Comments on: Diet, physiology and ecology of fossil mammals as inferred from stable carbon and nitrogen isotope biogeochemistry: Implications for Pleistocene bears by H. Bocherens et al.

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A detailed study of isotopic relationships in European Pleistocene ursid teeth have been presented by Bocherens et al. (1994). We agree with the results and broad conclusions derived from the stable carbon isotope relationships. These are findings that confirm the previous hypothesis relating to the diets of *Ursus deningeri* and *Ursus spelaeus*. We do, however, wish to take issue with a few points, notably the first paragraph in the subsection on p. 220 "teeth stop their growth at an early ontogenic state" and the statement on p. 222 "...most of the formation of the teeth occurs when the cubs are suckling and the mother is still in the den, consuming her fat".

Torres et al. (1991) demonstrate a clear size distribution in *Ursus spelaeus* sites (Fig. 1): (1) the remains of animals that died in the perinatal period or before leaving the cave for the first time (before weaning), (2) bearcubs that died during their first winter, and (3) mature bears that had become independent hibernants.

The mandibular remains of the group 1 animals consist only of deciduous teeth and some buds of definitive dentition composed of dentine. In this stage the animal is clearly suckler.

The mandibular remains of the group 2 (first year cubs) reveal enamel formation in premolars and molars and a very thin dentine layer in the roots, while the canine (without roots) has a 2 mm thick dentine in the apical portion of the crown. These animals with jaws that are replete with cusped teeth cannot be sucklers.

The mandibular remains of group 3 (mature animals), reveal that the roots from the youngest specimens are hollow.

Fig. 2 shows thin sections through *Ursus deningeri* canines from the Middle Pleistocene site of Sima de los Huesos in Atapuerca, Burgos (Torres, 1988). Fig. 2: *A*, *A′* show a transversal section from a two years old bear, based on techniques for age determination of mammals from annual layers in teeth from Klevezal and Kleinenberg (1967) and Lieberman (1994). The apical portion of the root is open and the root is totally hollow. Fig. 2: *B*, *B′* show a transversal section from the canine six-seven year old bear. Here the pulp cavity diameter is much greater than in very old animals, where it is almost sealed with dentine.

In our opinion, the idea that during ontogeny the total volume of any tooth portion, crown or root, maybe configured is not admissible. A given tooth reaches its definitive volume after several years into the lifetime of a given specimen. Therefore, any "anomalous" isotopic relationships

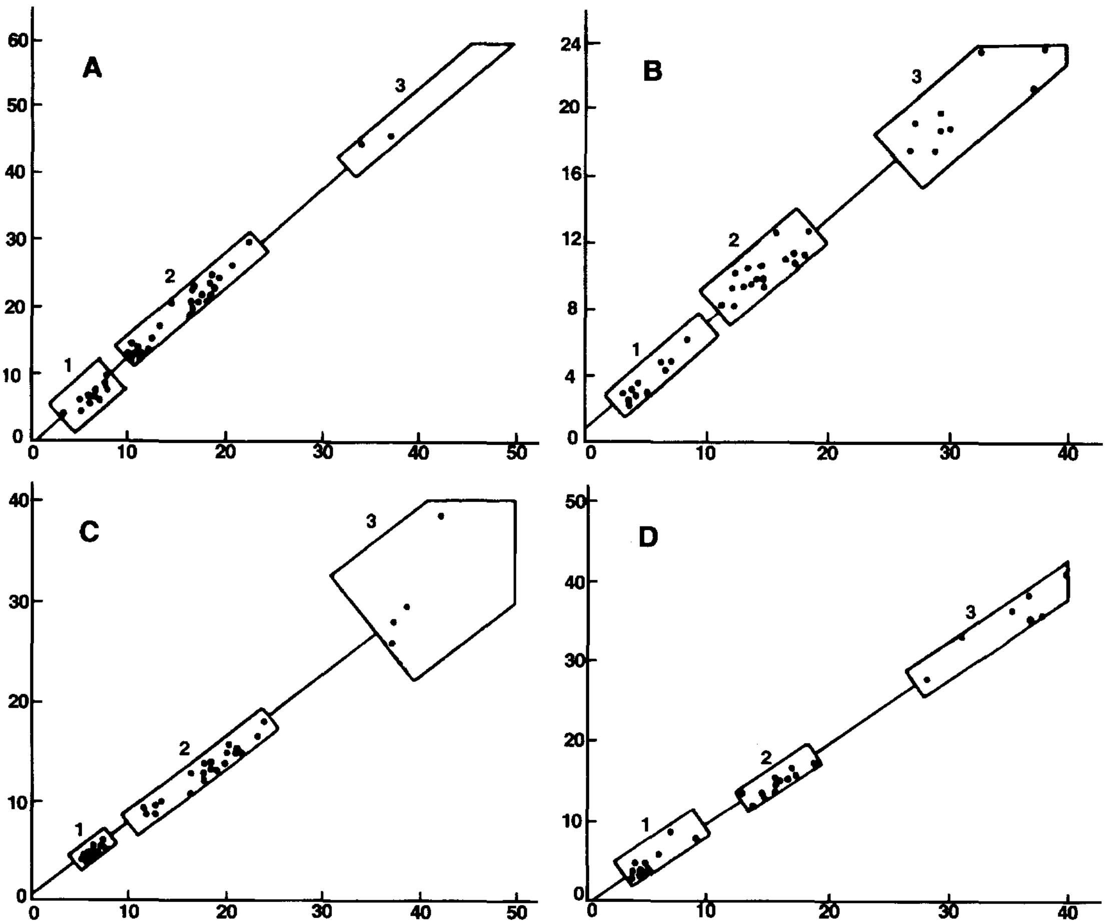

Fig. 1. *XY* plot of transversal (abscisae) and anteroposterior (ordinates) diaphysis of long bones. A. Humerus. B. Radius. C. Femur. D. Tibia. Group 1 newborn and unweaned bears, group 2 cubs, group 3 subadults and adults. Sex dimorphism can be observed in groups 2 and 3. All the measurements are in mm. From Torres et al. (1991)

must be interpreted in the context of the metabolism and the physiology in hibernating bears, which may be summarized as follows.

During hibernation, bears undergo a "lipid diet" derived from consuming body fat as a source of energy. The animal has evolved protective hepatic mechanisms to cape with this in order to reduce the toxicity of the highest quantities of ursodeoxicholic acid in the blood (Couturier, 1954; Camarra, 1989; Hagy et al., 1993).

Also during hibernation, bears do not excrete and reabsorb urea via the bladder. Therefore, during this period the proportion of amino acids in the blood does not decrease, despite the general weight loss. Indeed, an increase in some amino acids has been demonstrated (Nelson et al., 1975). The hibernation does not produce a protein reduction.

According to Nelson et al. (1975), if the bear is to maintain itself under summer starvation conditions, fat and protein will be used as a source of energy continuously and the nitrogenous waste products of the amino acids are excreted in the usual way via urine and faeces (Lyman et al., 1982).

Because of this, conclusions about hibernation may be interpreted in terms of an energy balance. It is clear that during the months of activity bears

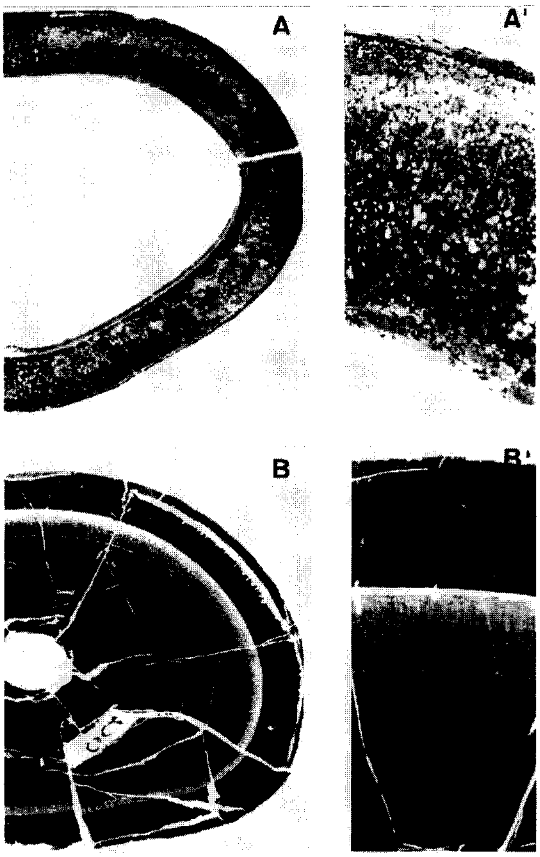

Fig. 2. Canine thin sections (general view and detail). *A*, *A'* cub canine germ, *B*, *B'* adult, 6–7 years old, canine.

eat and this leads to ^{15}N-depleted collagen relative to their winter condition. During lactation (newborns) and hibernation (cubs and mature bears), howewer, urea resorption enables ^{15}N enrichment.

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