Soil biomarkers as indicators of paleoenvironments

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Keywords: lignin, n-alkans, amino sugars, fatty acids, isotopes

DOI:10.36291/HIT.2021.032

Unlike humic acids, the formulas and chemical structure of which still remain unknown, biomarkers are organic molecules of known structure and origin. Individual molecules of phenols, amino acids, amino sugars, lipids can be reliably found in living organisms, in their remains and litter, in soil, in complex associates, in humic substances. Many biomarkers, due to their specific structure and biochemical functions at certain conditions turn out sustainable to degradation and mineralization in soils and, therefore, will be served by molecular traces of the paleobiota and terrestrial vegetation, as well as an indicator of the intensity of biochemical processes occurring in biosphere not only in the present but also in the past. At the same time, individual organic compounds are well preserved not only in the "normal" profiles of post-lithogenic soils, but also in products of their redeposition, in soil-colluvial and soil-alluvial complexes, in pedosediments, pedoliths, derivatives of individual horizons, in bottom sediments of water bodies, etc. Organo-mineral soil particles or soil concretions contribute to the preservation individual organic molecules in time, marking the conditions of paleoenvironments.

The objects of the study were polygenetic gray forest soils that form typical geochemical catena in Moscow (Kolomenskoe opolye), Vladimir and Bryansk (Trubchevskoe opolye) areas. Research methods included: group and fractional analysis of humus, gas-liquid chromatography to determine the fractional composition of fatty acids, amino sugars, lignin phenols, n-alkans. The isotopic composition of carbon was measured on a Thermo-Finnigan Delta V mass spectrometer Plus IRMS and elemental analyzer Thermo Flash1112. The age of the soils was determined by the method radiocarbon dating.

The content in the discussed soils of the total amount of lignin (VSC), chlorophyll and fungal pigment Pg reflects the degree of soil hydromorphism, naturally accumulating in Gley soils and in the second humus horizons. The samples have enriched with biomarkers of woody vegetation (n-alkanes C27 and C29).

Analysis of the presented data on the composition of lignin phenols in buried horizons of different polygenetic soils reveals that the compositional sets of lignin phenols in soils serve as molecular traces of terrestrial vegetation. However, the interpretation of the signal is largely complicated by the superposition of biochemical processes initiated by alternating vegetable associations. Informational role of organic compound groups (chlorophyll, fungal melanins, lignin in general) is less informative than individual biological molecules, trace amounts of which are easily determined by modern research methods.

The qualitative composition of lignin phenols, n-alkans, amino sugars, fatty acids is naturally reflected in $\delta^{13}\text{C}$ values of soil humus. At the same time, cinnamyl phenols increase the values of isotopic relationships that are very sensitive to C3-C4 changes. Vanilla and syringyl phenols of trees and shrubs (C-3 type of photosynthesis) facilitate them.

The results obtained and an attempt to apply them in paleosoil studies reveal the promise of using biomarkers and the need for further studying the pool of natural organic compounds of soils. In any case, the informational role biomarkers are found to be the highest in complex studies of organic matter daytime and paleosoils.

Acknowledgements. This work was supported by Grant of RSF № 17-14-01120n