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Warming increases hotspot areas of enzyme activity and shortens the duration of hot moments in the detritusphere

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Temperature effects on enzyme kinetics and on the spatial distribution of microbial hotspots are important because of their potential feedback to climate change. We used direct zymography to study the spatial distributions of enzymes responsible for P (phosphatase), C (cellobiohydrolase) and N (leucine-aminopeptidase) cycles in the rhizosphere (living roots of maize) and detritusphere (7 and 14 days after cutting shoots). Soil zymography was coupled with enzyme kinetics to test temperature effects (10, 20, 30 and 40 °C) on the dynamics and localization of these three enzymes in the detritusphere. Total hotspot areas of enzyme activity were 1.9-7.9 times larger and their extension was broader in the detritusphere compared to rhizosphere. From 10 to 30 °C, the hotspot areas enlarged by a factor of 2-24 and Vmax increased by 1.5-6.6 times; both, however, decreased at 40 °C. For the first time, we found a close positive correlation between Vmax and the areas of enzyme activity hotspots, indicating that maximum reaction rate is coupled with hotspot formation. The substrate turnover time at 30 °C were 1.7-6.7-fold faster than at 10 °C. The Km of cellobiohydrolase and phosphatase significantly increased at 30 and 40 °C, indicating high enzyme conformational flexibility, or isoenzyme production at warm temperatures. We conclude that soil warming (at least up to 30°C) increases hotspot areas of enzyme activity and the maximum reaction rate (Vmax) in the detritusphere. This, in turn, leads to faster substrate exhaustion and shortens the duration of hot moments.