An alternate H_2 sink in Anaerobic Environments Explains Non-Stoichiometric Greenhouse Gas Production Ratios in Boreal Peatlands and Thawing Permafrost.

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Project Goals: ***Our objective is to discover how microbial communities mediate the fate of carbon in thawing permafrost under climate change.*** **We propose a systems approach integrating *(a)* molecular microbial and viral ecology, *(b)* molecular organic chemistry and stable and radiocarbon isotopes, and *(c)* state-of-the-art modeling, along a chronosequence of permafrost thaw in subarctic Sweden.**

Following the depletion of inorganic electron acceptors, organic matter in anoxic environments decomposes by hydrolysis, fermentation, and methanogenesis requiring syntrophic interactions among microbes to achieve energetic favorability. In the classic anaerobic food chain, hydrogenotrophic methanogenesis is the terminal electron acceptor (TEA) and ultimately produces equimolar CO_2 and CH_4 for each molecule of organic matter degraded. However, CO_2:CH_4 production in deep anoxic peat often exceeds this 1:1 ratio, in seeming contradiction of thermodynamic theory. Here we present evidence that, in peatlands, the ubiquitous hydrogenation of a range of diverse unsaturated compounds serves as an alternative to methanogenesis as a terminal electron acceptor and H_2 sink. This mechanism lowers the partial pressure of dissolved H_2, maintains electron flow through syntrophic reactions, and promotes CO_2 production without concomitant CH_4 production. While organic TEAs have been proposed before to drive microbial respiration of organic matter through the reversible reduction of quinone moieties, the mechanism proposed herein differs from those earlier mechanisms by also acting as a requisite step in the degradation of the organic compounds that are reduced. The implication of this proposed mechanism is that it has the potential to control CO_2:CH_4 production and emission ratios from peatlands which ultimately determines their global warming potential.