

A Cave Occupied by Cave Bears for Thousands of Years in the Sobrarbe-Pirineos UNESCO Global Geopark (Huesca, Aragon, Spain)

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Abstract

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The Sobrarbe-Pirineos UNESCO Global Geopark shows an extremely well-developed underground karst relief as a result of the great abundance and thickness of its limestone formations. The most important Pleistocene vertebrate site within the Geopark is Coro Tracito Cave at Tella. The fossil association is made up exclusively of bones belonging to *Ursus spelaeus* from the upper Pleistocene, accumulated over several thousand years. Based on scientific analysis of the fossil bones, an interesting public outreach project has been organized, involving the refurbishment of the site within the cave and the creation of a permanent exhibition called the Tella Cave Bear Museum. These two infrastructures are visited by thousands of tourists each year and constitute the main geoscientific tourist attraction of the Sobrarbe-Pirineos Geopark.

Keywords: Pleistocene; Cave; Geopark; Cave Bear; Geoconservation.

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Introduction

The Sobrarbe-Pirineos UNESCO Global Geopark (Huesca, Spain) lies in the northern Iberian Peninsula, in the central part of the Spanish Pyrenees. Its northwestern part encompasses the Ordesa National Park, known worldwide for its extraordinarily sculpted limestones, a wealth of karstic caves, some of them hundreds of meters in size. Findings of fossil remains of Pleistocene vertebrates have tended to be rare in these caves, yet recent years have seen the discovery of some important evidence that sheds light on the extinct fauna of the upper Pleistocene (Sauqué *et al.* 2015; Nuñez-Lahuerta *et al.* 2015).

The most important underground vertebrate fossil site in the Sobrarbe-Pirineos Geopark has been excavated in Coro Tracito Cave. This is located near Tella, in the eastern area of the Ordesa y Monte Perdido National Park (Fig. 1), and it is popularly known as the Tella Bear Cave. In terms solely of the social repercussions it has had in the area, this is possibly the most significant paleontological asset in the Sobrarbe-Pirineos Geopark. In general, paleontological sites are difficult to use for cultural and scientific tourism, except for vertebrate tracksites (Rabal-Garcés *et al.* 2018). Despite these difficulties, shortly after the initial excavations, a strategy was devised to

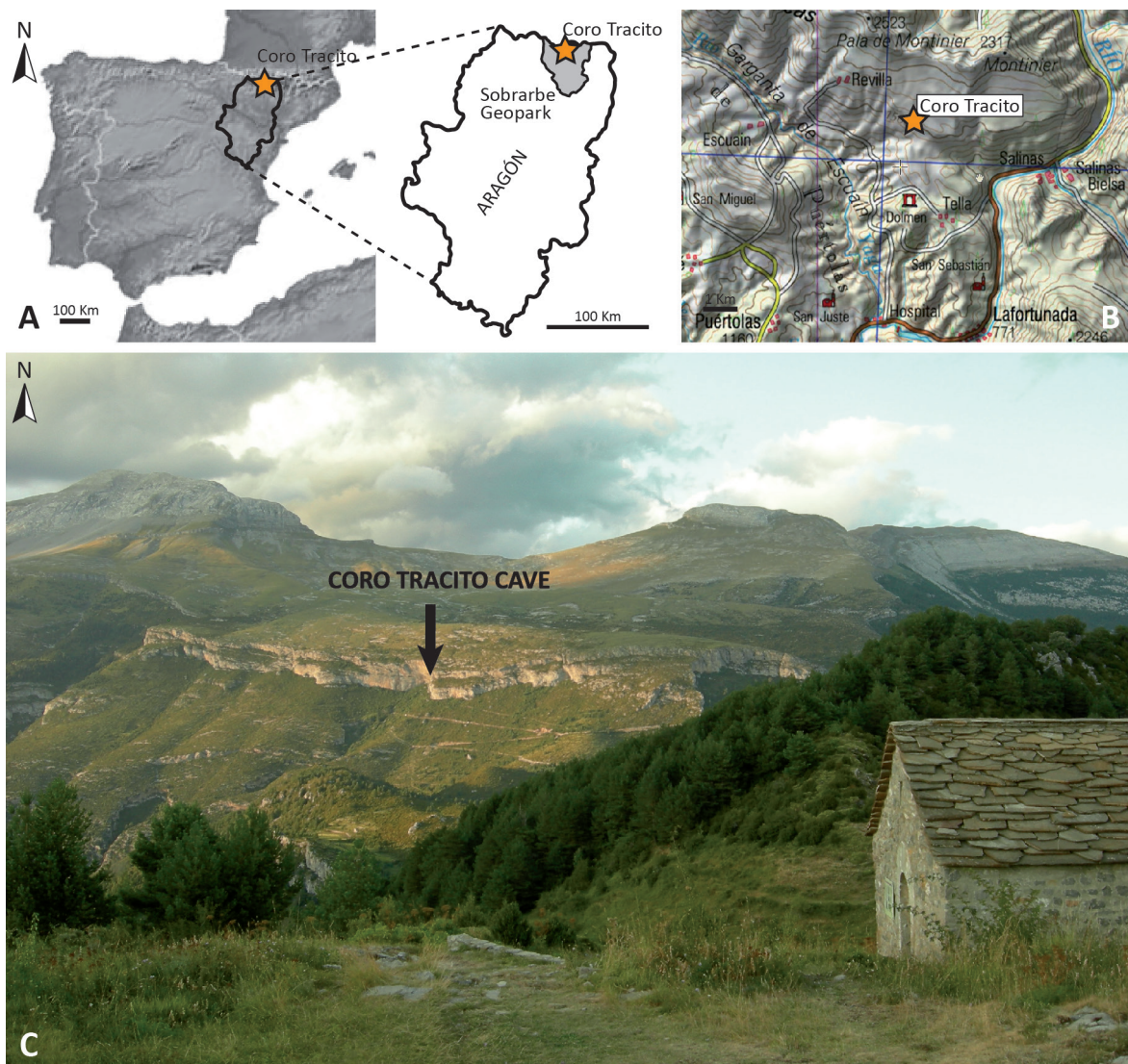


Figure 1. Geographical situation of Coro Tracito Cave, located north of the town of Tella (Huesca, Spain). A and B) Maps. C) Location of the cave entrance

make the cave and the site within it accessible to visitors.

In the year 2000, the Council of Tella-Sin installed light and prepared a path to the back of the cave. Furthermore, a gridding system was established in the excavation area to show visitors how the excavation of a site is undertaken. In 2006 the Cave

Bear Museum was inaugurated in the municipality of Tella, housing the reconstruction of an adult specimen with its cub, the replica of a complete skeleton, a number of bones remain recovered from the cave, and a variety of museum items such as information panels and placards (Canudo & Cuenca-Bescós 2006) (Fig. 2). The Bear Cave has become a reference point for tourists visiting the



Figure 2. A–D) Tella cave bear museum (A), where several of the best-preserved bones of *Ursus spelaeus* from the Coro Tracito Cave are exhibited, like this cranium (B), and a life-size replica of an *Ursus spelaeus* skeleton (D), among other museum items (C). E) Geology students from the University of Zaragoza in the cave of Coro Tracito

Sobrarbe-Pirineos Geopark, attracting thousands of visitors a year. It is currently run by the municipal council itself, and is open from April to October, meteorological conditions permitting (Fig. 2).

The Bear Cave is of notable scientific importance and provides the basis for the geo-tourism project. Thousands of fossil remains of *Ursus spelaeus* have been recovered from the site (Torres Pérez-Hidalgo *et al.* 2004; Rabal-Garcés 2013). Moreover, it is the cave bear site located at the highest altitude in the Iberian Peninsula. The site was the focus of the PhD thesis written by Rabal Garcés (2013), which sets forth the scientific information synthesized in the present publication. Our aim here is to bring together what is known of the Tella Cave Bear, this being one of the major items of heritage in the Sobrarbe-Pirineos Geopark.

Coro Tracito Cave

The entrance to Coro Tracito Cave is situated on the southern face of Mount Montinier at an altitude of 1580 m above sea level. Geologically, the cave forms part of the Pyrenean unit known as “Sierras Interiores” (Inner Sierras), at the base of the limestones of the Gallinera Formation, of a Paleocene to lower Eocene age. The Badalona Speleology Group explored the cave and discovered the first fossil remains in 1976. Since 1994, the Aragosaurus-IUCA research group of the University of Zaragoza has been in charge of the excavations, which have been directed by the present authors, with the collaboration of the Technical University of Madrid in the first excavation campaigns (Torres Pérez-Hidalgo *et al.* 1998, 2004). These interventions were carried out under the supervision of the Heritage Office of the Government of Aragon.

The cave is of relatively simple topography. In total it is 300 m long, with a vertical drop of 12.5 m. It is divided into two major galleries: a lower one and an upper one that is accessed via

the former. The site is situated at the back of the upper gallery (Fig. 3), at the point farthest away from the present-day entrance. The upper gallery is filled with sediment that can be divided into various levels of fine detrital material intercalated with levels of carbonate crusts. This detrital sediment stems, to a large degree at least, from the decalcification of the rock in which the cave is formed. The accumulation of fossil bones ranges from the surface of the deposit to a depth of some 80 cm, in a level formed by brown-colored silts and clays. The level excavated from the Coro Tracito site reached an average depth of roughly 40 cm; only a few square meters of this filling were excavated, not the whole surface (Rabal Garcés 2013).

The age of the site was established by carbon-14 dating, with various analyses, suggesting that bears occupied the cave for at least 7000 years from $36,280 \pm 350$ BP to at least 43,500 BP (some of the samples exceeded the limit of carbon-14 dating, which is 43,500 years). It can thus be assumed that this species inhabited the Aragonese Pyrenees at least during the middle part of marine isotope stage 3, characterized by a temperate climate that was not as hot as the present-day climate but was milder than the cold periods of glaciation according to the standardized SPECMAP isotope curve (Rabal Garcés 2013).

Cave Bears

Ursus spelaeus is an extinct species belonging to the ursid family, with closest living relative the brown bear (*Ursus arctos*). Both are descended from a common ancestor, *Ursus etruscus* (Kurtén 1976; Torres Pérez-Hidalgo 1984), which diversified into these two lineages between 1.2 Ma and 1.6 Ma, according to genetic studies (Bon *et al.* 2008).

The species *Ursus spelaeus* was defined by Johann Christian Rosenmüller in his PhD thesis in 1794. Thanks to the great abundance of its

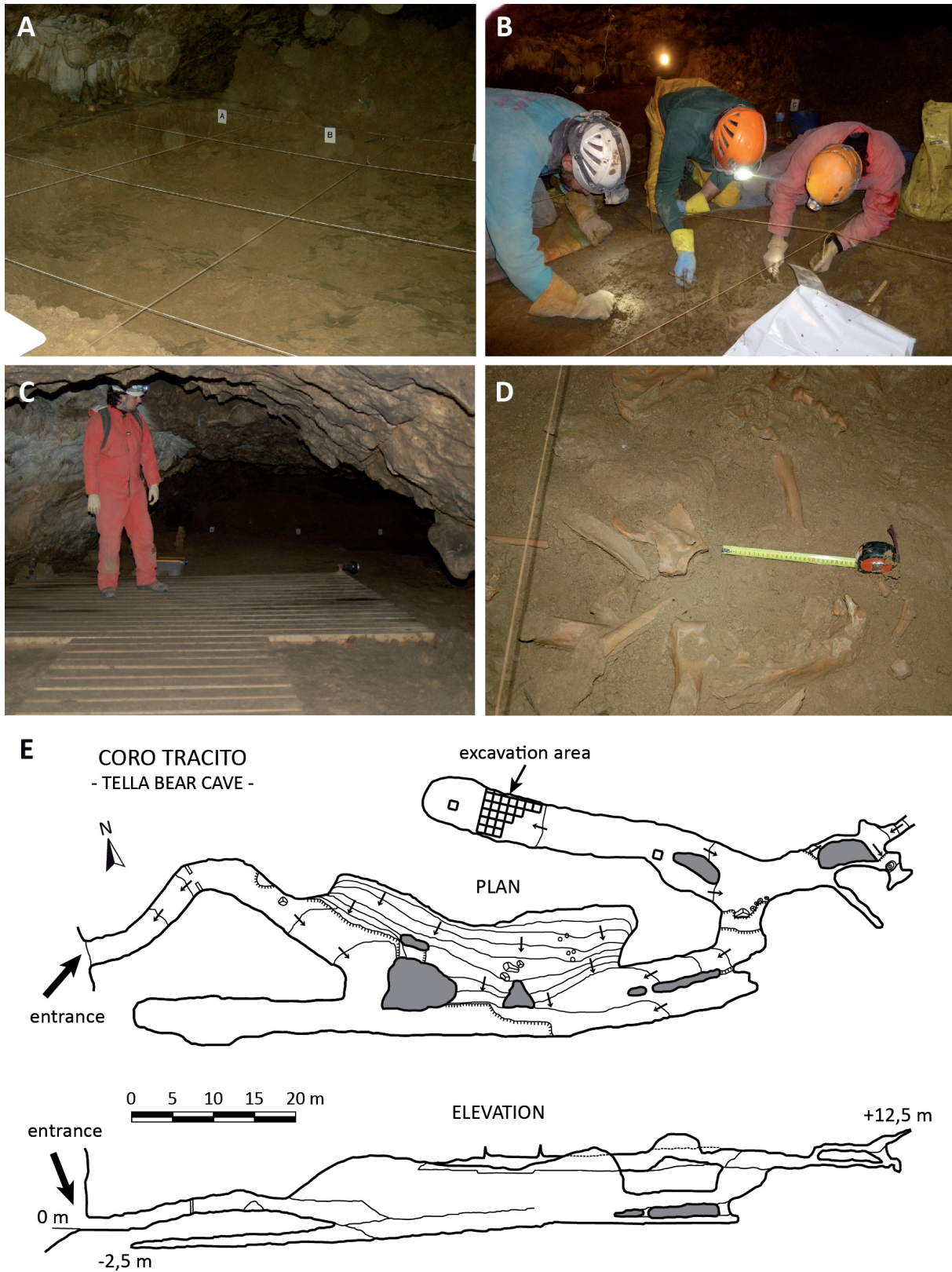


Figure 3. Excavation zone of the Coro Tracito Cave. A) Excavations grid. B) Works at the paleontological site. C) General view of paleontological site. D) Bones at the paleontological site. E) Cave map.

remains at numerous sites throughout Europe and western Asia, it has become one of the best-known extinct species. The cave bear is one of the biggest carnivorous mammals ever to have existed, similar in body mass to the recent polar bear (Viranta 1994). It displays clear sexual dimorphism, evident both in its estimated body size and in the ratios of the various skeletal elements, above all in the size of the canines, with the males of the species having considerably larger canines (Kurtén 1976). Traditionally, the cave bear was considered to have been mainly a plant-eating animal from its specialized dentition and the intense wear generally shown by its molars (Grandal d'Anglade & López-González 2005). This hypothesis is supported by stable isotope analysis, which can indicate the diet of extinct animals (Vila Taboada *et al.* 2001). Recent studies in taphonomy, isotope analysis, ecomorphology and dental microwear, however, suggest a certain element of meat in its diet (Pinto-Llona 2013) and at least occasional scavenging (Rabal-Garcés *et al.* 2012).

The cave bear hibernated in mountain caves (Nelson *et al.* 1998) in temperate or cold woodland. This use of caves put it in direct competition with human beings, and it was sometimes even hunted (Münzel & Conard 2004). The species *U. spelaeus* lived in Europe and the westernmost region of Asia, and existed for the greater part of the upper Pleistocene. It is generally thought to have appeared at the beginning of the last interglacial (MIS 5) around 127,000 years ago, and to have gone extinct roughly 24,000 years ago (Pacher & Stuart 2009). In the Iberian Peninsula, *U. spelaeus* dispersed over the whole of the northern margin from Galicia to Catalonia, as well as part of the central region (Torres Pérez-Hidalgo 1984).

The Tella Cave Bear

Coro Tracito is a major site in the Iberian Peninsula, being the only one with abundant remains of *U. spelaeus* in the central area of the Spanish Pyrenees. More than 5000 bones belonging to

this species have been recovered. These include both cranial and postcranial remains from adult, infant and neonate individuals, and comprise complete bones, fragmented bones and splinters (Fig. 4). There are bones from the entire skeleton, including ear bones. Bones have been recognized from at least 43 individuals, 17 of which are adults and 26 juveniles. Of the adult bones, 53% belong to females, and 47% to males. However, more identifiable bones have been recovered belonging to adult individuals than to juveniles, because the latter display greater fragility and are therefore not as well preserved in the site (Rabal Garcés 2013).

Almost all the bone remains were found in a state of disarticulation when excavated, so the bodies must have been displaced from their original position after death. According to taphonomic studies, the bone accumulation could have been altered by currents of water capable of selectively transporting the material, with greater transportation of less dense bones and less transportation of the denser ones (Rabal Garcés 2013). The long bones do not show a preferential orientation but are arranged haphazardly and in all directions. The long bones are arranged horizontally or sub-horizontally in relation to the surface, ruling out the hypothesis that a mudflow caused the transportation and accumulation of the bones, since this would have left the long bones arranged at random angles (Rabal Garcés 2013).

Morphological and metrical study of the bear bones from Coro Tracito shows the population to have the anatomical characters typical of *U. spelaeus*. The dental formula is typical of the species, with the loss of the three anterior premolars. There is a notable elevation of the frontals. The upper mandibular notch is inclined anteriorly. Also noteworthy is the marked robustness of the long bones of the extremities (Rabal Garcés 2013). The bears from Coro Tracito are characterized by the gracility of the mandible and some long bones with relatively less robust extremities (Rabal Garcés 2013) than other populations in the Iberian

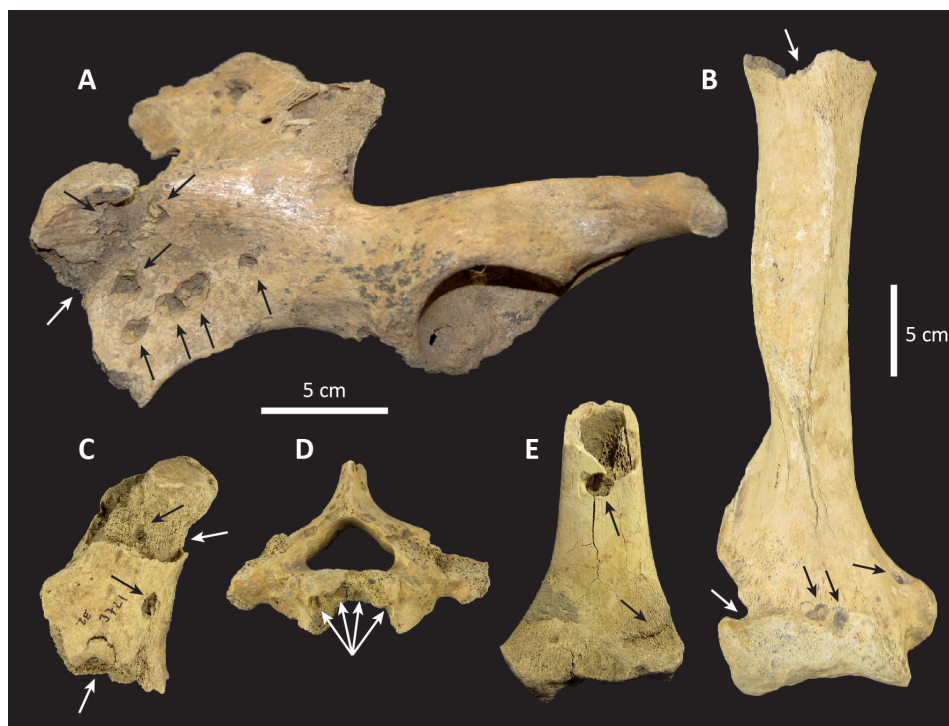


Figure 4. Examples of *Ursus spelaeus* bones from Coro Tracito Cave with many perforations and other teeth marks due to modifications attributed presumably to the cave bears themselves. A) adult hip, B) adult humerus, C) proximal fragment of adult femur, D) adult cervical vertebrae, E) distal fragment of juvenile femur.

Peninsula (Torres Pérez-Hidalgo 1984; Grandal d'Anglade 1993).

Analysis of the eruption and wear of the teeth from Coro Tracito following the methodology of Stiner (1998) reveals that the population's mortality pattern is of the normal, non-violent attrition type, i.e. with deaths due to natural causes affecting above all the weakest individuals (Rabal Garcés 2013). There is a greater proportion of juvenile individuals, a lesser representation of young adults, and a low representation of older individuals. The cave bear entered the caves to hibernate in the cold winter period, just as some present-day bears do. During this time, it would not ingest anything but, thanks to its remarkable metabolism, would subsist on body fats accumulated in the autumn (Nelson *et al.* 1998). If these reserves proved insufficient, however, the cave bears died in their caves. Being in an environment as conducive to

preservation as the inside of a cave, a large portion of the bears' bones came to form part of the fossil record, which is why so many bear bones have been found in Coro Tracito Cave.

A considerable percentage (around 13%) of the bone remains from Coro Tracito display carnivore tooth marks (Fig. 4). The most affected are the long bones (femur and humerus), followed by the vertebrae and the pelvic girdle. The bones of adult individuals are more damaged than those of juvenile individuals. The whole skeleton shows a predominance of bone tissue extraction marks and perforations, although notches and grooves can also be seen (Rabal-Garcés 2013). The alteration pattern of the long bones from Coro Tracito is like that at other monospecific *U. spelaeus* sites (Rabal-Garcés *et al.* 2012), where no other carnivores have been recorded and the tooth marks have been attributed to the cave

bears themselves (Pinto-Llona *et al.* 2005). This hypothesis has been corroborated by comparing the measurements of the perforations in the bones from Coro Tracito with those produced by extant carnivores, considering both the size of these perforations and their length-width ratio (Rabal Garcés 2013). The marks on the Coro Tracito bones were found to exceed in size those produced by any present-day carnivore (including wolves, lions, hyenas, among others), and the length-width ratio of the marks was notably less than that produced by any modern carnivore, but similar to the ratio shown by the *U. spelaeus* canines from Coro Tracito. These factors point to the hypothesis that cannibalism took place in Coro Tracito, with the bears themselves producing the damage through scavenging (Rabal-Garcés *et al.* 2012; Rabal-Garcés 2013).

In the last two decades, the increase in isotope studies of cave bear bones from different European sites has shed considerable light on their paleobiology and paleoecology. Three aspects of the biology of the cave bear influence the isotopic signal of its bones: its diet, the effect of lactation, and the period of hibernation (Fernández-Mosquera *et al.* 2001 and references therein). Carbon and nitrogen isotope analyses of the *U. spelaeus* bones from Coro Tracito yield high values for $\delta^{13}\text{C}$ and low values for $\delta^{15}\text{N}$, which indicate that hibernation periods in the cave were not very long, and that their diet contained a major component of nitrogen-fixing plants such as legumes. According to the $\delta^{13}\text{C}$ data, the vegetation in the area would have been made up of C3-type plants, i.e., trees and herbaceous plants associated with temperate and cold climates, forming an open landscape without dense tree cover (Rabal-Garcés 2013).

The Cave Bear Project: A Great Example of Geoconservation

The Tella cave bear project is a magnificent example of geoconservation of the Sobrarbe-Pirineos UNESCO Global Geopark paleontological heritage and a model that could be used in similar

sites in other parts of the world. On the one hand, some fossils of great scientific interest studied by researchers from the Aragosaurus-IUCA group at the University of Zaragoza have been recovered, and on the other, these fossils have been kept in a public museum (Museum of Natural Sciences of the University of Zaragoza). From here, a collection management program began, which has allowed the maintenance of a permanent exhibition in the small town of Tella. This “museum of Bear Cave” functions as a showroom of the Natural Sciences of the University of Zaragoza museum, which allows original vertebrate fossils to be exhibited that would otherwise not be by regional legislation. In addition, the cave of Coro Tracito was prepared for tourist visits, including the recreation of the original excavation grid. Some bones were left at the site so visitors could see them in situ. Visits to the cave and the site inside are in groups of ten people with a guide. The cave is closed if there is no guide; with this cave management methodology there have been no problems of theft or deterioration of the geological heritage in the 20 years of public visits to the cave. The opening of the museum of the bear and the cave was the main incentive for the town of Tella, which in the 1990s was practically abandoned (four inhabitants). The geopark is visited by thousands of tourists, which has allowed the opening of some rural tourism businesses.

Conclusions

The Tella Bear Cave is one of the most important sites of the upper Pleistocene of the Pyrenees, possessing a broad representation of *Ursus spelaeus* that casts new light on various aspects of life of this extinct animal from the central Pyrenees. The wide-ranging scientific study carried out by the Aragosaurus-IUCA research group from the University of Zaragoza has made it possible to characterize many features of its biology, as well as putting together an extraordinary collection of fossil bones. All this forms the basis of the most important paleontological outreach and tourism project in the Sobrarbe-Pirineos Geopark. Visitors

can see the cave where the fossils were excavated, and the same locality offers an exhibition where original material from the excavation is on display. Without a doubt, this is a unique experience and an invaluable way of learning about an extinct part of the fauna that lived more than 40,000 years ago in what is now the Sobrarbe-Pirineos Geopark.

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