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Preface

Taphonomy as an environmental science

Geology is the study of the history of the Earth and its Life. Paleontology, of course, is no different, and neither is taphonomy: taphonomists regularly infer taphonomic pathways and histories of biogenic particles. Taphonomy, paleontology, and geology are, then, historical sciences.

Geology, paleontology, and taphonomy are also 'environmental' sciences because their practitioners study ancient settings and their modern analogs. But unlike, say, physicists, chemists, or most ecologists, who often employ a reductionist approach over very short time scales (geologically speaking), Earth scientists deal with processes that typically occur over time scales much longer than those observable over one or a few human generations. The rates of these processes may be so imperceptible that the environment appears constant to us, when in fact it *is* changing. It is this perspective on *time* that is arguably the most valuable contribution that the Earth sciences have made to mankind's view of itself and its surroundings, and makes paleontology so eminently suitable to confront the environmental problems that now face society (Frodeman, 1995; Martin, 1998, 1999).

Until recently, the fortunes of paleontology, especially micropaleontology, have been tied, like an umbilical cord, to the fortunes of oil. Over the last decade, however, the applied Earth sciences have moved from an emphasis on resource exploration and exploitation toward one of resource conservation and management. In this respect, paleontology holds a tremendous advantage over ecology in that most ecologic studies are of too short a duration to assess the long-term (time-averaged) impact of environmental perturbations (natural or anthropogenic) on biological communities (Martin, 1991, 1995); the only recourse is the fossil record (e.g., Jackson, 1992; Aronson and Precht, 1997). Moreover, without the ability to reconstruct an undisturbed system in the historical record, studying the effects of anthropogenic disturbance has little meaning.

The surface mixed layer or Taphonomically Active Zone (TAZ) of sediment acts as a low pass filter, primarily through bioturbation and dissolution, that damps high frequency signals before their incorporation into the historical record. Typically, time-averaging of fossil assemblages results from sedimentation rates that are too slow to prevent mixing of ecological signals into accumulations of longer duration and lower temporal resolution. Although viewed negatively by most workers, *time-averaging is actually an advantage*, since short-term noise is damped (Behrensmeyer and Kidwell, 1985). For example, modern macroinvertebrate death assemblages from soft-bottom habitats are comparable to repeated (and expensive!) biological surveys in assessing the 'long-term' dynamics (hundreds of years) of biological communities (Peterson, 1977; Kidwell and Bosence, 1991; Kidwell and Flessa, 1995).

But natural systems also *evolve*, so they have a history, and any so-called *laws* derived from human observation and experimentation are constrained by the *rules*, the boundary conditions or context, of *history*. For example, although many calcareous hardparts dissolve according to the laws of chemistry and physics, they may in fact have different histories: shells of different taxa may be degraded by different pathways in the same taphofacies because of differences in size, mineralogy, and microstructure. Thus, the dynamics of shell input and loss must be evaluated for specific settings and taxa before further generalizations regarding taphonomy are *assumed*, which, unfortunately, has all too often been the case (Martin, 1998, 1999). How would differences in

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taphonomic histories (e.g., shell input, sedimentation rate, tectonic setting) affect the paleoenvironmental interpretation of ancient environments if one were attempting to compare pre-anthropogenic pristine systems with modern disturbed ones, especially when the pre-anthropogenic (historical) record is to be used as a yardstick for measuring anthropogenic disturbance? To ignore history is to ignore a whole untapped field of paleontology that will *make paleontologists employable*. To be sure, assessment of taphonomic histories is a daunting task that has only just begun and many of the current approaches to modeling will require extensive testing and revision, *but we have only to learn from the process. Precise understanding of taphonomic processes and filters bears strongly on the future of paleontology.*

This volume grew out of a Cushman Foundation Symposium entitled "Taphonomy of Microfossils: Paleoenvironmental Analysis and Environmental Assessment" at the 1995 Geological Society of America Annual Meeting in New Orleans that was designed to consider the issues discussed above. Considering the great advances made in taphonomic research in all areas of paleontology we decided to broaden the scope of coverage for this theme issue to include other disciplines in the field of taphonomy. The investigations range from those on invertebrate microfossils to plants and vertebrates in a broad range of environments, all demonstrating the utility of taphonomy in paleoenvironmental interpretation.

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