



Contribution of stable isotopes (C,N,S) in collagen of late Pleistocene large mammal trophic ecology and landscape use: a case study in Goyet and Scladina cave (30-40,000 years BP)

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Two Belgian caves yielded very rich large mammal associations dating around 30 to 40,000 years ago: Goyet and Scladina cave (layer 1A). These sites are only 5 km apart but the cave entrances open on different valleys, in a quite diverse landscape ranging between open, unprotected uplands, steep cliffs and sheltered sun-exposed gorges, with the larger Meuse valley nearby. This mosaic scenery permitted during the Last Glacial a rich diversity of fossil flora and fauna. The faunal association includes a large diversity of taxa including Aurochs *Bos primigenius*, steppe bison *Bison priscus*, reindeer *Rangifer tarandus*, giant deer *Megaloceros giganteus*, horse *Equus ferus*, woolly rhinoceros *Coelodonta antiquitatis*, woolly mammoth *Mammuthus primigenius*, cave bear *Ursus spelaeus*, brown bear *Ursus arctos*, wolf *Canis lupus*, cave lion *Panthera leo spelaea*, and cave hyaena *Crocota crocuta spelaea*. All the 90 studied bones and teeth yielded collagen with excellent collagen preservation, allowing reliable investigations of carbon, nitrogen and sulfur isotopic biogeochemistry. The combination of three different isotopic tracers allows to deciphering the effects of food selection and landscape use by different herbivorous and carnivorous taxa. This is the first study to include sulfur isotopic signatures in the study of late Quaternary large mammal palaeobiology. This new tracer yields evidence on mobility and differences in pasture areas, as different geological bedrock may exhibit various sulfur isotopic signatures that will pass on the herbivores and further on their predators. Using this feature in addition to the trophic information provided by carbon and nitrogen isotopic signatures, it appears that for some species present in both sites, such as horse and woolly rhinoceros, the individuals found in each site probably did not use the same pasture areas. This seems to also be the case for the overwhelmingly vegetarian cave bears. In addition, individuals from the same species found in one site sometimes exhibit clear isotopic differences in the three isotopic tracers that suggest different pasture grounds as well, and therefore the possibility of different herds in the vicinity of the cave site. In the case of cave hyaenas, the isotopic signatures of individuals from both caves are not significantly different and suggest that these predators obtained their prey from a large territory including the pasture grounds of herbivores from both caves. In addition, direct radiocarbon dating of some of the studied collagen allows to investigating possible chronological trends.

This study shows how new isotopic tracers can provide invaluable information on late Quaternary large mammal palaeobiology.