

# Chapter 9C

## PALEONTOLOGY, PART C

### TRACE FOSSILS

#### 1. INTRODUCTION

**1.1** What is a *trace fossil*? *Any indirect evidence of the life activities of organisms, are recorded in the solid medium, usually sedimentary, in or on which they lived.* In the literature, especially the older literature, the synonym *lebensspuren* (in German, “life traces”) is used for trace fossils. (German workers, in the early part of the twentieth century, were among the pioneers of the modern study of trace fossils.) The study of trace fossils is called *ichnology*.

**1.2** The organisms that leave traces that become preserved as trace fossils are in most cases *vagile* (that is, moving about in the course of their lives, in some way) rather than *sessile* (living in one place)—one important exception being rooted plants.

**1.3** You can readily surmise the common kinds of trace fossils: tracks, trackways, trails, burrows, and borings. Here are some common terms used in connection with study of trace fossils:

**track:** an impression in sediment left by a “foot” (more precisely the lower end of any appendage that makes contact with the solid substrate in the course of locomotion)

**trackway:** a succession of tracks that reflects directed movement of the organisms

**trail:** a continuous groove or furrow produced by movement of an animal with its body in continuous contact with the underlying sediment surface.

**boring:** a tubular excavation by an organisms into a rigid substrate (rock)

Burrow: a tubular excavation by an organisms into unconsolidated sediment

**shaft:** a dominantly vertical burrow or part thereof

**tunnel:** a dominantly horizontal burrow or part thereof

**burrow lining:** a burrow wall constructed by the organisms as a structural reinforcement

**burrow cast, burrow fill:** the sediment that infills a burrow (this can happen by the life activities of the organisms, or later by sedimentation).

**spreite:** sinuous, U-shaped, or spiraled structure consisting of sets of closely spaced, repeated, congruent feeding, dwelling, or grazing traces.

**1.4** Trace fossils are in contrast to *body fossils*: the actual bodies of once-living organisms, often in recrystallized or replaced form, or impressions of the bodies of the organisms, in the form of casts and/or molds. The organisms that produce the traces can be either animals (usually) or plants. Traces of plant roots are a common kind of trace fossil produced by plant growth.

**1.5** The study of trace fossils has an interesting history. Long ago, back in the nineteenth century, most trace fossils were considered to be fossilized plants—giant algae, called, collectively, *fucooids*. That view took a long time to die out and be replaced by the modern view of trace fossils as having been formed by a great variety of organisms, both plants and animals. (There *are* examples of macroscopic alga-like fossils in the sedimentary record, but they are not abundant.)

**1.6** Trace fossils are given genus names and, in many cases, also species names. In a sense, this is a holdover from the early time when it was generally thought that the traces were body fossils—the preserved remains, or impressions, of organisms. Most trace fossils are referred to be their “genus” names: as examples, *Cruziana*, *Skolithos*, *Thalassinoides*, and *Nereites* are among the most common trace fossils.

**1.7** The uninitiated reader might assume that the number and variety of trace fossils would vary enormously, given the extremely large numbers of fossil species that have existed during the latter part of geologic time. Further thought should help to convince you, however, that the relatively very small number of kinds of traces is a consequence of the fact that the number of modes of life, or ecological niches, is far smaller than the number of fossil species. Throughout the latter part of geologic time, various species, even of different phyla, became adapted to particular modes of life: living in vertical burrows, or grazing by executing a zigzag path across a sediment surface, for example. That leads naturally to the idea that trace fossils can be classified on the basis of the nature of the life activity that resulted in the traces:

resting traces: cubichnia  
crawling traces: reptichnia  
grazing traces: pascichnia  
feeding traces: fodichnia  
dwelling traces: domicchnia  
escape traces: fugichnia

**1.8** In almost all cases, the particular species of organisms that made a given trace is unknown! For that reason, trace fossils are almost entirely useless for correlation. Bu they are extremely useful for *paleoecological interpretation*. All a body fossil tells us is that the given species lived in the given environment; a trace fossil, by contrast, tells us something important about what the organism *did*. For that reason, ichnology is one of the most useful tools in deciphering depositional environments.

**1.9** The productive idea that certain kinds of traces are characteristics of certain kinds of environment has led ichnologists to try to associate certain kinds of traces with certain environments. Study of modern trace makers has helped greatly in doing that. Figure 9C-1; Crimes, T.P., 1975, The stratigraphical significance of trace fossils, in Frey, R.W., ed., The Study of Trace Fossils; A Synthesis of Principles, Problems, and Procedures in Ichnology: Springer-Verlag, 562 p. (Figure 7.2, p. 118); shows one attempt to associate kinds of traces with zones of water depth in marine environments. Taking this a step further, trace fossils have been grouped into trace-fossil assemblages, from the standpoint that given kind of trace fossisl might not be a very good guide to environment, but characteristic assemblages of trace fossils would be a better guide.

## COMMON TRACE-FOSSIL ASSEMBLAGES

<b><i>Scoyenia</i></b>	<b>vertebrate tracks, trails, burrows</b>	<b>fluvial</b>
<b><i>Glossifungites</i></b>	<b>vertical burrows etc.</b>	<b>very shallow, low energy</b>
<b><i>Skolithos</i></b>	<b>vertical burrows etc.</b>	<b>very shallow, high energy</b>
<b><i>Cruziana</i></b>	<b>crawling traces, inclined burrows</b>	<b>shallow</b>
<b><i>Zoophycos</i></b>	<b>grazing traces, simple to complex</b>	<b>shallow to bathyal</b>
<b><i>Nereites</i></b>	<b>complex grazing traces</b>	<b>bathyal to abyssal</b>

Figure by MIT OCW.

Figure 9C-2 gives a list of common trace-fossil assemblages, and

Figure 9C-3; Rhoads, D.C., 1975, The paleoecological and environmental significance of trace fossils, in Frey, R.W., ed., The Study of Trace Fossils; A Synthesis of Principles, Problems, and Procedures in Ichnology: Springer-Verlag, 562 p. (Figure 9.1, p. 150); shows the associated on such trace-fossil assemblages with zones of water depth.

**1.10** Figures 9C-4, 9C-5, 9C-6; Frey, R.W., 1975, The realm of ichnology, its strengths, and limitations, in Frey, R.W., ed., The Study of Trace Fossils; A Synthesis of Principles, Problems, and Procedures in Ichnology: Springer-Verlag, 562 p. (Figure 2.4, p. 23); shows the morphology of some of the more common trace fossils.

**1.11** Here's an important term for you to know: ***bioturbation***. Bioturbation is the term used to describe *any disturbance of a sediment by the life activities of organisms*. It's closely related to trace fossils, but it's not exactly the same. The degree or extent of bioturbation can range from what individual, isolated organisms do to the sediment, in the process of forming trace fossils, to total disruption of the sediment, to the point where all primary sedimentary fabric and structures are obliterated. In particular, one often sees, in a sediment or sedimentary rock, a distinctive kind of bioturbation in which numerous and pervasive burrows have imparted a kind of mottled appearance to the material. That's called ***burrow mottling***.

Figure 9C-7: Osgood, R.G., Jr., 1975, The paleontological significance of trace fossils, in Frey, R.W., ed., *The Study of Trace Fossils; A Synthesis of Principles, Problems, and Procedures in Ichnology*: Springer-Verlag, 562 p. (Figure 6.6, p. 95)

Figure 9C-8: Osgood, R.G., Jr., 1975, The paleontological significance of trace fossils, in Frey, R.W., ed., *The Study of Trace Fossils; A Synthesis of Principles, Problems, and Procedures in Ichnology*: Springer-Verlag, 562 p. (Figure 6.5, p. 94)

Figure 9C-9: Osgood, R.G., Jr., 1975, The history of invertebrate ichnology, in Frey, R.W., ed., *The Study of Trace Fossils; A Synthesis of Principles, Problems, and Procedures in Ichnology*: Springer-Verlag, 562 p. (Figure 1.3, p. 6)

Figure 9C-10: Osgood, R.G., Jr., 1975, The paleontological significance of trace fossils, in Frey, R.W., ed., *The Study of Trace Fossils; A Synthesis of Principles, Problems, and Procedures in Ichnology*: Springer-Verlag, 562 p. (Figure 6.4, p. 93)

Figure 9C-11: Osgood, R.G., Jr., 1975, The history of invertebrate ichnology, in Frey, R.W., ed., *The Study of Trace Fossils; A Synthesis of Principles, Problems, and Procedures in Ichnology*: Springer-Verlag, 562 p. (Figure 1.1, p. 4)

Figure 9C-12: Osgood, R.G., Jr., 1975, The history of invertebrate ichnology, in Frey, R.W., ed., *The Study of Trace Fossils; A Synthesis of Principles, Problems, and Procedures in Ichnology*: Springer-Verlag, 562 p. (Figure 1.2, p. 6)