A POPULATION STUDY ON THE CAVE BEAR (*URSUS SPELAEUS* ROS.-HEIN.) FROM COVA EIRÓS (TRIACASTELA, GALICIA, SPAIN)

AURORA GRANDAL-D’ANGLADE & JUAN RAMÓN VIDAL ROMANI


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ABSTRACT - The Cova Eiros site is at present the most western euroasiatic limit of the distribution of this species. To date, close to 4,000 bones, mainly *Ursus spelaeus*, have been found. Absolute dating (U/Th) carried out on the stalagmatic flows below the fertile levels give an age between 117,000 and 28,000 years BP 14C, whilst dating of a bone has given an age of 24,090 years BP. The taphonomic study discounts the existence of post mortem selective processes in the formation of the deposit. The population study indicates occupation of the site by bears of both sexes, being used during hibernation by both adult males and adult females, pregnant and/or with cubs. Distribution by age of the population has been possible by carrying out a study on the wear stages of the cheek teeth. The distribution by age shows a low mortality rate for adult bears (7%) whilst the mortality rate for neonates and yearlings was high (73%). The disappearance of this population can therefore be attributed to the aforementioned high mortality rate as well as the isolation of the population during the development of glaciers during the last glacial period.

KEYWORDS: *URSUS SPELAEUS*, UPPER PLEISTOCENE, COVA EIRÓS, SPAIN, POPULATION STUDY.

RÉSUMÉ - Le gisement d’Ours des cavernes de Cova Eiros représente, jusqu’à maintenant, la limite occidentale de la distribution de cette espèce. Près de 4.000 os d’*Ursus spelaeus* ont été récoltés. Les datations absolues (U/Th) réalisées dans les planchers stalagmitiques sous les niveaux productifs fournissent des âges compris entre 117.000 et 28.000 ans BP, alors que la datation d’un os par 14C donne un âge de 24.090 ans BP. L’étude taphonomique permet de rejeter l’influence de processus sélectifs *post mortem* dans la formation du dépôt. L’étude de la population indique une occupation de la cavité par des ours des deux sexes, fonctionnant comme refuge pendant l’hibernation pour les mâles adultes et les femelles gravides et/ou avec des petits. L’étude des stades d’usure de la dentition permet de réaliser une distribution de la population par classe d’âges. D’après celle-ci, il existe un taux de mortalité bas chez les ours adultes (7%), alors que la mortalité chez les nouveaux-nés ou chez les petits d’un an est plus élevée (73%). Ceci peut être considéré comme la cause de la disparition de cette population, par ailleurs isolée des autres populations cantabriques, en raison du développement des glaciers pendant le dernier glaciaire.

MOTS-CLÉS: *URSUS SPELAEUS*, PLÉISTOCÈNE SUPÉRIEUR, COVA EIRÓS, ESPAGNE, ÉTUDE DE POPULATION.

RESUMEN - El yacimiento de Oso de las Cavernas de Cova Eiros representa, hasta el momento, el límite occidental de la distribución de esta especie. Se han recuperado cerca de 4.000 huesos de *Ursus spelaeus*. Las dataciones absolutas (U/Th) realizadas en las coladas estalagmíticas bajo los niveles fértiles arrojan edades entre 117.000 y 28.000 años BP, mientras que la datación de un hueso por 14C da una edad de 24.090 años BP. El estudio tafonómico permite descartar la influencia de procesos selectivos *post mortem* en la formación del depósito. El estudio poblacional indica una ocupación de la cavidad por osos de ambos sexos, funcionando como refugio durante la hibernación para machos adultos y hembras preñadas y/o con crías. El estudio de los grados de desgaste en la dentición permanente permite realizar una distribución de la población por edades. Según ésta, existe una baja tasa de mortalidad de los osos adultos (7%), mientras que la mortalidad de los neonatos o crías de un año es más elevada (73%). Este hecho puede ser considerado la causa por la que esta población llegó a extinguirse, además del aislamiento de esta población de otras poblaciones cantábricas, a causa del desarrollo de glaciares durante el último periodo glacial.

PALABRAS-CLAVE: *URSUS SPELAEUS*, PLEISTOCENO SUPERIOR, COVA EIRÓS, ESPAÑA, ESTUDIO POBLACIONAL.
INTRODUCTION

The Eirós Cave (Galicia, Spain) has an important settlement of cave bears. This population constitutes to date the most westerly distribution of this species. To date, some 4000 bear bones, from at least 43 different individuals have been found at this site. Other species present, though not in abundance, are deer (*Cervus elaphus*) and horse (*Equus caballus*). The absolute dating allows us to assign the bones studied to a minimum age of the Upper Pleistocene.

GENERAL CHARACTERISTICS OF THE CAVE

LOCATION

The Eirós site is found on the Ouribio Sierra, in the East of the province of Lugo, which makes up, along with the sierras of Louzara, Piornal and the Albeia mountains, the extreme Northwest of the Courel Sierra (Fig. 1).

On the north face of Mount Penedo (885m) is found the entrance to the Eirós cave. Its coordinates are 42° 16' N and 7° 12' W, and its height above sea level is 780m. In this area the slope is 60°.

TOPOGRAPHY

The topography of the cave is notably elongated, following the same NNW direction as the limestone bands of the area. The total longitude of the cave is about 100m (Fig. 2).

The galleries develop on various superimposed levels. The level studied is almost filled with clay sediments inserted with crusts or stalagmite floors, which at the end of the cave almost reach the roof of the gallery. Both at the entrance and at the end of the cave the profile is elliptic, corresponding to the form of an ancient river passage, where the water moved under great pressure.

FIGURE 1 - Locality map of Cova Eirós. *Carte de situation de Cova Eirós.*

FIGURE 2 - Topography of the cave and differences in the percentages of trunk and limb bones between Pasillo and Galería. *Topographie de la grotte et pourcentages des restes osseux du tronc et des membres dans le Pasillo et la Galería.*
SEDIMENTOLOGICAL ASPECTS

The inside of the cave is made up mainly of rhythmic clays inserted with stalagmitic flowstones of varying thickness. The excavation has taken place in two areas, sedimentologically different: Pasillo and Galería. In Figure 3 the profiles of both areas can be seen, as well as an essay on the correlation of the levels. The study of these has been extensively discussed in other papers (Grandal 1993a; Grandal et al. 1995). There follows a brief description of these:

At the end of the Galería the sequence seen has a maximum thickness of 72cm. The following levels have been differentiated (Fig. 3W): Level W1 is made up of more than 10cm of clays with very rounded bones. This constitutes the lower fertile level. Level W3 is made up of clays with fragments of quartz debris, limestone and slabstones of slate. It has a thickness of about 10cm. The upper fertile level is W5, made up of clays with bones. In the sample area it is about 7cm though the thickness varies along the profile. Finally, Level W7 is made up of 14.5 cm of laminated silts. These clay levels alternate with stalagmite flowstones of varying thickness: W2, very crystalline, thickness 6 cm; W4, similar to the afore mentioned with a thickness of 4cm; W6 with a thickness between 0.5 and 1.5cm; and finally X8, 20cm thick, which makes up the roof of the filled-in sequence and the present day floor of the cave.

In the Pasillo, the cut studied has a thickness of more than 45cm. In this profile the following levels have been identified (Fig. 3, A): Level A1, made up of clay debris more than 15cm thick. Above this is found level A2, made up of a stalagmite flowstone with a thickness of 5cm. It corresponds to the level W2 of the Galeria. Above this flowstone is found the fertile level, A3, 17 cm depth, with much debris made up of clays with bones and quartz and slate pebbles. Finally, level A4, a stalagmite flowstone, 8 cm thick, which makes up the roof of the filled-in sequence of the cave and the present day floor of this part of the cave. This corresponds to the level X8 of the Galería.

CHRONOLOGY

The U/Th dating carried out on the flowstones has given the following results:

<table>
<thead>
<tr>
<th>Level</th>
<th>Age (BP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>W2</td>
<td>97,000</td>
</tr>
<tr>
<td>W4</td>
<td>28,000</td>
</tr>
<tr>
<td>A2 (=W2)</td>
<td>117,000</td>
</tr>
</tbody>
</table>

(Grandal 1993a; Grandal et al. 1995)

The AMS 14C dating of a bone from the upper fertile level of the Galería (level W5 in Figure 3) is dated at 24,090±440 years BP (Ua-4298)

PRESERVATION OF THE BONES

The conservation of the bones is different in the two areas of the cave excavated (Figure 2). In the Pasillo, the larger bones are fragmented and often rounded. The teeth and the peripheral bone remains (phalanxes, metapodials, carpus and tarsus), more easily separated from the skeleton make up more than 80%. The remains of the torso (vertebrae, ribs, scapulas and pelvises) are rare, representing less than 10%. Remains showing anatomic connections were not found, and all the data suggest that the remains experienced some form of transport.

In the upper level at the end of the galería (W5) the bones are well preserved, and not rounded. In
some cases anatomic connections are preserved, though in an approximated fashion. The percentage of peripheral remains and teeth descends to 37%, whilst the remains of the torso are more than 30% of the total (Grandal & Vidal 1992). There are no indications of selection by size in the deposit of the bones. In the inferior level (W1) there are few bones and they are very rounded thus making it very difficult to determine the sex and correct size of these remains. For the aforementioned reasons they have not been included in this study.

BIOMETRICS AND MORPHOLOGICAL TRAITS OF URSUS SPELAEUS OF EIRÓS WITH RESPECT TO OTHER POPULATIONS OF EUROPE

The different populations of the cave bears present variable morphological characteristics and size, both on an intrapopulation as an interpopulation level.

a) Sexual dimorphism. A great part of the variability within each population is caused by marked sexual dimorphism. Its effect on the morphometric study is avoidable or at least minimized, carrying out a sexing of the bone sample prior to a study of size, whether it be by traditional methods (Kurtén 1955) or by multivariate statistics (Grandal 1993a, 1993b). The dimorphism is shown, mainly by the body size and the robustness of the skull, jaw and limbs, the female being smaller and proportionally more slender (Kurtén 1955; Grandal 1993a, 1993b).

The frequency histograms of the basilar length (Fig. 4a) and the transversal diameter of the canine (Fig. 4b) from the skull found at Eiros shows clearly the net difference which exists between both sexes

b) Continual intraspecific variability. Even suppressing as far as possible the variability produced by the sexual dimorphism (Grandal 1993a, 1993b), the interpopulation variability in Eiros is high, as occurs in many other such populations of the species (Kurtén 1955; Grandal 1993a).

c) Polytypism (geographic standards or subspecies). Numerous subspecies of the cave bear have been described, paying attention to many different features. Interpopulation variability has given rise to a proliferation of the subspecies and forms as much in this species as in the preceding one, Ursus deningeri. In Torres (1984) and Torres et al. (1991) the following are mentioned: Ursus deningeri deningeri von Reichenau, U. d. savini Andrews, U. d. hundsheimensis Zappe, U. d. romanensis Prat, U. d. suevicus Koby, Ursus spelaeus Rosenmüller-Heinroth, U. s. minor de Blanville, U. s. odessanus von Nordmann, U. s. hercynica Rode and U. s. parvilatipedis Torres. There are also U. deningeri kudarense Barichnikov, U. spelaeus rossicus Borisssjuk, U. s. crimaicus Bachinsky and U. s. kanivetz N. Verestchagin.

This abundance of types is as a result of an elevated polymorphism of the species. Innumerable populations have been studied where both morphological and differences in size have been found

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**FIGURE 4** - Frequency distribution of the basilar length (a) and the transversal width of canines (b) of skulls from Cova Eiros showing the difference between females (white) and males (black). **Histogrammes de fréquences de la longueur basilaire (a) et de la largeur des canines (b) des crânes de Cova Eiros montrant la différence entre les femelles (blanc) et les mâles (noir).**
in almost all occasions between said populations. According to some authors (Thenius 1957; Kurtén 1955, 1958), these differences are as a result of separation by time and geographical distance and by processes of isolation. As far as we can determine the description of new subspecies is determined according to the criteria of each different author. Significant differences, at a taxonomic level, have not been found in the morphology of bones and teeth of *Ursus spelaeus* of the Eirós cave and that described by other authors on European populations.

d) Continual or clinal geographic variation (geographic clines). The morphometric variation of the cheek teeth of the cave bears is used frequently for comparative ends (Grandal 1993b, 1993c; Kurtén 1954, 1955; Rabeder 1983, 1989; Rabeder & Tsoukala 1990; Torres, 1988). Not only the size of the pieces or the development of the cusps, but also the grade of complexity reached by these, are the characteristics that best discriminate between different populations (Grandal 1993a, 1993b).

A study carried out for cluster analysis on a group of morphotypes of the cusps of the lower first molar of different populations of the Iberian peninsular and Europe (Fig. 5), shows what seems to be an influence in the geographical distance between the populations on the formation of the groups, to a far greater degree than the influence of time (at least on the populations where the age is known). Nonetheless these groups do not suggest the existence of an authentic clinal variation.

The gradient discovered by Kurtén (1955) on the medium length of the upper second molar, depending on the geographical distance where these sites are found, particularly between Mixnitz (10) and Troskaeta (2), disappears when the data of other Iberian peninsular populations are added, in which is found that of Eirós (Fig. 6).

This phenomenon has already been considered possible by Kurtén himself (1955) who on the one hand doubted that the populations could have been contemporaries and on the other did not
consider his conclusion to be conclusive until other interjacent populations were included.

The population of El Toll (6) seems to correspond to the gradient, as mentioned by Kurtén, (1955) between Mixnitz and Troskaeta. However, the presence of other populations geographically very near to Troskaeta, such as Ekain (3), the bears from the upper levels (speloid type) of Lezetxiki (7), and the population of Arrikrutz (4), all of which reached many different values in the average length of the second upper molar, does not support the existence of this gradient. The possibility of a North-South gradient (Bergman’s rule) can be ruled out, in this case, by the size of this piece in the Lezetxiki (7) site and even more so in Arrikrutz (4).

The existence of an altitudinal gradient on the length of this piece has also been found on the Austrian sites. The sites situated at a higher altitude show medium values lower to those found nearer sea level. This has been interpreted as a dwarf phenomenon provoked by a disfavourable environment for the development of the bears (Spanhi 1954; Kurtén 1955; Thenius 1957).

Nonetheless, eliminating from the study the cases of dwarfism already described by Spanhi (1954), and adding the data of the Iberian peninsular (Fig. 7) there cannot be observed any indices of the existence of an altitudinal gradient.

**STRUCTURE OF THE POPULATION OF EIRÓS**

**DISTRIBUTION OF THE POPULATION BY SEX**

Distribution of the population by sex was calculated from the sexable pieces with almost complete
reliability: skull, jaw, limb bones, cheek teeth, and canines. The results are shown in table 1. A slight predominance of females over males can be seen, though the difference is not significant. Only in the case of the limb bones is the difference between the sexes found to a degree greater than that expected (50%-50%).

**DISTRIBUTION OF THE POPULATION BY AGE**

The distribution by age has been calculated on the cheek teeth. The separation by age groups of the cheek teeth was carried out according to the grade of wearing out or eruption. Nonetheless one has to bear in mind that not all the pieces that form the teeth are found in the upper and lower jaw at the same time.

The appearance of permanent cheek teeth in the cave bear is produced following the sequence below, based on the brown bear *Ursus arctos* (Ehrenberg 1955; Erdbrink 1953; Dittrich 1960; Andrews & Turner 1991):

<table>
<thead>
<tr>
<th>TOOTH</th>
<th>AGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>First molars</td>
<td>5 months</td>
</tr>
<tr>
<td>Fourth premolars</td>
<td>6 months</td>
</tr>
<tr>
<td>Second molars</td>
<td>8 months</td>
</tr>
<tr>
<td>Third lower molar</td>
<td>13 months</td>
</tr>
</tbody>
</table>

This sequential eruption determines an equally sequential wearing out of the teeth from the front to the back of the jaw. In this way, when the first molars show a moderate wearing out, the second molars seem to be found with hardly any wearing out and the lower third molars are still coming out and with the roots hardly developed. The sets of teeth which show the first molars strongly worn out show the second molars only mildly worn out, and in the case of the lower series, third molars without hardly any indices of wearing out.

Andrews & Turner (1991) using the permanent teeth and more concretely the cheek teeth, distinguish four age groups. The newly born, represented by the new teeth of the upper and lower fourth premolars; The yearlings, represented by the fourth premolars and the upper and lower first molars, without any wearing out or with a slight wearing out, the lower and upper second molars coming out or without any wearing out and with the lower third molars coming out. The sub-adult (two years old) is represented by the upper and lower second molars with slight wearing out and the lower third molars without wearing out or with very slight wearing out. Finally, the adults in which all the pieces were present a strong wearing out. To refer to bears having survived a second winter as subadults seems somewhat exaggerated as the wearing out of the teeth can be more or less accelerated depending on the kind of food of the individual.

Table 2 shows the distribution of the grade of wearing out of the cheek teeth (in absolute values). Table 3, offers the distribution in age groups calculated following the data of dental wearing out.

There doesn't seem to exist a significant proportion of senile individuals with dental wearing out so bad as to be able to deduce death as a result of lack of sufficient alimentary reserves. However there does appear to exist a high mortality rate in the first stages of development (the individuals included in the first two age groups make up 72.91 % of the total), though it is no greater than

<table>
<thead>
<tr>
<th>CHEEK TEETH</th>
<th>WEAR STAGE</th>
<th>total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 2 3 4</td>
<td></td>
</tr>
<tr>
<td>FOURTH</td>
<td></td>
<td></td>
</tr>
<tr>
<td>upper</td>
<td>11 13 4</td>
<td>21</td>
</tr>
<tr>
<td>PREMOLAR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lower</td>
<td>6 0 6 12</td>
<td>12</td>
</tr>
<tr>
<td>FIRST</td>
<td></td>
<td></td>
</tr>
<tr>
<td>upper</td>
<td>11 1 39 5</td>
<td>56</td>
</tr>
<tr>
<td>MOLAR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lower</td>
<td>12 0 30 4</td>
<td>46</td>
</tr>
<tr>
<td>SECOND</td>
<td></td>
<td></td>
</tr>
<tr>
<td>upper</td>
<td>22 3 22 1</td>
<td>48</td>
</tr>
<tr>
<td>MOLAR</td>
<td></td>
<td></td>
</tr>
<tr>
<td>lower</td>
<td>14 3 22 1</td>
<td>40</td>
</tr>
<tr>
<td>THIRD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MOLAR</td>
<td>11 1 3 2</td>
<td>17</td>
</tr>
</tbody>
</table>

**Table 1 - Distribution of sex in the population of Eirés, according to various kinds of sexable remains, in absolute values (a.v.) and percents (%). Distribution des sexes dans la population d'Eirés, selon plusieurs types de restes sexuellement attribuables, en valeurs absolues (a.v.) et pourcentage (%).**
that calculated in other large European sites, which is around 75% (Kurtén, 1958).

CONCLUSIONS

Many cave bear sites show a disproportional relation between sexes. Some authors (Kurtén 1958, 1969; Andrews & Turner 1991) attribute this to preferential occupation, in such a way that some caves or parts of a cave are used by females with cubs, whilst other cavities or parts of the cave are inhabited by male adults. This could also be due to the different longevity of both sexes (Andrews & Turner 1991).

From the distribution of sexes in the cave of Eirós it is deduced that after a long period of preferential occupation, alternating between males and females, the proportion of both sexes is equal, or rather the phenomenon of the use of the cave for hibernation by males and females separately does not occur.

In as much as the high mortality rate observed in the juveniles studied, this can be explained on various grounds, such as the death of the mother due to problems during the birth or as a result of lack of fat reserves, or lethal congenital defects, in the case of the newly born. Also due to accidents (falls etc... in the cave), confrontations with male adults or lack of fat reserves to survive the winter, mainly in the case of juvenile individuals.

In all of these the largest cause of mortality seems to be the lack of available food. Following the absolute dating obtained (Grandal 1993a) the occupation of the cave occurred during a small glacial maximum (Vidal 1996) with an average temperature less than at present. The limestone areas where the caves used by the bears for winter refuge are found, are relatively rare in Galicia. They coincide with mountainous areas where the action of the glacial ice was far more intense and longer lasting. As such, the development of Quaternary glaciers in these areas had to have grave repercussions on the habitats and refuges of the cave bears. This could force the migration of the bear population towards areas where the climate was less harsh (for example from the nearby sierras of Ancares and Courel, towards the area of Eirós). Said glaciers also caused the isolation of the Galician populations from those in Leon and Asturias in the Cantabrian mountains.

Both phenomena would bring about a double impoverishment, both genetic and ecological, of all the implicated populations. The first would be produced when the genetic flow between the bears that inhabited Galicia and those which inhabited Asturias and Leon was cut off. The second would have been caused by the increase in the concentration of the individuals in lower regions which would signify an over exploitation of the food resources and the competition for winter refuge, due to the rarity which was afore mentioned. If the fact that the climate was cold or with long cold periods is born in mind (which implicates a reduction in the time available for feeding of the bears) an important percentage of those would go into hibernation with an insufficient fat reserve to survive until spring. This would be one further reason to justify the decline of the cave bear in Galicia.

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