

Exploring the deep sea for the origin of eukaryotes

The events that led to the origin of complex cellular life, eukaryotes, is a biological mystery. Asgard archaea were pivotal in the origin of complex cellular life. Hodarchaeales (Asgardarchaeota class Heimdallarchaeia) were recently shown to be the closest relatives of eukaryotes. A massive DNA sequencing of coastal and deep-sea sediments has doubled the number of Asgardarchaeota genomes. Global distribution analysis reveals that Heimdallarchaeia clades are present in a variety of marine environments and suggest niche partitioning, with Hodarchaeales primarily found in coastal marine sediments. Metabolic reconstructions suggest Heimdallarchaeia form distinct metabolic guilds from other Asgardarchaeota. These archaea encode hallmark proteins of aerobic lifestyle eukaryotes, suggesting the last common archaeal-eukaryotic ancestor was capable of oxygen utilization. Based on these findings, we have updated Heimdallarchaeia-centric model of the origin of eukaryotes in which key hallmarks for aerobic respiration may have been present in the Asgard-eukaryotic ancestor. We have also recently started to characterize the lipid composition of Hodarchaeales and have shown they contain pathways for dipteroids, that have been shown to mediate symbiotic interactions in bacteria. This expanded catalog of Asgard genomic diversity reveals that these Archaea likely conferred energetic advantages during the early stages of eukaryogenesis and constitutes a valuable resource for investigations into the origins and evolution of cellular complexity.