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The added value of biomarker analysis to the genesis of Plaggic Anthrosols.

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Coversands (chemical poor Late-glacial aeolian sand deposits) dominate the surface geology of an extensive area in northwestern Europe. Plaggic Anthrosols occur in cultural landscapes, developed on coversands. They are the characteristic soils that developed on ancient fertilized arable fields. Plaggic Anthrosols have a complex genesis. They are records of aspects environmental and agricultural history. In previous studies information of the soil records was unlocked by application of pollen analysis, 14C and OSL dating. In this study we applied biomarker analysis to unlock additional information about the applied organic sources in the production of plaggic manure. Radiocarbon dating suggested the start of sedentary agriculture (after a period, characterized by shifting cultivation and Celtic fields) between 3000 and 2000 BP. In previous studies is assumed that farmers applied organic sods, dug on forest soils and heath to produce organic stable manure to fertilize the fields. The mineral fraction of the sods was supposed to be responsible for the development of the plaggic horizon and the raise of the land surface. Optically stimulated Luminescence dating however suggested that plaggic deposition on the fields started relatively late, in the 18th century. The use of ectorganic matter from the forest soils must have been ended in the 10th-12th century, due to commercial forest clear cuttings as recorded in archived documents. These deforestations resulted in the first extension of sand drifting and famers had to protect the valuable heath against this ´environmental catastrophe´. The use of heath for sheep grazing and other purposes as honey production could continue till the 18th century, as recorded in archived documents. In the course of the 18th century, the population growth resulted in increasing demand for food. The deep stable economy was introduced and the booming demand for manure resulted in intensive sod digging on the heath. This caused heath degradation, resulting in the second extension of sand drifting. To improve our knowledge about the evolution of plaggen soils we can combine data of pollen and biomarker spectra of samples of plaggic deposits. Species, present in pollen spectra of plaggic deposits, can have three sources: 1. Pollen, already present in sods, used in the stable to produce manure. 2. Pollen, originating from flowering crop species. 3. Pollen, originating from flowering species in the surroundings. Species, present in biomarker spectra, can have three sources: 1. Biomarkers from tissues, present in sods, used for manure production. 2. Biomarkers from decomposed roots of crop species. 3. Biomarkers from straw of crop species, used in the stable for manure production. Comparison pollen and biomarker spectra of samples of a regular Anthrosol (Posteles, NE-Netherlands) and a Buried (Nabbegat, SE-Netherlands, buried around 1800 AD) Plaggic Anthrosol yielded some interesting features: a. The biomarker spectra of the 2Ap horizons (agricultural layer below the plaggic deposits) are dominated by biomarkers of deciduous trees (dominated by Quercus), indicating the use of organic litter from the forests. These trees are also present in the pollen spectra. b. The biomarker spectra of the plaggic deposits are dominated by crop species (Avena, Secale, Fagpyrum), Calluna is absent in most of the spectra. This is different from pollen spectra where Calluna is present, together with crop species and transported pollen of other species. Only the biomarker spectra of the upper 10 cm of the plaggic horizons are dominated by Calluna. c. Comparison of the spectra of the buried and regular Plaggic Anthrosols show the contribution of biomarkers of roots of Zea mais (introduced around 1950 AD), suppressing the other species. The negligible percentages of Calluna in biomarker spectra of plaggic deposits suggest an overestimating of the use of heath sods in the traditional interpretation of the genesis of plaggic horizons, the dominance of crop species in biomarker spectra of plaggic deposits suggests underestimating of the use of straw as source material for the production of organic stable manure to fertilize ancient arable fields. While the results of biomarker analyses seem to indicate compelling new insights in the practices of plaggen agriculture in The Netherlands, we wish to stress that the biomarker method using VERHIB is still in the early stages of its development and some care must be taken with the interpretation of the results.

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