Direct use of inorganic colloidal iron by marine mixotrophic phytoplankton

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ABSTRACT: Three species of photosynthetic flagellates capable of phagotrophy (mixotrophic species) were tested for their abilities to use inorganic iron colloids for growth. *Ochromonas* sp., *Chrysochromulina ericina* (a coastal strain), and *C. ericina* (an oceanic strain) were grown in iron-free seawater supplemented with 1 μM Fe-ferrihydrite (amorphous hydrous ferric oxide), magnetite (Fe_3O_4)/maghemite (gamma-Fe_2O_3), hematite (a-Fe_2O_3), or goethite (a-FeOOH). Desferrioxamine B, an iron-binding siderophore, was used to reduce the concentration of dissolved iron in the colloid-amended media, and none of the flagellates were able to use its iron complex as an iron source under the conditions of the experiments. Both strains of *Chrysochromulina* grew at 35%-70% of their maximum rates with goethite, hematite, and magnetite/maghemite but were unable to use ferrihydrite. *Ochromonas* grew well with ferrihydrite but could not use any of the other forms. *Thalassiosira oceanica* (clone 1003) and *Thalassiosira pseudonana* (clone 3H), diatoms that could only take up dissolved forms of iron, were unable to use any of the colloids tested. The mechanism of iron acquisition by the flagellates appeared to involve ingestion of the iron colloids, because bacteria resident in the cultures were too iron poor to be a significant source of iron and were unable to use the iron contained in the colloids themselves. Variations in the sizes of the colloids were hypothesized to account for differences in their availability, independent of colloid chemical stability. The results provide the first strong evidence for direct use (i.e., without prior dissolution) of colloidal iron by mixotrophic phytoplankton and document a new pathway of iron acquisition that may be important for their survival in low-iron waters of the sea.

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