

Behavioural evolution of early metazoan: study of Precambrian trace fossils

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Preceding the explosive evolution of multicellular animals (metazoan) in the Cambrian, soft-bodied macro-organisms, known as Ediacaran fauna, had already emerged. Although they attract interest of many scientists, their origin is still controversial; some say they are ancestral forms of known Phanerozoic-type metazoan; others say they are extinct organisms having no relation to metazoan. Much more reliable evidences of the earliest metazoan are given as trace fossils, which are undoubtedly produced by muscle-propelling bilaterian. Trace fossils not only provide the information on early evolution of animals, but are useful tools to the stratigraphic correlation of the Precambrian rocks. Studies of Precambrian trace fossils are reviewed here and some forms collected during our expedition in Namibia are reported.

The first question is the age of the oldest trace fossil, i.e. the oldest evidence of metazoan. There are some reports on 'trace fossils' older than 1 billion years. Most of them are, however, (1) falsely dated; (2) although real traces, much younger than the rock; (3) although biogenic, not produced by metazoan (algae, biomat-related structure, etc.); (4) not biogenic structures but physical ones (tectonic structures, desiccation cracks, gas/fluid-escape structures, etc.). The newest reports on such oldest trace fossils are from the Chorhat Sandstone of India about 1.6 billion years old (Seilacher et al., 1998; Rasmussen et al., 2002a); and from the Stirling Range Formation of southwestern Australia older than 1.2 billion years (Rasmussen et al., 2002b). Unfortunately there is no positive evidence to support their existence as animal traces.

As a matter of fact, most of the Precambrian traces are simple and their origin is difficult to judge, especially when they occur individually. Therefore, what is important might not be when they appeared first, but when they came to be common. This is apparently in the Late Proterozoic (Vendian); abundant trace fossils are known especially from the stratigraphic levels equivalent to those of the Ediacaran fauna. More than 40 ichnogenera have been reported from the Vendian rocks. Unfortunately, it is difficult to identify the producer of trace fossils (so is the case with Phanerozoic ones). They give, however, information on the behaviour of the trace makers. Most of the Precambrian trace fossils are unbranched, horizontal grooves, ridges, strings, or series of projections or depressions arranged as such. They are produced when an animal moves or grazes in the sediment. Some of them show regular meandering pattern, which is a result of effective foraging strategy. The characteristic of the Precambrian trace fossils is that they are two-dimensional structures restricted to one plane. In the Cambrian the diversity of trace fossils became much higher and a lot of complex traces with three-dimensional constructions appeared.

The authors collected some trace fossils from the uppermost Proterozoic of south Namibia. They are derived from the Spitzkop Member (Nama Group) in the Farm Swartpunt. Two specimens have a characteristic forms having branching. One of them has bundle-like branching pattern and the branches are in contact with each other. Another specimen has a dendritic form with curved branches. There are some other reports on such branched burrows from the Precambrian strata. In order to produce such branching, the producer must have turned in its burrow. The animal might have kept its burrow for a period, making branching to extend its burrow system, perhaps for the purpose of deposit feeding.