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Methane emission from flooded soils - from microorganisms to the atmosphere

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Methane is an important greenhouse gas that is affected by anthropogenic activity. The annual budget of atmospheric methane, which is about 600 million tons, is by more than 75% produced by methanogenic archaea. These archaea are the end-members of a microbial community that degrades organic matter under anaerobic conditions. Flooded rice fields constitute a major source (about 10%) of atmospheric methane. After flooding of soil, anaerobic processes are initiated, finally resulting in the disproportionation of organic matter to carbon dioxide and methane. This process occurs in the bulk soil, on decaying organic debris and in the rhizosphere. The produced methane is mostly ventilated through the plant vascular system into the atmosphere. This system also allows the diffusion of oxygen into the rizosphere, where part of the produced methane is oxidized by aerobic methanotrophic bacteria. More than 50% of the methane production is derived from plant photosynthetic products and is formed on the root surface. Methanocellales are an important group of methanogenic archaea colonizing rice roots. Soils lacking this group seem to result in reduced root colonization and methane production. In rice soil methane is produced by two major paths of methanogenesis, the hydrogenotrophic one reducing carbon dioxide to methane, and the aceticlastic one disproportionating acetate to methane and carbon dioxide. Theoretically, at least two third of the methane should be produced by aceticlastic and the rest by hydrogenotrophic methanogenesis. In nature, however, the exact contribution of the two paths can vary from zero to 100%. Several environmental factors, such as temperature and quality of organic matter affect the path of methane production. The impact of these factors on the composition and activity of the environmental methanogenic microbial community will be discussed.