

# A novel in-silico model explores LanM homologs among *Hyphomicrobium* spp

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Investigating microorganisms in metal-enriched environments holds the potential to revolutionize the sustainable recovery of critical metals such as lanthanides (Ln<sup>3+</sup>). We observe *Hyphomicrobium* spp. as part of a Fe<sup>2+</sup>/Mn<sup>2+</sup>-oxidizing consortia native to the ferruginous bottom waters of a Ln<sup>3+</sup>-enriched lake in Czechia. Notably, one species shows similarities to recently discovered bacteria expressing proteins with picomolar Ln<sup>3+</sup> affinity. This finding was substantiated by developing an in-silico ionic competition model and recombinant expression of a homolog protein (*Hm-LanM*) from *Hyphomicrobium methylovorum*. Biochemical assays validate *Hm-LanM* preference for lighter Ln<sup>3+</sup> ions (from lanthanum to gadolinium). This is comparable to established prototypes. Bioinformatics analyses further uncover additional *H. methylovorum* metabolic biomolecules in genomic proximity to *Hm-LanM* analogously dependent on Ln<sup>3+</sup>, including an outer membrane receptor that binds Ln<sup>3+</sup>-chelating siderophores. These combined observations underscore the remarkable strategy of *Hyphomicrobium* spp. for thriving in relatively Ln<sup>3+</sup> enriched zones of metal-polluted environments.