**Appendix A. Supplementary description of the sample**

*A.1 Gran Dolina site: lithostratigraphic and geochronological context*

The Gran Dolina cave (TD) is part of the karst system of the Sierra de Atapuerca (Burgos, Spain). This large cavity about 27 m deep and with a maximum width of 17m (Bermúdez de Castro et al., 2003) was cut by the construction of a railway trench, resulting in the exposure of its stratigraphic section. Gil et al. (1987) divided this section from bottom to top into 11 levels: TD1 to TD11. In 1993, an archaeological survey pit of 6 m2 was excavated, reaching level 6 (TD6) in 1994 (Bermúdez de Castro et al., 1999b). This level has been divided into three sublevels: TD6-1, TD6-2, and TD6-3 (Bermúdez de Castro et al., 1999b; Campaña et al., 2017). At least 160 human fossils, as well as more than 300 artefacts and several thousand micro- and macromammal fossil remains were found in sublevel TD6-2 (Carbonell et al., 1999; Cuenca-Bescós et al., 1999; García and Arsuaga, 1999; van der Made, 1999). Parés and Pérez-González (1995) observed a polarity reversal between TD7 and TD8, interpreted as the Matuyama/Brunhes boundary, meaning that levels TD8 to TD11 were deposited during the Middle Pleistocene, whereas levels TD7 to TD1 were deposited during the Early Pleistocene (Parés and Pérez-González, 1995, 1999). These results were supported by further geochronological techniques applied to samples from TD7 and TD6 (Arnold et al., 2014; Berger et al., 2008; Falguères et al., 1999; Moreno et al., 2015). A recent study undertook a series of TT-OSL suitability assessments on known-age samples from TD6 (Arnold and Demuro, 2015). Using this method, they obtained a weighted average age of 0.85 ± 0.04 Ma for TD6-3. The last study published in which the results of the first direct Electron Spin Resonance (ESR) dating of *Homo antecessor* were reported, provided a final age estimate ranging from 624 to 949 ka, (Duval et al., 2018). In summary, taking into account all this information we consider that the TD6 hominins could be assigned to Marine Isotope Stage (MIS) 21.

*A.2 Sima de los Huesos site: lithostratigraphic and geochronological context*

To date, more than 6500 human fossils from at least 28 individuals have been recovered from the Sima de los Huesos (SH) site located in the Cueva Mayor karst system (Burgos, Spain) (Arsuaga et al., 1997, 2014; Bischoff et al., 1997). The hominin remains from this site are represented in a single lithostatigraphic level (LU6) of the 12 levels that make up its sedimentary record (Arsuaga et al., 2014). U-series dating of a cave raft speleothem deposited directly on a hominin cranium (cranium 4) provided a weighted age of 434 +36/-24 kyr for the SH hominins (Bischoff et al., 2003). The presence of archaic forms of some carnivore species (Ursus deningeri and Panthera leo cf. fossilis), as well as the microfauna (Clethrionomys acrorhiza), are in agreement with these dates and would suggest that SH corresponds to MIS 15/16 (Arsuaga et al., 2014; Cuenca-Bescós et al., 1997; García and Arsuaga, 2011). The more recent data refer to the post-infrared-stimulated luminescence (pIR-IR) dating of K-feldspars and the thermally transferred optically stimulated luminescence (TT-OSL) dating of individual quartz grains, which have provided a mean age of 433±15 kyr and 416±12 kyr, respectively (Arnold et al., 2014).

*A.3 Krapina site: lithostratigraphic and geochronological context*

The fully Neanderthal fossil collection from the Croatian site of Krapina comprises more than 850 skeletal remains belonging to up to 70 individuals (Brace, 1979; Brace et al., 1964; Radovčić, 1988; Smith, 1976; Wolpoff, 1979), which makes their fossil record widely recognized as the largest Neanderthal collection from any one site in the world. This collection derives from a rock shelter in Hušnjakovo (northern Croatia), the stratigraphic levels of which were well described by Gorjaniociĉ-Kramberger (1906). ESR and U-Series dating suggested a date between 120–130 kyr for the site with the entire stratigraphic sequence accumulating over a short 20 kyr time period or less (Rink et al., 1995). Most of the hominid material derives from levels 3 and 4, which correspond with the last interglacial and the early last glacial period, although some specimens may have been deposited later (Malez, 1970).

**Table A.1.** Krapina upper and lower permanent canines included in this study.

**Tableau A.1.** Canines permanentes supérieures et inférieures de Krapina incluses dans cette étude.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Specimen** | **Tooth** | **Root conservation** | **Wear stage** | **Buti *et al.* 2017** |
| D120 | 43 | Incomplete | 1 | Included |
| D121 | 43 | Incomplete | 1 | Included |
| D102 | 23 | Incomplete | 1 | Included |
| D103 | 23 | Incomplete | 1 | Included |
| 45,1 | 23 | Incomplete | 1 | Not included |
| D75 | 43 | Complete | 2 | Included |
| D119 | 43 | Incomplete | 3 | Included |
| D37 | 23 | Complete | 3 | Included |
| D76 | 13 | Complete | 3 | Included |
| D141 | 13 | Incomplete | 3 | Included |
| D36 | 13 | Complete | 4 | Included |
| D147 | 23 | Complete | 4 | Not included |
| D56 | 13 | Complete | 5 | Included |
| D142 | 23 | Incomplete | 5 | Not included |
| D145 | 43 | Incomplete | 5 | Not included |
| D146 | 23 | Complete | 5 | Not included |
| D138 | 33 | Complete | 6 | Not included |
| D144 | 23 | Incomplete | 6 | Included |

Tooth type has been named following the World Dental Federation (FDI) system. Wear stages following Molnar (1971). In this table the teeth included in Buti et al. (2017) study are also indicated.

Le type de dent a été établi suivant le système de la World Dental Federation (FDI). Stades d'usure selon Molnar (1971). Dans ce tableau, les dents incluses dans l'étude de Buti et al. (2017) sont également indiquées.

**Table A.2.** Modern human upper and lower permanent canines included in this study.

**Tableau A.2.** Les canines permanentes supérieures et inférieures des humains modernes inclus dans cette étude.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Collection** | **N** | **Origin** | **Females** | **Males** |
| Escuela de Medicina Legal de Madrid | 58 | European | 26 | 31 |
| Pretoria Bone Collection | 57 | African | 28 | 29 |
| Sudanese collection | 10 | African | 5 | 5 |
| Total | 125 |  | 59 | 66 |

**Appendix B. Supplementary data**

**Table B.1.** Descriptive statistics of the indices obtained from the measurement assessed on the upper canines with a wear stage greater than 3 (Molnar, 1971). SD: standard deviation. Var. (%): percentage of variation between the means of each wear stage with regard to the slightly worn teeth [(µi-µ1-3)/µ1-3 x100); i: wear stage].

**Tableau B.1.** Statistiques descriptives des indices obtenus à partir de la mesure évaluée sur les canines supérieures avec un état d'usure supérieur à 3 (Molnar, 1971). SD: écart-type. Var. (%):pourcentage de variation entre les moyennes de chaque stade d'usure par rapport aux dents légèrement usées [(µi-µ1-3)/µ1-3 x100); i: stade d'usure].

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Population/ Site** | **Wear Stage** |  | **3DAET** | **3DRET** | **Vcdp/Vc** | **OES/EDJS** |
| SH | 4 | N | 1 | 1 | 1 | 1 |
| Mean (SD) | 0.73 | 12.22 | 62.87 | 1.32 |
| Var. (%) | -17.05 | -21.41 | 13.77 | -2.94 |
| Krapina | 4 | N | 2 | 2 | 2 | 2 |
| Mean (SD) | 0.70 (0.04) | 10.62 (0.26) | 66.27 (1.79) | 1.29 (0.01) |
| Var. (%) | -22.78 | -27.51 | 14.59 | -7.19 |
| SH | 5 | N | 2 | 2 | 2 | 2 |
| Mean (SD) | 0.80 (0.00) | 14.31 (0.82) | 62.02 (2.30) | 1.41 (0.01) |
| Var. (%) | -9.09 | -7.97 | 12.23 | 3.68 |
| Krapina | 5 | N | 3 | 3 | 3 | 3 |
| Mean (SD) | 0.76 (0.82) | 12.82 (1.21) | 63.15 (2.09) | 1.35 (0.02) |
| Var. (%) | -15.56 | -12.49 | 9.20 | -2.88 |
| MH | 5 | N | 1 | 1 | 1 | 1 |
| Mean (SD) | 0.63 | 11.84 | 65.58 | 1.35 |
| Var. (%) | -31.52 | -35.19 | 23.36 | -8.16 |
| SH | 6 | N | 3 | 3 | 3 | 3 |
| Mean (SD) | 0.62 (0.06) | 11.46 (0.71) | 69.06 (1.95) | 1.34 (0.03) |
| Var. (%) | -29.17 | -26.30 | 24.97 | -1.72 |
| Krapina | 6 | N | 1 | 1 | 1 | 1 |
| Mean (SD) | 0.75 | 11.36 | 64.75 | 1.05 |
| Var. (%) | -16.67 | -22.46 | 11.97 | -24.46 |

3DAET: 3-D average enamel thickness index (Ve/EDJS, mm); 3DRET: the 3-D relative enamel thickness index (3DAET/$\sqrt[3]{Vcdp}$) x 100); RDV: relative dentine volume defined as the percentage of coronal volume that is dentine and pulp (Vcdp/Vc x100); and relative outer enamel complexity (OES/EDJ, free scale).

3DAET: indice moyen d'épaisseur 3-D de l'émail (Ve/EDJS, mm); 3DRET: indice relatif d'épaisseur 3-D de l'émail (3DAET/$\sqrt[3]{Vcdp}$) x 100); RDV: pourcentage de volume de la couronne incluant dentine et pulpe (Vcdp/Vc x100); et complexité relative de la surface externe de l'émail (OES/EDJ).

**Table B.2.** Descriptive statistics of the indices obtained from the measurement assessed on the lower canines with a wear stage greater than 3 (Molnar, 1971). SD: standard deviation. Var. (%): percentage of variation between the means of each worn stage with regard to the slightly worn teeth [(µi-µ1-3)/µ1-3 x100); i: wear stage].

**Tableau B.2.** Statistiques descriptives des indices obtenus à partir de la mesure évaluée sur les canines inférieures avec un état d'usure supérieur à 3 (Molnar, 1971). SD: écart-type. Var. (%):pourcentage de variation entre les moyennes de chaque stade d'usure par rapport aux dents légèrement usées [(µi-µ1-3)/µ1-3 x100); i: stade d’usure].

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Population/ Site | Wear Stage |  | 3DAET | 3DRET | Vcdp/Vc | OES/EDJS |
| SH | 4 | N | 1 | 1 | 1 | 1 |
|  |  | Mean (SD) | 0.73 | 15.83 | 54.01 | 1.36 |
|  |  | Var. (%) | -3.95 | 6.38 | -3.74 | 0.74 |
| MH | 4 | N | 8 | 8 | 8 | 8 |
|  |  | Mean  | 0.69 (0.13) | 14.73 (2.99) | 57.67 (6.74) | 1.34 (0.15) |
|  |  | Var. (%) | -13.29 | -11.27 | 6.57 | -6.47 |
| SH | 5 | N | 3 | 3 | 3 | 3 |
|  |  | Mean  | 0.64 (0.08) | 12.53 (2.35) | 63.92 (5.52) | 1.32 (0.09) |
|  |  | Var. (%) | -15.35 | -15.77 | 13.93 | -2.22 |
| Krapina | 5 | N | 1 | 1 | 1 | 1 |
|  |  | Mean  | 0.59 | 9.71 | 68.76 | 1.25 |
|  |  | Var. (%) | -24.36 | -25.65 | 13.88 | -8.09 |
| MH | 5 | N | 5 | 5 | 5 | 5 |
|  |  | Mean  | 0.67 (0.09) | 14.51 (2.22) | 57.92 (4.53) | 1.38 (0.06) |
|  |  | Var. (%) | -15.19 | -12.61 | 7.04 | -3.64 |
| SH | 6 | N | 1 | 1 | 1 | 1 |
|  |  | Mean  | 0.59 | 10.53 | 68.79 | 1.26 |
|  |  | Var. (%) | -22.37 | -29.23 | 22.60 | -6.67 |
| Krapina | 6 | N | 1 | 1 | 1 | 1 |
|  |  | Mean  | 0.52 | 8.58 | 72.90 | 1.24 |
|  |  | Var. (%) | -33.33 | -34.30 | 20.74 | -8.82 |

3DAET: 3-D average enamel thickness index (Ve/EDJS, mm); 3DRET: the 3-D relative enamel thickness index (3DAET/$\sqrt[3]{Vcdp}$) x 100); RDV: relative dentine volume defined as the percentage of coronal volume that is dentine and pulp (Vcdp/Vc x100); and relative outer enamel complexity (OES/EDJ, free scale).

3DAET: indice moyen d'épaisseur 3-D de l'émail (Ve/EDJS, mm); 3DRET: indice relatif d'épaisseur 3-D de l'émail (3DAET/$\sqrt[3]{Vcdp}$) x 100); RDV: pourcentage de volume de la couronne incluant dentine et pulpe (Vcdp/Vc x100); et complexité relative de la surface externe de l'émail (OES/EDJ).

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