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Remembrance of Iron Ages Past and Anticipation for the Discoveries that Lay Ahead

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The first description of an Fe-oxidizing microbe appeared in 1797. From the mid 1800s to the early 1900s, ‘the iron bacteria’ were a hot topic for natural historians and geologists armed with muck boots and microscopes. Many of the morphotypes recognized today as Fe-oxidizing bacteria (FeOB) were described during this time. As microbiology became a laboratory-focused science and led to the molecular revolution, interest in these enigmatic microbes that resisted growth in the confines of a petri dish waned. Fortunately, the field of geomicrobiology emerged, renewing interest in how microbes fundamentally impact Earth’s elementary cycles, and better yet, merged with the molecular revolution to offer new insights into the ‘iron bacteria’. This talk will offer a perspective on modern research on microaerobic, lithoautotrophic FeOB. Novel culturing methods resulted in the isolation of a number of new species of FeOB, first from freshwater iron mats, and then from low-temperature, marine hydrothermal vents. Phylogenetic analysis revealed that freshwater strains belong to a ‘traditional family’ of FeOB, the Gallionellaceae. Marine strains, while bearing striking morphological and physiological similarities to freshwater FeOB, belong to the Zetaproteobacteria, an entirely different Class; thus, representing a classic case of convergent evolution - or is it? Genomic analysis of isolates along with growth experiments revealed new insights into the process of energy capture via extracellular electron transfer, where mechanistic versatility seems to be key. These studies also discovered additional metabolic diversity among some FeOB, including strains able to grow on H_2 or reduced S-compounds, as well as obligate mixotrophy in *Leptothrix ochracea*. Ecological surveys revealed FeOB play important roles in diverse habitats including temperate wetlands, the wetland plant rhizosphere, marine sediments, and biocorrosion processes. Recent work in the Arctic has revealed a remarkable abundance of FeOB in aqueous tundra/permafrost ecosystems, and their potential role in controlling the phosphorus cycle. Yet another tundra surprise was the predominance of *Rhodoferax*, a renegade outside the traditional club of iron bacteria. New *Rhodoferax* isolates possess the unique capacity to couple growth to either microaerobic Fe-oxidation or anaerobic Fe-reduction, making them well adapted to dynamic Arctic ecosystems, and offering new avenues for discovery.