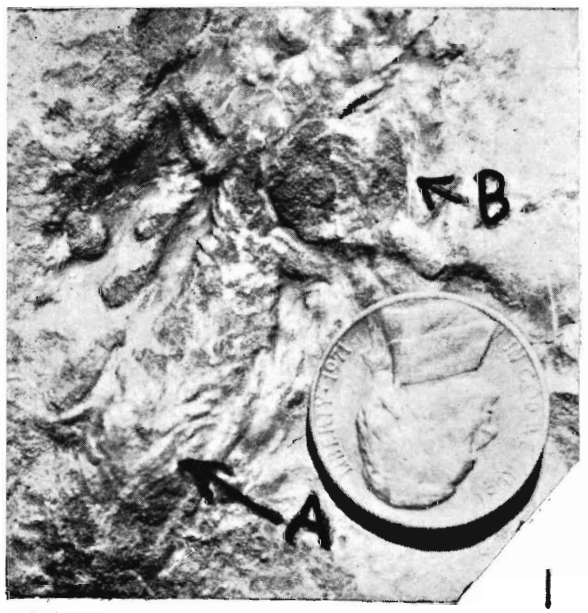
Illustrations : No magnification.

Plate I.

1. *Cruziana* sp. and *Skolithos* sp.
2. *Rusophycus* sp.

Plate II.

1. *Lockeia* sp.
2. *Planolites* sp. and Ichnoforma A.
3. *Skolithos* sp.
4. *Arthrophycus* sp.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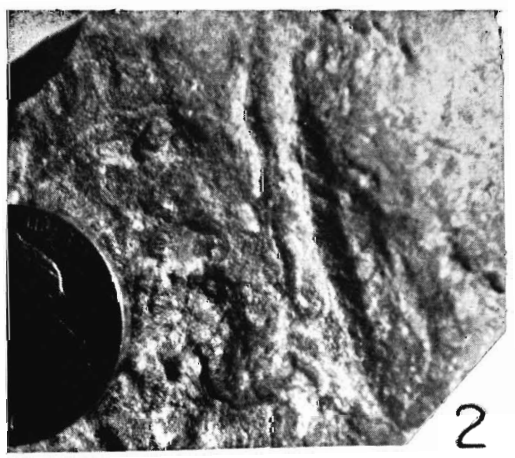
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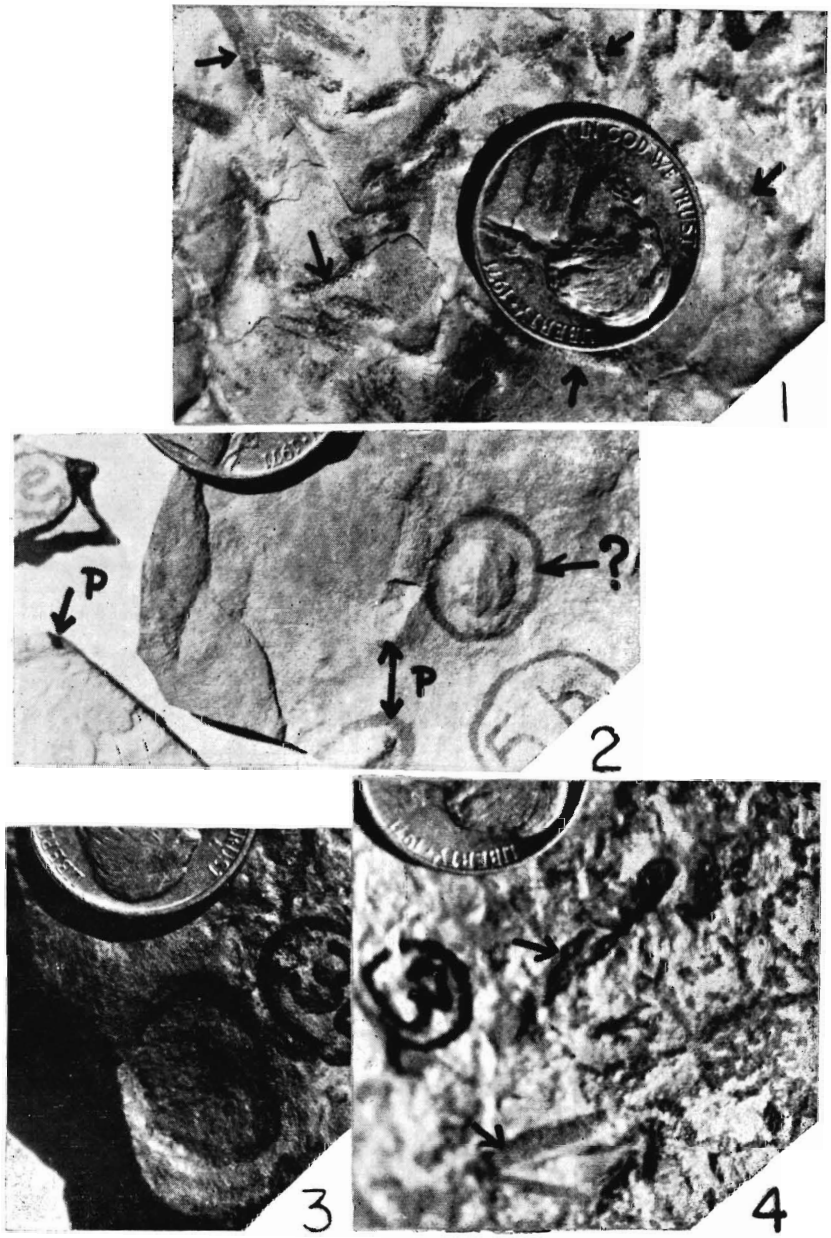
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