Goldschmidt 2026 Abstract
https://doi.org/10.46427/gold2026.38081

Clade-specific iron adaptation shapes the ecological distribution of *Bathycoccus*

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Picoeukaryotes contribute significantly to primary production and food web dynamics, particularly in High-Nutrient Low-Chlorophyll (HNLC) regions where iron (Fe) limitation constrains the growth of larger phytoplankton. Within picoeukaryote lineages, adaptive divergence has given rise to distinct ecotypes, reflecting niche partitioning across marine environments. While Fe utilization strategies are well-characterised at the species level, how clade-level ecotypic diversity influences Fe-mediated carbon cycling remains poorly understood. Here, we use strains from three distinct *Bathycoccus* clades (I, II, and III) as model organisms to investigate how evolutionary divergence shapes their physiological responses to Fe availability. We conducted controlled culture experiments across a range of bioavailable Fe concentrations (1.62×10^{-4} to 2.75×10^{-1} nM), monitoring growth, elemental stoichiometry, and dissolved inorganic carbon (DIC) uptake rates. Our data reveal that decreasing Fe availability drives a significant divergence in growth responses across clades. This divergence is underpinned by distinct Fe utilization efficiencies, despite comparable intracellular Fe quotas at the same bioavailable Fe level. Clade I and III, which share the most recent common ancestor, displayed highly similar physiological response trends and Fe luxury uptake patterns, suggesting a phylogenetic conservation of Fe metabolism traits. In contrast, Clade II exhibited a markedly distinct response, highlighting the functional diversity within the genus. To elucidate the molecular mechanism underlying these clade-specific Fe utilization strategies, transcriptomic analysis is being conducted. The clade-specific variation in growth and Fe utilisation efficiency directly links evolutionary diversity to carbon cycling, suggesting that Bathycoccus communities, which shaped by Fe bioavailability, may modulate the biological carbon pump and air-sea CO_2 exchange in Fe-limited regions.