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Ordovician small shelly fauna from the Elgin Member of the Maquoketa: Ecologically dwarfed or taphonomically biased?

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ORDOVICIAN SMALL SHELLY FAUNA FROM THE ELGIN MEMBER OF THE MAQUOKETA: ECOLOGICALLY DWARFED OR TAPHONOMICALLY BIADED?

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Some of the earliest fossils of multi-cellular animals are the “small shelly faunas” from Lower Cambrian (~540 million years old) sediments, marking the “Cambrian Explosion”. Small shelly faunas include millimeter-sized phosphatic internal molds of shells. While similarly-preserved small fossils are found in sediments ranging up to recent times, these later occurrences are often poorly studied or ignored entirely in favor of larger fossils in the same sediments.

In Iowa, the Upper Ordovician Elgin Member of the Maquoketa Shale contains phosphorite beds that include a small shelly fauna. This fauna has received attention because the small fossils make up the bulk of the rock, and the phosphorite strata are widely distributed. The small size of the mollusks in this fauna has been interpreted as an instance of widespread ecological dwarfism as an adaptation or response to anoxic conditions. Thus the presence of this fauna has been used as evidence for oceanic anoxic events during the Ordovician.

An alternative hypothesis is that phosphogenesis is taphonomically biased, and that smaller fossils are preserved as phosphatic molds in small sized individuals. If phosphatic preservation is size-selective and if there were evidence of the presence of normal marine fauna in these deposits, the hypothesis that the fauna was ecologically dwarfed may be reconsidered.

To test the competing hypotheses of ecological dwarfism vs. small-pass taphonomic bias, rock samples were collected from two phosphorite beds at Graf, Iowa. Polished slabs and thin sections were made from these samples. Remaining sample were dissolved in acetic acid and the residues picked for phosphatized fossils. Acid residues contain normally-sized specimens of bryozoan zoecial molds, crinoid columnals, and umbilical molds of snails, all of which are small parts of larger animals. Also certain clams and snails seen in thin section are only partially filled with phosphate. These findings suggest that phosphate preferentially precipitated in small pores and could not fully fill larger ones. Therefore preservational bias favored either small shells, or small parts of larger shells. This finding suggests that the original fauna may not have been dwarfed, but that larger shells were not preserved as phosphatic molds before being destroyed.

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