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Quantify the effects of shrub encroachment on soil organic carbon molecular-components in Inner Mongolian grasslands

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Shrub encroachment frequently occurs in global grasslands. The phenomenon usually changes soil biogeochemical cycles and influences regional carbon cycling. Although differences in soil organic carbon (SOC) stocks have been recognized, few studies have examined the vertical changes in SOC molecular-components after shrub encroachment; such analyses are very important for understanding the mechanisms of SOC dynamics. In this study, we established the specific biomarkers and parameters based on the local plant characteristics and then quantified the distribution of the SOC biomarkers (free lipids, bound lipids and lignin-derived phenols) in the shrub patches and the grassy matrix of three Inner Mongolian grasslands. The principal component analysis showed that the SOC composition in the shrub patches were negatively related to the free lipids, cutin, suberin and lignin compounds in the upper 50 cm layer. In comparison, the SOC composition was positively related to the (Al/Ad)s ratio and suberin contents along the entire 1-m profile in the grassy matrix and the 50-100 cm layer in the shrub patches. The acid to aldehyde ratios of the vanillyls and syringyls increased simultaneously along the 1-m profile in the grassy matrix; however, this trend was not observed in the shrub patches. Moreover, the vanillyls to syringyls to cinnamyls ratio was and 3:2:1 or 2:2:1 in the grassy matrix and approximately 3:2:1 in the shrub patches. This study demonstrated that the vertical distribution of SOC composition were strongly affected by shrub encroachment and soil processes. Furthermore, the similarity of lignin composition between shrub patches and grassy matrix suggests that shrub encroachment influenced the SOC composition not only under the shrub canopy but also in the grassy matrix via the horizontal extension of the root systems of the sprouting shrubs. These results have important implications for understanding the mechanisms of soil carbon dynamics with vegetation shifts.