Thermococcales in the genomic era: diversity, physiology, applications and adaptation to deep sea hydrothermal vent conditions

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Over the past 40 years, researchers from several countries have explored deep-sea hydrothermal vent environments around the globe and studied a number of microorganisms, their metabolic and physiological properties, and their vast phylogenetic diversity. Deep sea hydrothermal vents are characterized by large fluctuations in salinity (0.1-6%), temperature (2-407°C), pH (1-8) and hydrostatic pressure (up to 60 MPa). Accordingly, the archaeal and bacterial communities inhabiting vent environments are expected to include numerous ecotypes and physiotypes. Among the hyperthermophilic Archaea, dwelling in deep sea hydrothermal vents the members of the Thermococcales order, which is actually represented by three genera: Pyrococcus, Thermococcus and Palaeococcus. Most of Thermococcales species are obligate anaerobic organothrophic hyperthermophiles that prefer to utilize polymeric substrates like proteins and carbohydrates (preferentially oligo and polysaccharides) as carbon and energy sources. Elemental sulfur is required in some cases for the growth and is used as an electron acceptor to remove reduced products during fermentation. If Thermococcales members can serve not only as obligate heterotrophs, but also facultative carboxydotrophs and formate-utilizing organisms within in situ microbial communities, the ecological role of predominant Thermococcales populations should be reconsidered. Most of the isolated Thermococcales are inherently adapted to the extreme conditions of their environment (i.e. to the high-pressure, low- to high temperature, low to high pH, anaerobiosis to aerobiosis conditions). The emphasis is placed on recent progress in understanding the biodiversity, genomes, transcriptomes, and biotechnology applications of Thermococcales in the genomic era.