**SUPPLEMENTARY INFORMATION**

***Acquisition details of the CT scans***

The *Ursus americanus*, *Ursus thibetanus*, *Ailuropoda melanoleuca* and *Tremarctos ornatus* specimens belong to the osteological collections of the University of Valladolid (Spain). The CT scanner used for these skulls is a CT medical scanner of model Aquilion 32 TOSHIBA with 32 multislicer at University Hospital of Valladolid. The conditions of acquisition in the CTscan were a 512x512 image matrix. 120 Kv and 250 mA. For each specimen the following CT data was obtained. For *U. americanus* and *U. thibetanus* the voxel size is 0.4680 (X.Y) and 0.3 mm of inter-slice (Z). For the first specimen were obtained 1114 slices and for of second 1127 slices. The voxel size for *T. ornatus* was 0.3819 (X.Y) and 0.5 mm of inter-slices (Z) and the voxel size for *Ailuropoda melanoleuca* were 0.5200 (X.Y) and 0.3 mm of inter-slices (Z).

Furthermore, the CTs of *Ursus arctos* and *Ursus maritimus* were obtained from the Digimorph website (http://www.digimorph.org). The scans were performed at the University of Texas High-Resolution X-ray CT Facility with either a 1024X1024 image matrix, resulting in inter-slice spacing in the range 0.70–1 mm. The conditions of acquisition in the CT scanning for the *Ursus arctos* specimen were 450 kV, 3 mA, obtaining 425 slices. For the *Ursus maritimus* specimen was 420kV, 1.8 mA, obtaining 540 slices. The fossil *U. spealeus* ssp.was in 5 parts. These five scans were performed at the Steinmann-institut (Bonn, Germany) and the microCT machine was a Phoenix x-ray 240kV. Such parts were joined considering the same pixel sizes on the X, Y, Z axes, obtaining 2087 slices. The characteristics of the CT data are 1024x1024 matrix and the voxel size X, Y, Z were 0.2463 mm. The conditions of acquisition in the CT scanner for this specimen are 180 kV and 160 microA.

The CT of *Ursus spelaeus ladinicus* (PIUW-CU 703) was scanned at the University of Vienne using a microCT machine Viscom X8060. The conditions of acquisition were 130kV and 330 microA, obtaining 2732 slices and voxel size 0.15mm in X, Y, Z axes.

The CT of *Ursus spelaeus eremus* (PIUW-SW 483) and *Ursus ingressus* were CT scanned at a private medical center of the city of Málaga (Spain), using GE Medical Systems (Brivo CT385 Series) scanner machine. The conditions of acquisition were 512x512 image matrix, 120Kv and 160 mA, with an interslecice of 0.2mm. For *Ursus spelaeus eremus* specimen we obtained 2573 slices with a voxel size of 0.5332 for (X, Y) and 0.2 (Z). For *Ursus ingressus,* we obtained 2601 slices with a voxel size of 0.6113 for (X. Y) and 0.2 (Z).

The CT of *Ursus spelaeus spelaeus* (E-ZYX-1000) were CT scanned at a veterinarian hostpital Rof Codina, Lugo. Spain. The conditions of acquisition were 512x512 image matrix, 120Kv and 160 mA, with an interslecice of 0.365mm. For this specimen we obtained 1386 slices with a voxel size of 0.75 for (X, Y) and 0.3650 (Z).

***Sex of the specimens***

In order to assess the sex of the cave bear specimens analysed in this study, we measured the same metric variables of the skull reported in Grandal d’Anglade and López-Gonzalez (2005) in our sample of cave bears (Basilar length [BASL], Total length of the skull [TOTL], Occipital breath [OCCB], Bizigomatic breath [BIZB], Parietal minimum breadth [PARB], Frontal breadth [FORB], and Interorbital minimum breadth [INTB]). Afterwards, we performed a Principal components Analysis (PCA) of these variables using our cave bear sample (Table S2) plus the average of these variables for males and females across different populations of cave bears (Eiros [Spain], Liñares [Spain], Gailenreuther [Spain], Mixnitz, and Goffontaine [Spain]) taken from Grandal d’Anglade and López-Gonzalez (2005) in a comparative framework.

The results of the PCA are shown in Fig. S1 and Table S3. The first PC explains 88.6% of the original variance (λ=6.2) and mainly separates males from females (Fig. S1). As all variables are positively loading on this eigenvector (Table S3), this indicates that the difference between males and females is due to size, being of course males bigger than females. The second PC (λ=0.46), however, only explains 6.5% of the original variance, and mainly separates the females from two Spanish populations (Eiros and Liñares) from the rest of the sample.

From a visual inspection of Fig. S1, it is deduced that all cave bear specimens included in our sample fall within the range of males with the sole exception of *Ursus spealeus ladinicus*. However, it is worth considering that this specimen was found in Conturines cave (Italy) with an altitude of more than 2.800m above sea level, and it is well-known that these forms were dwarfs (e.g., Ehrenberg 1929, Rabeder et al. 2008, 2014). Therefore, and given that the first PC accounts for size differences between males and females, our results are uncertain concerning the sex attribution of *U. sp. ladinicus.* Therefore*,* it is doubtful to know if its small skull size is because it corresponds to a female, or in contrast, because it was a dwarf specimen as a result of its high-alpine adaptations (Ehrenberg 1929, Rabeder et al. 2008, 2014).

Ideally, one of the most widespread measures for sexual dimorphism in cave bears is the transverse diameter of the canine (Kurtén 1965, 1969). However, the lack of available data for the canine transverse diameter in the population of Conturines, as well as in other cave bear populations, precludes us to assess the sex of our *U. spelaeus ladinicus* specimen and the other cave bears included in our sample*.* However, following Kurtén (1955) the canine transverse diameter for males reach an average value of 21.87mm with a range between 21.62mm and 22.12mm, and for females 16.34 mm, ranging from 15.95mm to 16.73mm, at least for the regular-sized population of Mixnitz (Austria). The value of canine transverse diameter of our specimen of *U. spelaeus ladinicus* is 22.0mm, and therefore, within the range of the males of the Mixnitz population. As a result, as evidenced by its canine transverse diameter, the small skull of *U. speleaues ladinicus* is not due because it belong to a female, but because it was a dwarf specimen as a consequence of the high-alpine region it inhabited, and for this reason, it plot with the females of other regular-sized populations of cave bears in Fig. S1. In summary, following our results we can conclude that the cave bears included in our sample are all male.

References

Grandal-d'Anglade A, López-González F. 2005. Sexual dimorphism and ontogenetic variation in the skull of the cave bear (Ursus spelaeus Rosenmüller) of the European Upper Pleistocene. Geobios. 38(3): 325-337.

Kurtén B. 1955. Sex dimorphism and size trends in the cave bear. Acta Zool. Fennica. 90:1-47.

Kurtén B. 1969. Sexual dimorphism in fossil mammals. In: Westerman, G.E.G. (Ed.), Sexual Dimorphism in Fossil Metazoa and Taxonomic Implications. E. Schweizerbart’sche Verlagsbuchhandlung, Stuttgart. 226–233.

**Table S1**. Species, museum numbers and location of the specimens used in this article.

|  |  |  |  |
| --- | --- | --- | --- |
| ***Species*** | ***Abbreviations*** | ***Museum Number*** | ***Location*** |
| *Ailuropoda melanoleuca* | Ame | VU 3156b | Valladolid, Spain |
| *Ursus arctos* | Uar | USNM 82003 | University of California, Los Angeles. Department of Organismic Biology. |
| *Ursus americanus* | Uam | VU 261 | Valladolid, Spain |
| *Ursus thibetanus* | Uth | VU 2421 | Valladolid, Spain |
| *Ursus maritimus* | Uma | H. 001-05 | University of California, Los Angeles. Department of Organismic Biology |
| *Tremarctos ornatus* | Tor | VU 1661 | Valladolid, Spain |
| *Helarctos malayanus* |  | AMNH28254 | Mammology collection to the AMNH, NY, USA. |
| *Melursus ursinus* | Uur | AMNH54464 | Mammology collection to the AMNH, NY, USA. |
| *Ursus spelaeus* ssp. | U.sp sp\*\* | unnumbered sp. | University of Bonn |
| *Ursus spelaeus ladinicus* | U.sp.la | PIUW-CU 703 (paratype) | University of Vienna, Department of Paleontology.Vienna, Austria |
| *Ursus spealeus eremus* | U.sp.er | PIUW-SW 483 | University of Vienna, Department of Paleontology.Vienna, Austria |
| *Ursus ingressus* | U.ing | PIUW3000/5/105 | University of Vienna, Department of Paleontology.Vienna, Austria |
| *Ursus spelaeus spelaeus* | U.sp.sp\* | E-ZYX-S-1000 | University Institute of Xeoloxia of the University of A Coruña, Spain. |

**Table S2**. Metric variables taken from the skull of the cave bear to assess the sex of the specimens. Abbreviations: Basilar length [BASL], Total length of the skull [TOTL], Occipital breath [OCCB], Bizigomatic breath [BIZB], Parietal minimum breadth [PARB], Frontal breadth [FORB], and Interorbital minimum breadth [INTB]).

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Specimens | BASL | TOTL | OCCB | BIZB | PARB | FROB | INTB |
| U. spelaeus spelaeus | 446.68 | 502.95 | 234.66 | 303.24 | 94.38 | 151.96 | 110.72 |
| U.spelaeus ssp. | 436.74 | 499.33 | 229.26 | 289.79 | 82.71 | 139.85 | 108.12 |
| U. spelaeus ladinicus | 358.85 | 394.19 | 161.74 | 212.65 | 75.89 | 101.52 | 72.91 |
| U. spelaeus eremus | 408.17 | 466.99 | 205.05 | 268.6 | 78.48 | 127.49 | 96.66 |
| U.ingressus | 446.65 | 501.34 | 213.42 | 290.69 | 88.17 | 139.55 | 104.05 |

**Table S3**. Factor loadings of the variables on the first two eigenvectors obtained from a PCA computed from the metric measurements of the skulls of different populations of cave bears with known sex and of the cave bears of our sample.

|  |  |  |
| --- | --- | --- |
|  | Eigenvector | |
| I | II |
| LogBASL | 0.963 | -0.197 |
| LogTOTL | 0.962 | -0.218 |
| LogOCCB | 0.959 | -0.142 |
| LogBIZB | 0.966 | -0.132 |
| LogPARB | 0.823 | 0.548 |
| LogFROB | 0.967 | 0.181 |
| LogiNTB | 0.942 | 0.040 |

**Figure S1**. Bivariate plot of PCA results from metric measurements of our cave bear sample (black circles) plus the average of these variables for males and females across different populations of cave bears. The first PC explains 88.6% of original variance explained and the second PC explains 6.54%.

