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Soft-tissue preservation in Miocene frogs from Libros, Spain: Insights into the genesis of decay microenvironments

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ABSTRACT

The Late Miocene Libros biota is a lacustrine-hosted, Konservat-Lagerstätte from Libros, near Teruel in northeast Spain. Adult frogs are characterized by the preservation of their soft tissues, some in histological detail. The soft tissues of the body outline are preserved as a layered structure, which comprises a central carbonaceous bacterial biofilm enveloped by the phosphatized remains of the mid-dermal Eberth-Katschenko layer, external to which is a second, thinner, carbonaceous bacterial biofilm. Bacterial autolithification is restricted to limited phosphatization of the cell margins of bacteria adjacent to phosphatized dermis. Phosphatization occurred during the late stages of decay; phosphate was sourced primarily from the dermis itself. Other tissues and organs are also defined in authigenic minerals: nervous tissue (aragonite), the stomach (calcium phosphate), and collagen fibers of the dermal stratum compactum (calcium sulphate); bone marrow is organically preserved. The disparate modes of soft-tissue preservation within individual specimens reflects development of several highly localized, chemically distinct microenvironments within the frog carcasses during decay. These microenvironments correspond to individual organs and tissues, were established at different times during decay, and varied in their duration. The preservation of soft tissues via multiple taphonomic pathways was controlled ultimately by anatomical and physiological factors.