Models and Methods for Material and Environmental Sciences – XXXVII Cycle

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Understanding animal life-histories: highly spatially resolved elemental and isotopic analyses of fossil teeth

The cultural period that spans approximately between 20,000 and 10,000 years ago, known in Italy as the Epigravettian period (from an environmental point of view mostly corresponding to the Late Glacial period, 16.500-11.500 years cal. BP), marks the end of the Upper Paleolithic. The melting of the glaciers that occurred after the Last Glacial Maximum led human groups to penetrate into the mountain area. There they built a complex settlement system characterized by sites located at different altitudes, which sometimes seems complementary from a functional point of view, in accordance with a seasonal mobility system. In light of the first evidences of faunal control dating back to the end of the Pleistocene and the beginning of the Holocene in Italy, the analysis of contexts from the transition between Pleistocene and Holocene will allow us to deepen our knowledge of the earliest forms of faunal control by human groups and our understanding of different human and animal adaptive strategies in rapidly changing environments.

In my project, animal teeth (in particular of caprids) from Paleolithic and Mesolithic contexts will be analysed at high-resolution for isotope and trace elements. High resolved strontium ($^{87}Sr/^{86}Sr$) and oxygen ($\delta^{18}O$) isotopes will be measured along the tooth growth (on both thin section and whole tooth crowns) by means of a Neptune multi-collector mass spectrometry (MC-ICPMS) and isotope ratio mass spectrometry (IRMS). The MC-ICPMS will be coupled to a laser ablation system for the Sr isotope measures along the enamel-dentine junction (i.e. following tooth growth), while sequential micro-portions of enamel will be sampled along the dental crown length for $\delta^{18}O$ IRMS analyses. Such analyses will allow to precisely disclose the provenance and (altitude) mobility of such animals during their life, owing to the strong link of Sr and O isotopes with specific eco-geolithological areas. In addition, laser ablation inductively-coupled-plasma mass spectrometry (LA-ICPMS) elemental analyses will be performed along the enamel-dentine junction of thin sectioned teeth, obtaining dietary and physiological information about this caprids (i.e. their life histories) at a weekly resolution. Specifically, strontium and barium will inform on eating habits and weaning timings, zinc on the enamel mineralization pathway, lead on possible heavy-metal pollution, and rare earth elements + uranium on potential post-depositional diagenetic modifications of the specimen.

This project will allow to understand if pre-domesticated or animal management events occurred across the transition between Paleolithic and Mesolithic, at the onset of the Holocene period. Taken together, the isotopic data will let us to evaluate the (altitude) mobility of the fauna, and to understand e.g. whether or not it has been influenced by the interaction with human groups. The high-resolution oxygen analyses of these teeth will help us to infer on climate conditions (up to a sub-annual level), ultimately resolving the possible role of climate change, that characterize the transitional period between Pleistocene and Holocene, on human and animal behavior. The analysis of trace elements instead will allow us to get crucial information on paleodiet and weaning timing; the latter will be particularly useful for evaluating any anthropic interventions in the early weaning of (pre)domesticated animals.

Finally, the isotope and elemental composition of modern animal enamel with known geographic provenance will be measured to improve the modelling of isotope maps and to understand their power in predicting fauna movements.