Paper

Reconstructing ancient diets using a novel Bayesian approach

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Abstract

Stable isotope analysis is one of the main analytical tools used within archaeological research for ancient human diet reconstruction. However, several issues need to be addressed so that a truly quantitative diet reconstruction becomes possible. A three step approach is hereby proposed:

1) Characterization of the isotopic baseline, i.e., identifying possible food sources, characterizing corresponding isotopic signals, and defining food groups.

2) Use of multiple isotopic proxies for which having well established dietary routing mechanisms relying on data from controlled animal feeding experiments.

3) Use of statistical models that allow integration of all sources of data variability plus dietary routing information.

An illustrative example of a quantitative approach to ancient diet reconstruction is hereby presented. Individual human remains, in an excellent state of preservation, were collected from the medieval cemetery of Oude Markt in Vlissingen (The Netherlands). Stratigraphically associated fish, animal, and grain material located in an ancient cesspit permitted a characterisation of the isotopic baseline. Archaeological data was complemented with historical information on dietary habits of medieval Dutch coastal populations. Compiled information was used to define food groups (e.g. cereals, land animals, freshwater fish, and marine fish). Estimates of food nutrient composition and isotopic variability relied on previously published data.

A Bayesian mixing model was designed to take into account the dietary contribution of different food nutrients and components to the organic and inorganic carbon in bones. For each measured isotopic signal (δ13C and δ15N in bone collagen, δ34S in collagen's methionine, and δ13C in bioapatite) weight contributions of the different food nutrients and/or components were determined from an analysis of compiled results of controlled animal feeding experiments (e.g. Warinner and Tuross 2009, Froehle et al. 2010).

Model output provided, for each individual, probability distributions and confidence intervals on the consumption of each food group. These results were used to provide an estimate of each individual's reservoir effect. The reliability of such an estimate was assessed by comparison with age offsets observed between collagen radiocarbon dates and the dating (dendro and radiocarbon) of wooden caskets in which the individuals were buried.

WARINNER, C., AND TUROSS, N., 2009, Alkaline cooking and stable isotope tissue-diet spacing in swine: archaeological implications, Journal of Archaeological Science 36(8), 1690-1697.

FROEHLE, A.W., KELLNER, C.M., AND SCHOENINGER, M.J., 2010, FOCUS: effect of diet and protein source on carbon stable isotope ratios in collagen: follow up to Warinner and Tuross (2009), Journal of Archaeological Science 37(10), 2662-2670.

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