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Extremotolerant fungi: phylogenomics and physiology of *Parengyodontium* spp

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Certain fungal species, such as *Parengyodontium spp.*, inhabit particular ecological niches. Their presence on monuments, and in places with biomineral precipitation suggest they may play a larger role in biodeterioration than previously thought. Studying the conditions that promote their growth and understanding the mechanisms by which they degrade materials is crucial for the effective conservation of built heritage.

This work aims to elucidate the phylogenomic relationships between 50 *Parengyodontium* strains isolated from various environments over the world and assess their extremotolerance. Whole-genome sequencing and bioinformatic analyses were used to clarify species boundaries. Growth experiments were conducted under extreme physiological conditions to assess tolerance to salt, pH, and temperature. Strains were cultured in liquid media containing selected mineral salts (magnesium sulfate heptahydrate, calcium chloride hexahydrate, sodium chloride, and magnesium chloride hexahydrate) at varying molar concentrations and pH values. Growth response was measured using a microplate reader (Synergy H1, Biotek). Additionally, temperature tolerance was assessed at 5, 15, 25, 30, and 37 °C, and morphological features were examined via slide culture microscopy.

The results revealed a clear phylogenomic distinction between *Parengyodontium album*, *P. americanum*, and *P. torokii*, including the possible reclassification of certain strains previously misidentified as *P. album.* Physiological tests demonstrated that low-temperature tolerance and the ability to grow in high-salt environments are key distinguishing traits between these species with *P. torokii* showing greater adaptation to cold and higher salt tolerance.

These findings highlight the extremotolerant nature of *Parengyodontium* strains and their adaptability to the harsh environmental conditions often present in deteriorated materials.

Their resilience and ability to metabolise diverse substrates likely contribute to their persistence and damaging effects on materials surfaces.

Keywords: *Parengyodontium* spp., fungi, phylogeny, salts, extremotolerance

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