Diffusion of human practices in Europe: timing and impacts

Highlights and perspectives from organics in soils and sediments

Jérémy Jacob and Anaëlle Simonneau

The debate on the beginning of the Anthropocene renews questions on both the calendar of human practices, their emergences and spreads, and their impacts on continental ecosystems (soil erosion, lake waters eutrophication, biodiversity alteration). There is consequently increasing needs for qualifying and quantifying these practices and impacts, integratingthem into a spatio-temporal framework that could connect knowledges provided by archaeologists with the onesreconstructedby palaeoenvironmentalists.For example, archaeologists built a rather coherent (although still incomplete) picture of broomcorn millet diffusion across Eurasia, based on a large dataset of charred millet grain occurrences in archaeological sites (Marinval, 1992; Hunt et al., 2008). Then, palaeoenvironmentalists detected tiny traces (miliacin, a molecular biomarker) of millet in lake sediments. The first occurrence of miliacin in sediments of Lake Le Bourget, dated back to ca. 1700 BC, was consistent with the import of millet in the Alps at that time (Jacob et al., 2008). But surprisingly, no archaeological remain attested to human presence around the lake during this period. Extended to LakeLedro and LakePaladru, this geological approach allowed precising the timing of millet arrival in the Alps, with significant diachronism in the records(until 1000 yrs), that illustrates the progressive diffusion of millet (Simonneau et al., 2013), even when no archaeological structurewas previouslyidentified in the vicinity of the lakes studied. In both cases, archaeological and palaeoenvironmental approaches thus proved to behighly complementary. Precision in millet cultivation spread across Europe (and beyond) is expected from additional sedimentary records of miliacin first occurrence along the suspected diffusion routes.Into the sedimentary infillsof these three lakes, the first miliacin occurrence was associated with drastic increases in others organic materials: a molecular biomarker (TTHC; Jacob et al., 2009) suspected to be formed in soil litters and organic particles known to derive from soil erosion. Additionally, enhanceddetritic fluxes or thicker flood depositswere noted in some lakes. Hence, populations not only brought millet as a new cereal, but also developed new land management practices that significantly affected soil quality.Impacts of millet cultivation on vegetation cover were however more diverse. No major impact on the catchment vegetation was noted in Lake le Bourget whereas significant changes were recorded in Ledro (Joannin et al., 2013) and Paladru (Simonneau et al., 2013; Doyen et al., 2016). This heterogeneous response of vegetation underlines the importance of the context when discussing an ecosystem response to a given stimulus. It also questions the surface areasused for cultivation compared to those unused, i.e. hot spots of human activities efficient for being recorded in lake sediments. Considering the steep catchment of Lake Le Bourget, only few areas are available to cultivation compared to more flat areas around LakePaladru. Identifying those hot spots, for example by studying the chemical legacy of former arable soils,constitutes an interdisciplinary challenge. In Ukrainian, detecting miliacin in paleosoils allowed confirmingmillet cultivation by nomad populations during the Iron Age (Motuzaite-Matuceviciute et al., 2013). A more precise picture of spatial strategies in land use will undoubtedly be obtained from studies integrating the analysis of both soil legacies within catchments, and sedimentary records.

These different examples claim for a more detailed picture of spatio-temporal trajectories of agricultural practices coupled to a fine analysis of their impacts. It is thus necessary to get benefit from the multiplication of experiences (varying practices, varying impacts, various contexts) that allows the history of mankind. Future directions should not only focus on qualifying but also on quantifying the human-driven ecosystems evolution, and establish neat causal, spatial and temporal links between stimuli and impacts.