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Fossil Lagerstätten

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The concept of fossil Lagerstätten (Seilacher 1970) has changed our attitude and approach to fossiliferous sites from that, essentially of the collector, to a geologically based evaluation leading to an understanding of the environmental conditions pertaining, and hence to predicting sites elsewhere and at other times (see, for example Wade 1970; Collins *et al.* 1983). Fossil Lagerstätten, particularly those of the conservation type (deposited under anoxic conditions and by smothering) emphasized here by Professor Seilacher, owe their origin to the combination of a number of factors as Seilacher (1970) explained. These may be considered as:

(i) the extrinsic factors relating to the tectonic–sedimentary setting, and the physical and chemical factors (for example, turbulence and water chemistry), and,

(ii) intrinsic factors directly related to the morphology and ecology of the organisms.

Both sets show change over the Phanerozoic (presumably with the exception of gravity).

Professor Seilacher emphasizes that there is nothing peculiar about the sedimentary facies of fossil Lagerstätten and that it is the ecology of the organisms that is overwhelmingly important in determining the composition of the assemblage. Nevertheless, in trying to understand each particular site, determination of all the factors is necessary. The hypothesis of plate tectonics has been used with success in explaining the occurrences of various types of ore bodies (Lagerstätten) (Mitchell & Garson 1976). It is also relevant to fossil Lagerstätten, particularly to their palaeogeographical distribution and to understanding the type of sedimentary setting, basinal or otherwise. When linked with the predicted distribution of past climatic belts and ocean current circulation the hypothesis explains the distribution of many coal Lagerstätten (Parrish *et al.* 1982) and petroleum source-rocks (Parrish & Curtis 1982), both of which include notable fossil Lagerstätten. Indeed, many coals are fossil Lagerstätten by right.

While biological evolution has determined what types of organisms are available for fossilization through geological time it has also led to changes in preservation (fossilization) potential. There are a number of aspects that concern fossil Lagerstätten.

(i) The materials; for example, whether soft-bodied, weakly skeletized or fully mineralized skeletons. The innovations and changes over geological time of the materials are far from fully understood, as is the relationship of skeletal mineralogy to water chemistry (see, for example, Kazmierczak 1984). Although much is known about skeletal diagenesis, for example, syntaxial overgrowth in echinoderms, we need to appreciate better the preservation potential of various types of soft tissues under various environmental conditions.

(ii) Changes in tolerance to the ecological (physical, chemical and biological) limiting factors, including biological interrelationships, is a broad and much-discussed aspect.

(iii) Changes in nutrition as from the Ediacaran mode (Seilacher, this symposium) to filter feeding, browsing, predation and scavenging.

(iv) Changes in the mode and method of growth is particularly pertinent if only considering evolution and variation in arthropod ecdysis.

(v) Changes in reproduction modes are particularly relevant in understanding plant fossil Lagerstätten but also influence animal assemblages (for example, reproductive aggregations).

(vi) Changes in method of movement and dispersal are particularly relevant to Lagerstätten with a dominantly pelagic fauna.

(vii) Changes in substrate relationships, epifauna to infauna, are well documented and their significance appreciated (see, for example, Aigner 1982).

(viii) Changes in ability to escape might also be included since so many conservational type Lagerstätten represent traps.

(ix) As has been emphasized many times (Seilacher 1970; Reif 1971), body design and skeletal construction influence post-mortem behaviour (breakage, compaction, rollability) and consequently preservation potential.

While this meeting emphasizes Lagerstätten featuring soft-bodied and weakly skeletized organisms, most with biotas strongly biased away from life-assemblages, the fossil Lagerstätten concept is broad and includes conserved communities such as those described by Bray (1972) from the Devonian of New York, where preservational detail is sufficient for detailed association analysis and potential study of palaeoenergetics, as well as the preservation of colour markings in trilobites (Esker 1968). The sedimentary setting here is probably similar to that of the German Holzmaden Shales (Seilacher, this symposium). The ordinary neritic sediments of the Ludlovian of the Welsh Borderland also yield much information with careful analysis (see, for example, Watkins 1979). The quite ordinary guttercasts of the Wealden of southern England, which have yielded such a rich assemblage of insects (predominantly wings) and provide so much environmental and ecological information (Jarzembowski 1984), might qualify for inclusion as both conservational and concentration type fossil Lagerstätten.

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