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Applications of stable isotopic signals ($\delta^{13}C$, $\delta^{15}N$) as palaeoenvironmental indicators.

The case of *Ursus spelaeus* Ros.-Hein.

by

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Key words: Stable isotopes, $\delta^{13}C$, $\delta^{15}N$, bone collagen, palaeodiets, *Ursus spelaeus*, *Ursus arctos*, *Cervus elaphus*, palaeoclimatology.

Stable isotopic signals in bone collagen let follow up not only diet type, but also metabolism and environmental variables (i.e. trophic chains) for the considered species and, eventually, help to identify doubtful bone remains. Then, $\delta^{13}C$ and $\delta^{15}N$ values may be used indirectly as palaeoenvironmental indicators. Values for $\delta^{13}C$ and $\delta^{15}N$ measured on Galician *Ursus spelaeus* Ros.–Hein bone remains (NW of the Iberian Peninsula) from two different radiocarbon dated sites, (Grandal & Vidal, 1997; Grandal *et al.*, 1997; Grandal & López, 1998; Vila, 1998) are compared with samples of different ages from Central Europe caves, trying to identify the limits for isotopic preservation in progressively older samples. Additionally, some samples of *Ursus arctos* L. and Pleistocene *Cervus elaphus* from Galician sites were measured in order to discriminate the differences in signals depending on species (see fig. 1).

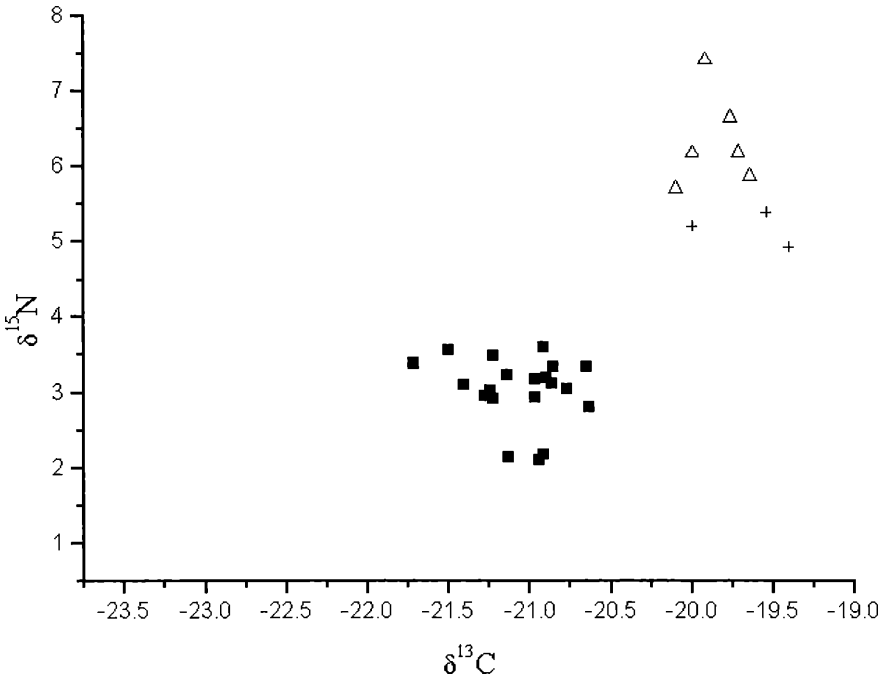

Figure 1: Isotopic signatures outcomes for *Ursus spelaeus* (■) from Liñares site, fossil *Cervus elaphus* (Δ) and fossil *Ursus arctos* (+) treated in this work.

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Previous studies have demonstrated the usefulness of this kind of isotopic information in cave bear, as it allows to identify this species as a true herbivore (Bocherens et al., 1994).
In addition, our research asserts the significant difference in $\delta^{15}N$ of two cave bear groups from the same site depending on their age class: suckling and non-suckling. This difference has been caused by the fact that the former group feeds directly on mother's milk. Suckling cubs show a higher trophic level due to an additional isotopic fractionation, see fig. 2 (Fernández, 1998).

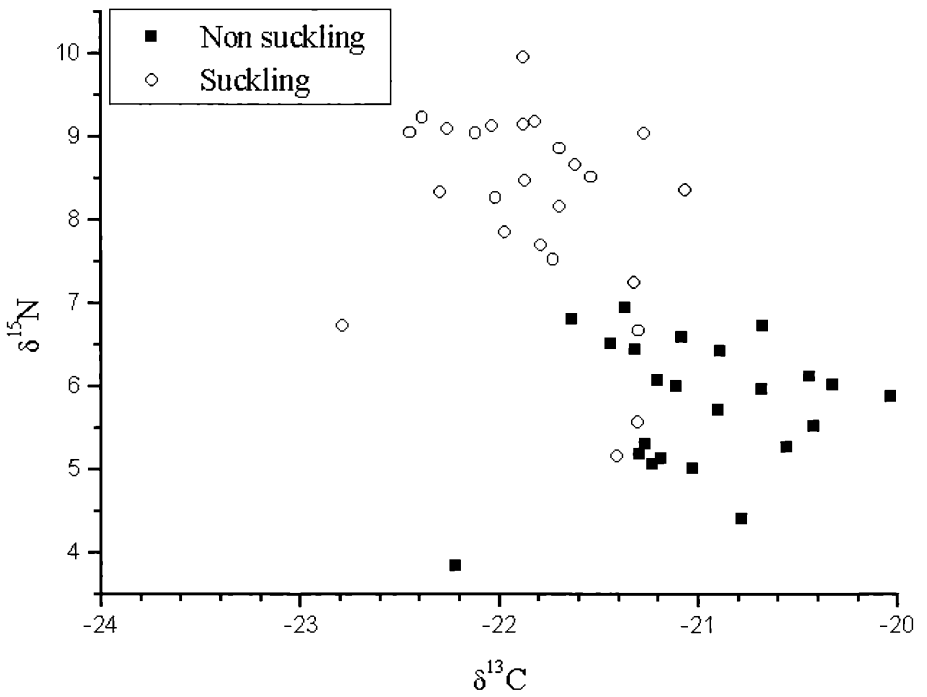

Figure 2: Differences in nitrogen isotopic signals depending on age class. Suckling individuals show a higher $\delta^{15}N$ because of their nutrition with mother's milk, which means a trophic level higher to the one they will have in their adult life. Data from Eirós cave (Fernández, 1998).

This analysis of bone remains has excluded teeth samples because isotopic signatures vary in both tissues. By avoiding differences in age (only adults were compared), kind of tissue and bone type (ribs), it can be asserted that the cause of variation in isotopic signatures is due to environmental factors, allowing easy and clear comparisons (see figs. 1 and 2).

Differences in carbon and nitrogen isotopic signal from Eirós and Liñares specimens were tested. The N_2 fixation raises (decreasing $\delta^{15}N$) when wet conditions are present; it happens, for instance, during a warm phase – included in a glacial event – as the one identified around 40.000 y BP (Isotopic Stage 3). Then, caves as Liñares (1115 m a.s.l.) (Grandal & López, 1998) were occupied by cave bears. Later, 25.000 y BP (Isotopic Stage 2) the climate changed towards colder conditions and individuals moved to lower caves as Eirós (780 m a.s.l.) (Grandal & Vidal, 1997).

Global references as the Vostok ice core prove that the alternation – cold and warm – pattern included in the last glacial phase and inferred by the palaeontological isotopic record of Eirós and Liñares is feasible.

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