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Pyrogenic organic matter can alter microbial communication

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Soil microbes communicate with each other to manage a large range of processes that occur more efficiently when microbes are able to act simultaneously. This coordination occurs through the continuous production of signaling compounds that are easily diffused into and out of cells. As the number of microbes in a localized environment increases, the internal cellular concentration of these signaling compounds increases, and when a threshold concentration is reached, gene expression shifts, leading to altered (and coordinated) microbial behaviors. Many of these coordinated behaviors have biogeochemically important outcomes. For example, methanogenesis, denitrification, biofilm formation, and the development of plant-rhizobial symbioses are all regulated by a simple class of cell-cell signaling molecules known as acyl homoserine lactones (AHLs).

Pyrogenic organic matter in soils can act to disrupt microbial communication through multiple pathways. In the case of AHLs, charcoal's very high surface area can sorb these signaling compounds, preventing microbes from detecting each others' presence (Masiello et al., 2014). In addition, the lactone ring in AHLs is vulnerable to pH increases accompanying PyOM inputs, with soil pH values higher than 7-8 leading to ring opening and compound destabilization. Different microbes use different classes of signaling compounds, and not all microbial signaling compounds are pH-vulnerable. This implies that PyOM-driven pH increases may trigger differential outcomes for Gram negative bacteria vs fungi, for example.

A charcoal-driven reduction in microbes' ability to detect cell-cell communication compounds may lead to a shift in the ability of microbes to participate in key steps of C and N cycling. For example, an increase in an archaeon-specific AHL has been shown to lead to a cascade of metabolic processes that eventually results in the upregulation of CH4 production (Zhang et al., 2012). Alterations in similar AHL compounds leads to shifts in denitrification (Toyofuku et al., 2007). This talk will review the types of signaling compounds used by soil microbes, and discuss the potential biogeochemical outcomes of charcoal's disruption of their detection.

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