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Fruit carbonate in *Lithospermeae*: ^{14}C , stable isotope composition and potential as a paleoenvironmental proxy

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The tribe *Lithospermeae* (fam. *Boraginaceae*) represents one of very few taxa vascular plants that accumulate appreciable amounts of calcium carbonate in their tissues. The CaCO_3 is localized in the pericarp sclerenchyma, which makes their small fruits (nutlets) mechanically durable and provides their good preservation in sediments and cultural layers. Fossil *Lithospermeae* fruits appear as whitish, slightly elongated entities, 3-5 mm in length. At archaeological sites, the nutlets can be of diverse origin: in most contexts they represent carpological evidence for weed flora of the past, however, some findings suggest that they were used for decorative purposes (beads etc.).

Here we overview the potential use of fruit carbonate of *Lithospermeae* in paleoecological research.

^{14}C -dating: Fruit carbonate of the taxon can be successfully dated with radiocarbon.

The ^{14}C concentration in the CaCO_3 fraction of modern nutlets is well-correlated to the recent atmospheric ^{14}C levels. Radiocarbon ages of old nutlets are in good correspondence with the age ranges of archaeological contexts. Obviously, fruit carbonate can represent a geochemically closed system for millennia in sediment environments.

$\delta^{18}\text{O}$ values: Our data based on an array of herbarium exemplars of *Lithospermeae*, suggest that the $\delta^{18}\text{O}$ of fruit carbonate is distinctively sensitive to the amount of atmospheric precipitation during the warm season. The degree of correlation between $\delta^{18}\text{O}$ and local air temperatures is lower.

We further performed an experiment on gromwell (*Buglossoides arvensis* (L.) I.M. Johnst), irrigated by water with different oxygen isotope signatures. The $\delta^{18}\text{O}$ values of fruit CaCO_3 showed correlation to the $\delta^{18}\text{O}$ of irrigation water. The oxygen isotope fractionation in fruit carbonate turned out to be surprisingly low with $1000\ln\alpha = 4.72 \pm 3.49$, which is relatively close to foraminiferal CaCO_3 .

$\delta^{13}\text{C}$ values: In contrast to the oxygen isotope signature, we did not find a strong correlation of the $\delta^{13}\text{C}$ values of fruit carbonate to precipitation and temperature. However, the photosynthetic origin of carbon in fruit CaCO_3 admits a possibility of some links of $\delta^{13}\text{C}$ to ambient factors.

