Ichnology for the 21st Century: Understanding the differences between continental and marine trace fossils, with implications to the diversity, distribution, and evolution of soil biota

Abstract:
The study of ichnology has come a long way since its inception and it continues to evolve. In particular, progress is being made in understanding the implications of trace fossils in the continental realm and how they can be used in conjunction with subdisciplines in geology to reconstruct the past. Organisms in all domains of life display behaviors that greatly expanded our definition of ichnology. Ichnology is the study of all organism behavior-not just animals. Accordingly, a trace fossil is the product of an organism interacting with a medium in an environment, which generates a three-dimensional physical structure-the resultant trace fossil can be micrometers to kilometers in scale. Though behaviors and resultant trace fossils may be similar morphologically in continental and marine settings, the organisms and behaviors that produced them and the physicochemical factors that controlled their distribution, depth, diversity, and abundance can be strikingly different. Ongoing research with modern terrestrial and aquatic organisms in the field and laboratory reveal the behaviors behind the production of burrow morphologies whose genesis and significance would otherwise be misinterpreted. The study of these modern traces, organisms, and their distribution allows us to recognize how their burrow morphologies and sedimentary associations record the environmental, ecologic, hydrologic, and climatic settings in which they are formed. Comparison of these modern structures and their tracemakers to trace fossils in continental deposits in the geologic record provide stronger clues about the implications of trace fossils for interpreting and reconstructing the sequence of events and conditions that produced those deposits. They also provide information on the evolution and radiation of organisms and ecosystems where the body fossil record is poor. As a result of these new research endeavors, trace fossils are being used to (1) extend the fossil record and understand the radiation of organisms, (2) interpret more accurately environments of deposition and the extent of pedogenesis that have modified those deposits, (3) contribute to understanding better the effects of climate change on biota, environments, and hydrologic systems, and (4) correlate significant surfaces in continental strata and identify subtle but significant shifts in physicochemical conditions and environments.

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