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Evolution of habitat and environment of deer during the Late-glacial and early Holocene: the case of red deer in French Jura.

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The Late-glacial and early Holocene transition is a key period of environmental changes in a context of to a global warming. In northwestern Europe, extensive studies have documented the vegetation and faunal recomposition with the replacement of the cold steppe-tundra ecosystem by the forested temperate ecosystem we can still observe. Paleoecological interest focused on the extinct large mammals species like the Mammoth. In comparison, little has been done to decipher the ecological adaptation of the surviving species, especially those that are still present in the very same region than in the past. A better knowledge of the impact of changing environmental conditions on the ecology would be useful to define the degree of selective pressure.

Thus, we have studied the habitat and environment evolution of red deer (*Cervus elaphus*) during the Late-glacial and early Holocene using stable isotopes and radiocarbon investigations. The analyzed bone material was selected from archaeological sites in French Jura. Performing direct radiocarbon dating on the bone collagen of the selected remains solved the problem of possible chronological uncertainties of the stratigraphical record of the sites. The same bone collagen samples were used for stable isotope measurements. We investigated the relative abundances in ^{13}C to examine changes in habitat closure (canopy effect), in ^{15}N to decipher changes in pedogenic activities (soil maturation) of the animals dwelling, and in ^{18}O to track changes in altitude and/or local temperatures of the occupied territories. The results demonstrate that the stable isotopic composition of red deer bone collagen can be a valuable and sensitive indicator of habitat use and environmental conditions. The associated direct dating allows us to reconstruct the chronology of ecological changes. The combined chronological and ecological results evidence local differences in red deer adaptation at a small geographical scale.