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Ichnology and Main Types of Trace Fossils

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ABSTRACT

Ichnology studies the traces of activities left by modern and ancient animals. The advantage of trace fossils of biological activity and solid fossils is that the trace fossils are not modified by late diagenesis. They are the original deposits of organisms on the sedimentary environment and can directly reflect the living habits of animals and their living environment. According to the sedimentary substrate in which animals live, trace fossils can be divided into tracks, traceways, trails, crawling traces, resting traces, burrows on the soft ground, and erosion traces made by animals on the hard ground.

KEYWORDS

Trace fossils; soft ground; hard ground; sediment.

1. INTRODUCTION

Broadly speaking, the research object of ichnology includes two aspects: on the one hand, it is to study the traces of modern biological activities, that is, through the detailed observation and reporting of the trace makers activities of various types of modern animals, to understand the activity rules of various types of trace makers, trace points and distribution characteristics and their relationship with the sediment. Then the controlled environmental factors are analyzed[1][2]. On the other hand, it is to study the traces of ancient biological activities. It is mainly to study the trace fossils left by ancient animals. This kind of trace fossils is formed by the traces left by various life activities of ancient animals at the bottom layer, which are filled and buried by sediments, and then formed by the later diagenesis[3]。The study of modern biological activity traces is of great significance for researchers to speculate on the living rules and ancient environment of ancient organisms. There are seven common types of bottom materials for paleontological activities: hard ground, firm ground, stiff ground, soft ground, soup ground, shell ground and wood ground[5][3].

There are usually the following 10 kinds of life activities left by ancient organisms on the bottom layer: (1) Running- animals move rapidly at the surface or within the layer. (2) Walking-Biological walking on the level. (3) Crawling- creatures use toes or appendages to crawl on the level, but the body of the creature often does not contact the level; (4) Peristaltic-Biological use of the body to contact the underlying crawling; (5) Rest- creatures rest on a level, mainly to avoid predators or to eliminate fatigue; (6) Foraging-Biological predation at or near the level. (7) Feeding- organisms move from the surface to the deep layer and explore the behavior of feeding; (8) Inhabitation- usually refers to the activity of organisms to control submarines or drill holes in the layer in order to seek shelter; (9) Swimming- Swimming activities carried out by various animals in the water near the water-sediment interface; (10) Flight- the movement of an animal suddenly leaving the bottom layer to fly in the air. The traces left by these biological activities on the surface are likely to form trace fossils. These trace fossils are different from solid fossils. Trace fossils can reflect the relationship between

organisms and the bottom layer, and directly reflect the living habits of organisms and the ecological environment in which they are located[6][7][8].

2. CLASSIFICATION OF TRACE FOSSILS IN SOFT BOTTOM

1.tracks

Footprints are discontinuous single toe prints left by animals when they move (walk or run) on the sediment. These traces often appear on beaches or beaches, and their trace-making animals are mostly bipedal animals, such as amphibians, reptiles, mammals, insects and birds. Table 1 lists the different assemblage types of trace fossils in different periods.

2.trackways

Foot tracks are a series of toe prints that are in rows or in groups or in multiples and discontinuous when animals make certain directional movement or crawling on the bottom surface (Figure 1). Most of these trace-selecting organisms are multi-legged arthropods or tetrapods, such as trilobites and scorpions.

3.trails

A tugging trace is a continuous groove trace caused by a part of the body (often ventral) touching the bottom layer and creeping, crawling or moving on the bottom layer during continuous movement of an animal.

Table 1. The main types of trace fossils

Tracks in soft ground	1.tracks,2.traceways,3.trails,4.crawling traces,5.tresting traces,6.burrows
Traces of plants in soft ground	Rootpenetration structures, algal stromalolites
Traces of biological erosion on a hard ground	Borings, drill holes or drilling marks, rasping and scraping traces, bite traces

4.crawling traces

Creeping trace is the trace left by animals when they use their moving organs or appendages to crawl on the bottom layer of ununited sediments.

5.resting traces

Stopping marks refer to the marks left by animals when they suddenly stop moving or stay at normal rest due to fatigue or encountering natural enemies when they are running on the bottom layer of soft sediment. This trace can often reflect the size and part of the external morphological characteristics of the trace animals.

6.burrows

Buried caves refer to various caves excavated by animals into the bottom layer (Figure 2). Generally speaking, there are four different structural characteristics of the buried cave, including the buried cave wall, the buried cave tube, the buried cave chimney and the buried cave model. The buried cave wall refers to the outer wall of the cave. If it is reinforced and thickened by some materials, it is called the lining wall. There are many types of burrows. According to the directional relationship between burrows and the bottom layer and the complexity of burrows, ichnologists can be further divided into vertical burrows, horizontal burrows, U-shaped burrows, etc.

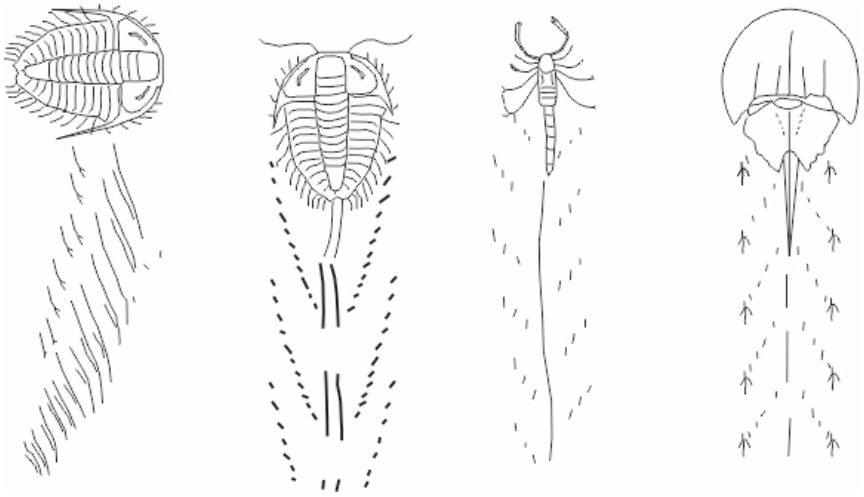

Figure 1. Several trackways

1,2- triobita; 3- scorpions; 4- limulacea

Plant traces in soft-bottom sediments : Plant traces formed in soft-bottom sediments mainly include two types: one is the traces left by plant roots infiltrating into the bottom layer, known as root traces ; the other is the trace formed together with the associated sediments during the growth of plant algae, which is called algal stromatolites.

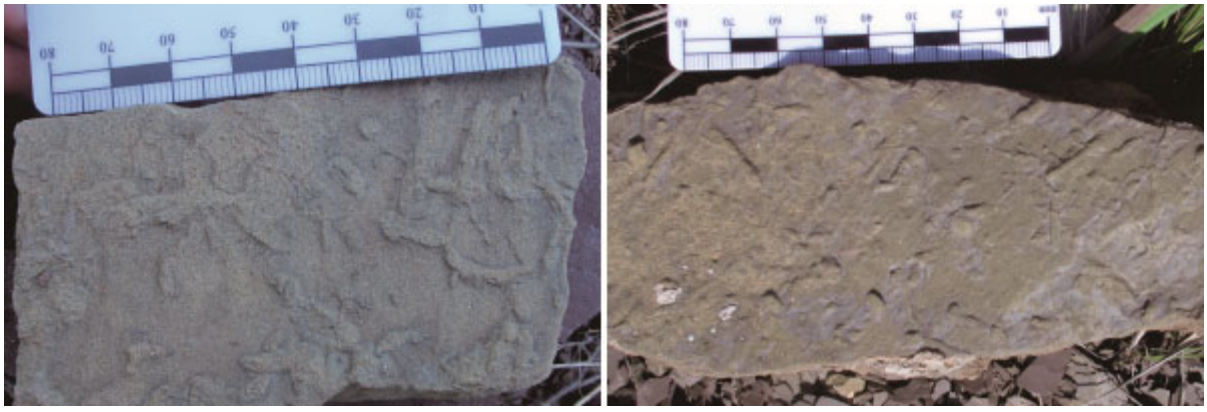

Figure 2. Biological burrows

3. TRACES OF BIOLOGICAL EROSION ON A HARD GROUND

The hard sediment here includes rock, consolidated sediments, wood and the bottom layer formed by the accumulation of the shell. There are four common types of biological traces produced on these hard substrates, namely, drilling, drilling holes, abrasions and scratches, and bite marks. The construction of these traces by trace makers is considered to be accomplished through erosion, so such traces are also called biological erosion structures. There are two methods for biological erosion of hard ground. One is a mechanical or physical method. The organisms using this method often have the ability to punch holes and abrasion. The other is a chemical method. The organisms using this method can secrete a corrosive acid to erode the hard ground.

4. SUMMARY

The preservation of trace fossils is not as strict as the preservation of solid fossils. Under some high-energy conditions, there can also be some excavation burrows[4]. Trace fossils are good research materials, which can reflect some habits and living environment of organisms, and help researchers to explore the changes of paleoenvironment and paleoclimate. Some special trace fossils exist on the mineral resource layer, which is a good indicator of mineral resources. At present, ichnology has made a lot of achievements in paleoecology and paleoenvironment research, sequence stratigraphy research and energy exploration. The development of ichnology has great potential in the future. In the future interstellar exploration, the efforts of geologists are indispensable, and the future ichnology will inevitably have greater development space.

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