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Molar tooth fragment BL5-0: the oldest human remain found in the Plio-Pleistocene of Orce (Granada province, Spain)

A molar tooth fragment from the Plio-Pleistocene Barranco León site 5 at Orce is shown to belong to *Homo* by analyses of its enamel in terms of the arrangement of the striae of Retzius and Hunter-Shreger bands, presence of perikymata, and of the thickness of the enamel, when compared with teeth of similar-sized mammals of other taxa.

Introductory background

Although well-known remains uncovered at Boxgrove in England (Roberts et al., 1994; Stringer et al., 1998) and Atapuerca in northern Spain (Carbonell et al., 1995) show that *Homo* was established in early Middle Pleistocene Europe, there are much older human remains and palaeolithic artifacts from Orce in southern Spain that testify to human presence in Europe as early as the Plio-Pleistocene boundary. Identification of the Olduvai magneto-subchron at site 7 in the Barranco de Orce (**BO**-*7*) (Agustí et al., 1997) scarcely 150 m from site 5 in the Barranco León (**BL**-*5*) strongly supports attributing a similar antiquity to the latter and its assemblage, which includes part of a human tooth crown and root (hominid **BL5-0**), palaeolithic artifacts, and faunal remains.

In 1983 a human calvarial fragment (**VM-0**) was reported from a Plio-Pleistocene faunal assemblage at the Venta Micena site at Orce (Gibert, Agustí & Solà-Moyà, 1983). Recent research confirming its human juvenile form (Gibert, Campillo, Arqués et al., 1998) is well corroborated by biochemical and immunological analyses (Borja, García-Pacheco, García-Olivares et al., 1997; Borja, García-Pacheco, Ramírez-López & García-Olivares 1992; Gibert, Campillo, Arqués et al., 1998), notwithstanding some ongoing controversy provoked by opinions that **VM-0** could have belonged to a young equid (Agustí & Moyà-Solà, 1987; Moyà-Solà & Agustí, 1989; Moyà-Solà & Köhler, 1998; Palmqvist, 1998); the Venta Micena excavations have also provided undoubtedly human humeral shafts — a nearly complete young juvenile specimen (**VM-1960**: Gibert, Sánchez, Malgosa, Walker et al., 1992; Gibert, Sánchez, Malgosa & Martínez, 1994; Sánchez et al., this volume, and refs.) and a fragment of an adult one (**VM-3691**, ibidem). A complete human phalangeal bone (**CV-0**) and two fragments of adult human

humeri (**CV-1, CV-2**) have also been described from the karstic Cueva Victoria near Cartagena in Murcia province, 200 kilometres east of Orce, (Gibert & Pérez-Pérez, 1989; Gibert & Pons-Moyà, 1984; Gibert, Pons-Moyà & Ruz, 1985, 1989; Gibert, Sánchez, Malgosa, Walker et al., 1992; Sánchez et al., this volume, and refs.; Santamaría & Gibert, 1992), which has a faunal assemblage comparable to Venta Micena and is of uncontestably Lower Pleistocene age, although no palaeolithic artifacts occurred. At Orce, by contrast, Lower Pleistocene many palaeolithic artifacts have been excavated in sealed layers, most particularly at Barranco León site *5* and Fuentenueva site *3a* (Gibert, Gibert, Iglesias & Maestro, 1998; Gibert J., Iglesias A., Maillo, A. & Gibert, Ll., 1992; Martínez et al., 1997; Roe, 1995; Tixier et al., 1995), and cut-marks on animal bones, and intentional breakage of bones by percussion, are both documented at the Venta Micena site (Gibert, Ferrández et al. 1992; Gibert & Jiménez, 1991; Jiménez & Gibert, 1992).

Geological and geochronological background

The NE sector of the Guadix-Baza basin in SE Spain (Fig. 1) displays a continental sedimentary sequence over 100 m thick, representing continual sedimentation from the Middle Pliocene to the Upper Pleistocene. Plio-Pleistocene sedimentary outcrops correspond to five unconformity-bounded depositional cycles (Fig. 2), each beginning with fluviatile sediments and ending with lacustrine ones — deposition of the one or the other depended on the relative height of the lake level which, in turn, reflected global climatic oscillations. The **BL-*5*** deposit lies in a bed of fine sand that belonged to the distal part of a small alluvial system. Excavation of 20 m^2 here in 1995 uncovered part of a human molar tooth (Fig. 3), and a *Hippoptamus amphibius antiquus* mandible surrounded by over 100 palaeolithic artifacts; the fauna includes *Castillomys* cf. *crusafonti*, *Mimomys* sp., *Allophaiomys pliocaenicus* and *Equus granatensis*. The Venta Micena site (**VM**) was a den used by scavenging animals (Gibert & Caporicci 1989; Martínez, 1992a,b). An intriguing feature of the assemblage is presence of cut-marks on some bones and of signs of intentional breakage by percussion on others (Gibert, Ferrández et al. 1992; Gibert & Jiménez, 1991; Jiménez & Gibert, 1992) and, as it also includes apparent manuports, there are implicit indications of sporadical human activity here, although the human remains show evidence of carnivore action. Stratigraphical analysis situates Venta Micena between Barranco León-*5* (**BL-*5***) and Fuentenueva-*3a* (**FN-*3a***) in Lower Pleistocene times, in accordance with the **VM** fauna: *Homo* sp., *Desmana* sp., *Allophaiomys pliocaenicus*, *Apodemus* aff. *mystacinus*, *Castillomys crusafonti* ssp., *Eliomis intermedius*, *Hystrix major*, *Prolagus capensis*, *Oryctolagus* cf. *lacosti*, *Ursus etruscus*, *Canis etruscus*, *Canis falconeri*, *Vulpes praeglacialis*, *Homotherium latidens*, *Megantereon whitei*, *Lynx* sp., *Pachycrocuta brevirostris*, cf. *Meles*, *Mammuthus meridionalis*, *Equus granatensis*, *Stephanorhinus etruscus*, *Hippopotamus amphibius antiquus*, *Praemegaceros* sp., Cervidae gen et sp. indet., *Praeovibos* sp., Bovini indet. (aff. *Bubalus*), *Soergelia minor*, *Hemitragus alba*, *Testudo* sp., *Lacerta* sp., *Opidia* indet., *Rana* sp., and Charadriiforme indet. (aff. Laridae) (Fig. 3). Fuentenueva site *3a* (**FN-*3a***) was situated near the edge of the basin and its sedimentary outcrop reflects the environment of the lake margin, containing variable amounts of detrital and organic matter. Systematic excavation in 1995 uncovered numerous palaeolithic artifacts associated with remains of large mammals in a faunal context of *Mimomys* sp., *Hystrix major*, *Allophaiomys* sp., *Hippopotamus amphibius antiquus*, *Mammuthus meridionalis*, *Stephanorhinus etruscus*, *Equus granatensis*, *Praemegaceros* sp., *Cervus* sp., Bovini indet., *Hemitragus* sp., *Megantereon* sp. and *Ursus* sp. (Fig. 3).

Palaeomagnetic determinations demonstrate presence of five normal-polarity episodes in a geological section near Galera, just west of Orce, another one in the Barranco de Orce section, and another probable one in the Fuentenueva section (Figs. 2, 3). The Olduvai magneto-subchron has been identified at Barranco de Orce site *7* (**BO-*7***) and because, only 150 m to the east, Barranco León site *5* (**BL-*5***) lies in the same stratum, and both sites have similar fauna, it is eminently reasonable to assign **BL-*5*** to the Olduvai magneto-subchron (Garcés, 1993; Garcés et al., 1997; Gibert , Arribas et al., 1994; cf. Agustí et al. 1997) and hence the hominid molar fragment **BL5-0** must also belong to this same early time.

Hominid molar fragment

Only mesial parts of the crown and root remained after the tooth (**BL5-0**) underwent an ancient bucclolingual fracture that was not, however, parallel to its buccolingual axis (Fig. 4, Fig. 5a, 5b). A large wear facet is present on the crown and dentine is exposed on the occlusal surface. The fragment belonged to an upper, possibly left, adult molar. Crown height on the mesial face is 4.6 mm and the length of the broken root is 2.9 mm. The maximum enamel thickness is 1.2 mm.

Material and research methods

Advances in technology and methodology enable unequivocal identification of **BL5-0** as human, as follows:

(1) Striae of Retzius and Hunter-Shreger (H-S) bands were located and investigated with a polarized-light analyzer coupled to a Wild M3Z binocular microscope equipped with a camera and source of cold light illumination (Itralux 5000) with polarizers. In order to enhance contrast during observation and photography **BL5-0** was immersed in alcohol.

The last imbricate stria was located in the fractured part of the enamel, and the H-S bands could be followed throughout nearly the entire crown fragment. The position of the bands, and the angles they formed with the dentine, allowed us to separate ancient from modern forms of *Homo* (cf. Benyon & Wood, 1987). The parallel pattern of the H-S bands permitted the human pattern to be distinguished from the non-parallel pattern found in carnivores ¾ as reported in hyaenas by Stefen & Rensberger (1995) and extended here to several other carnivore molars (particularly bear molars).

(2) The enamel prism patterns were examined by scanning electron microscopy (SEM). Patterns were grouped by Boyde (1964, 1965) into three types: 1, 2 and 3. Hominids display type 3 patterns, together with carnivores, pinnipeds, and proboscideans (Boyde, 1965, 1971). Gantt and colleagues differentiated pattern types 3a and 3b, identifying the former in hominoids and the latter in *Australopithecus* and *Homo* (Gantt, 1982; Gantt & Cring, 1981; Gantt, Pilbeam & Steward, 1977). The **BL5-0** fragment was fixed on to a stud with a conductive adhesive and photographed with the SEM at a low operating voltage, without further processing. The SEM images also revealed perikymata of the enamel.

(3) Changes in enamel thickness were compared in different groups of mammals because enamel thickness is a key feature in identifying specimens of *Homo* (Boyde, 1964, 1965, 1971, 1978), Gantt (1977, 1979), Gantt et al. (1977), Lavelle et al. (1977), von Koenigswald (1977). **BL5-0** was compared with different mammal groups (especially *Ursus* third molar sections).

Results

Low-power microscopy, following Benyon & Wood (1986, 1987), enabled observation of the striae of Retzius and H-S bands on the fractured surface of the inner enamel. The arrangement of the H-S bands was also observed on the buccal surface (Fig. 6). The first stria of Retzius of the imbricate part of the enamel was followed throughout the enamel, thereby permitting data given by Beynon & Wood (1986), given first here, to be compared with our findings on **BL5-0**, given second, as follows: stria of Retzius angle 30-33°, **BL5-0** 30°; H-S angle 50-68°, **BL5-0** 80°; enamel thickness 1.2-2.1 mm, **BL5-0** 1.2 mm. The position of the last imbricate stria suggests **BL5-0** belonged to an early *Homo* (cf. Benyon & Wood, 1987) (Figs. 7, 8). Other important features were observed with the SEM. The enamel prism pattern was visible near the base of the crown, and corresponds to type 3b (or keyhole) (Figs. 9a, 9b) (cf. Gantt & Cring, 1981). Perikymata were observed on the tooth surface (Fig. 10). Enamel thickness in **BL5-0** is characteristic of *Homo* and separated the specimen from teeth of small artiodactyls, pigs, carnivores (particularly bears), and cercopithecids (Fig. 11).

Discussion

BL5-0 is distinguishable from teeth of several other mammals of comparable body size. It has already been mentioned that human teeth are distinguishable from those of hyaenas. Similarly, **BL5-0** can be distinguished from teeth of cercopithecids, carnivores, felids, canids, ursids, suids, and small artiodactyls: these are distinguishable from **BL5-0** in terms of enamel thickness (Fig. 11), arrangement of the enamel in the crown, non-parallel as against parallel H-S bands (Fig. 6), enamel prism pattern (Figs. 10a, 10b), and presence or absence of perikymata (Fig. 12).

Conclusions

Analyses of the associated **BL-*5*** fauna, stratigraphical position, and palaeomagnetic findings, strongly suggest that **BL5-0** is the oldest known human remain in Europe. Furthermore, Barranco León *5* (**BL-*5***) and Fuentenueva *3a* (**FN-*3a***). This implies that the Orce Plio-Pleistocene contains the oldest palaeoanthropological sites in our continent.

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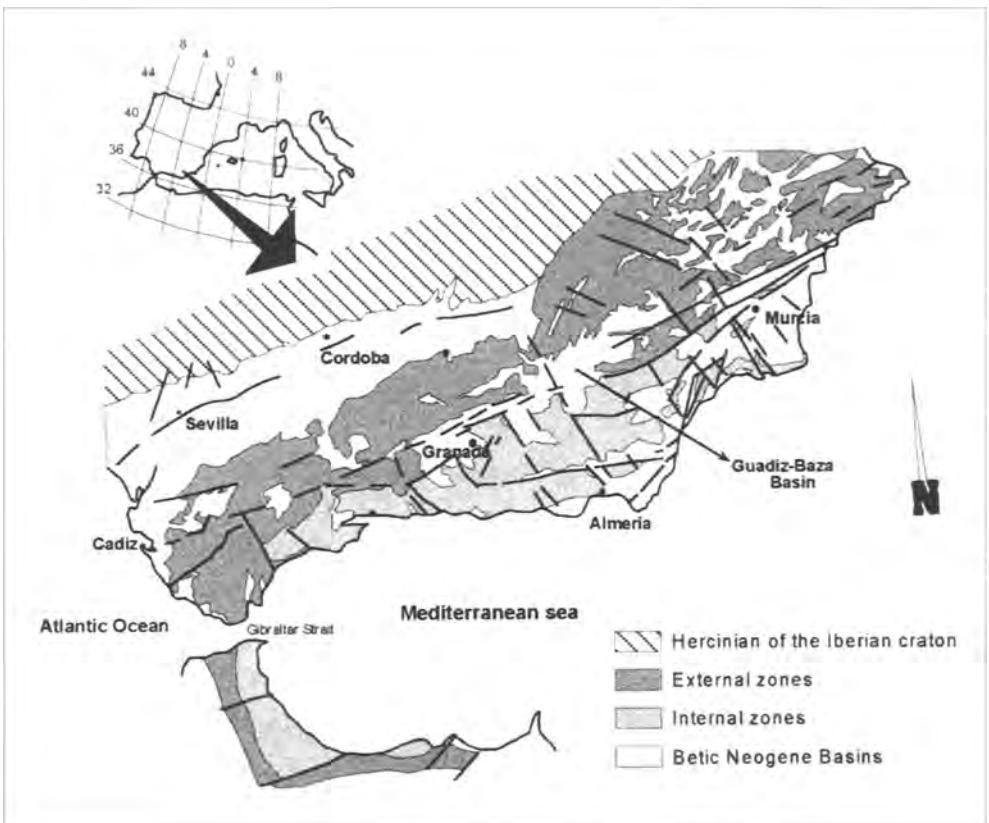


Fig. 1 Geological situation of the Guadix-Baza basin, SE Spain.

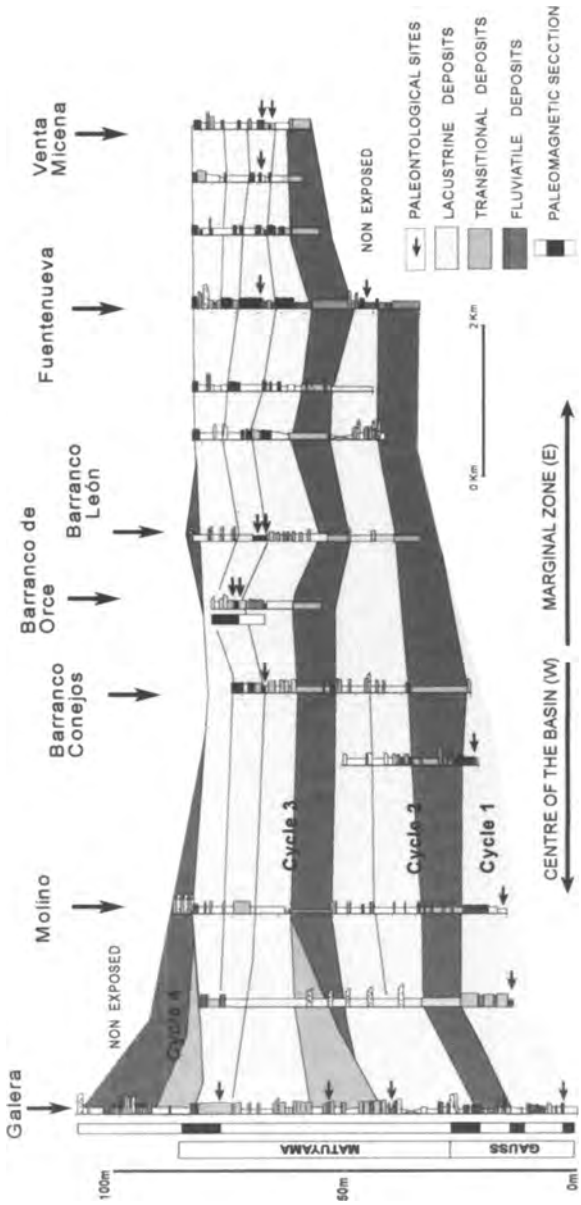


Fig. 2 General correlation of different stratigraphical sections in the Orce region, including the sections where palaeomagnetic data exist: the stratigraphical sequence shows unconformity-bounded depositional cycles with high-resolution time lines. Most of the palaeontological sites in the eastern part of the region lie in a black detrital member (7), formed by palustrine sedimentation within cycle 3 of the Orce lacustrine depositional sequence, and their fauna belongs to a single group, belonging in time to the Normal magnetic episode defined at the Barranco de Orce and Fuentenueva, interpreted as the Olduvai magneto-subchron by several authors.

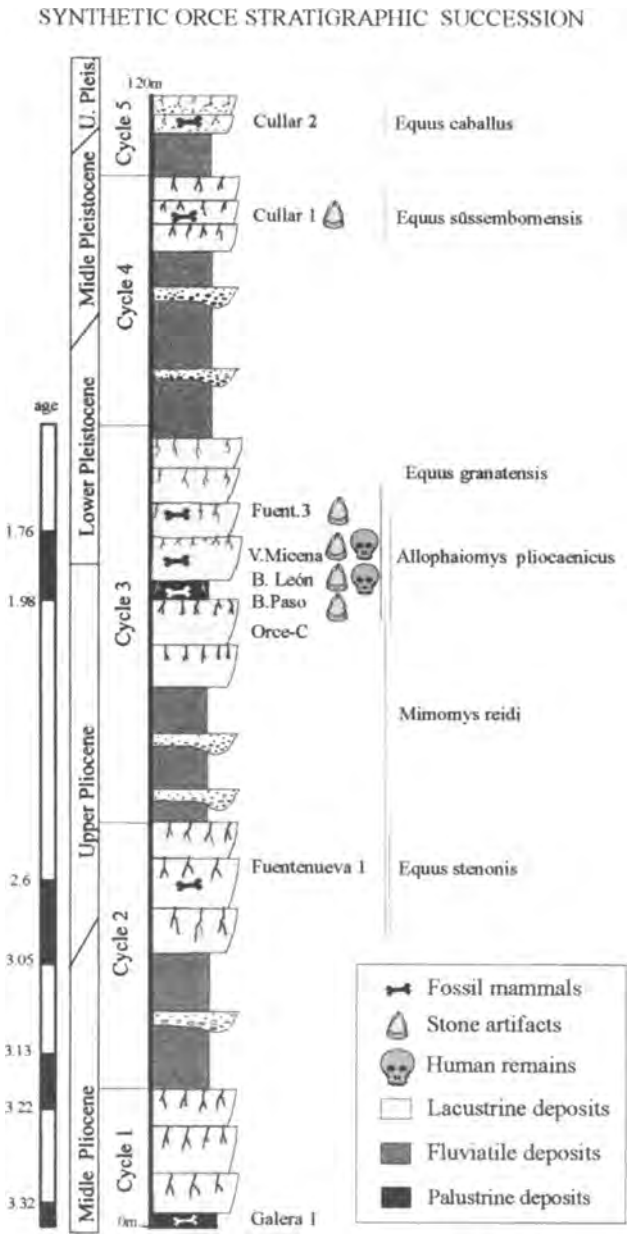


Fig. 3 Simplified stratigraphical column showing the succession of sites, stone artifacts, and human remains, as well as taxa of biostratigraphical significance.

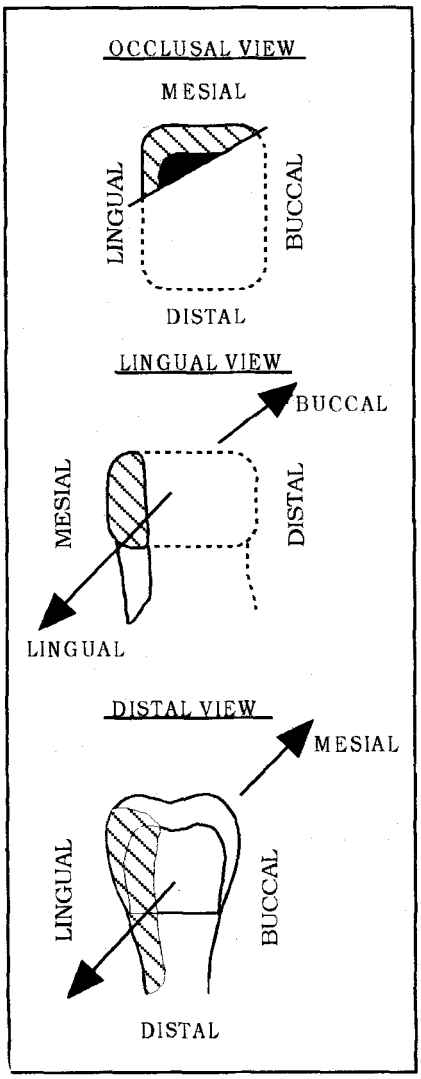


Fig. 4 Possible orientation of tooth fragment ***BL5-0.***

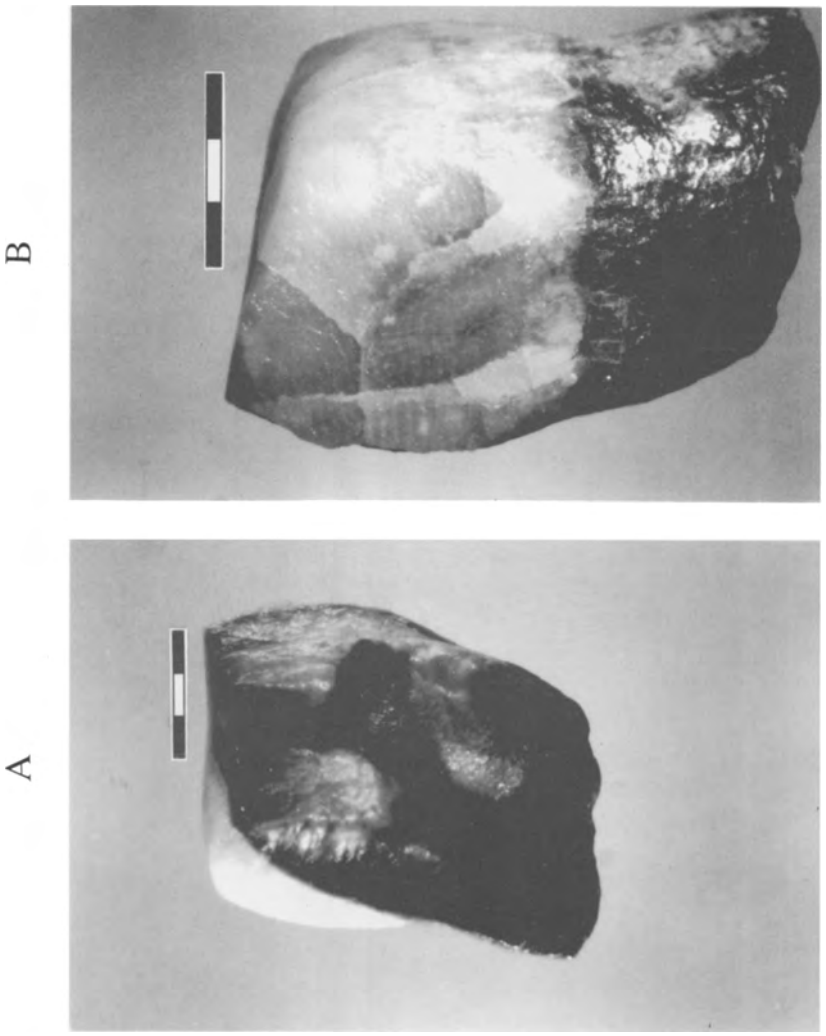


Fig. 5a,b ***BL5-0:*** *A= fractured face of enamel and - **B=** mesiolingual view of crown and root.*

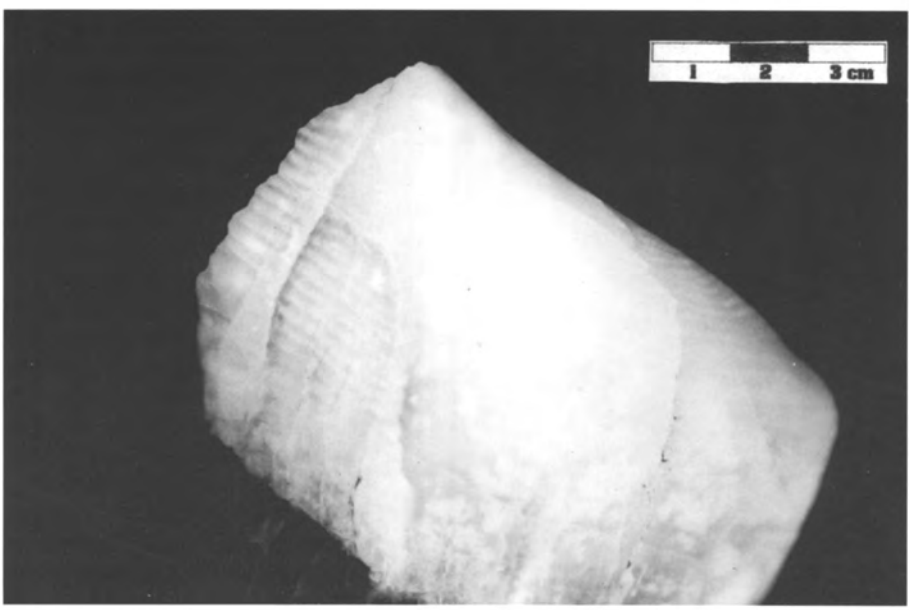


Fig. 6 ***BL5-0****: polarized-light photograph to show parallel Hunter-Schreger bands.*
Fig. 7 ***BL5-0****: polarized-light photograph to show striae of Retzius and Hunter-Schreger bands.*

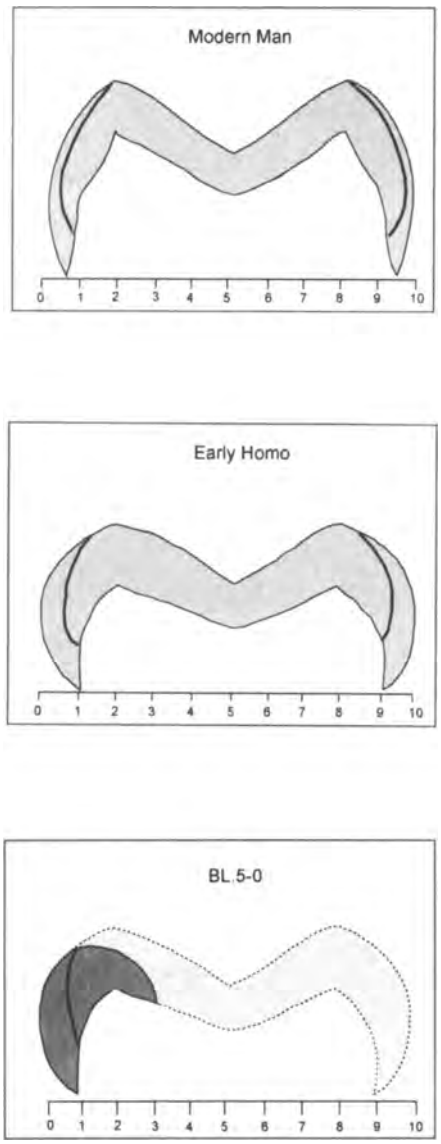
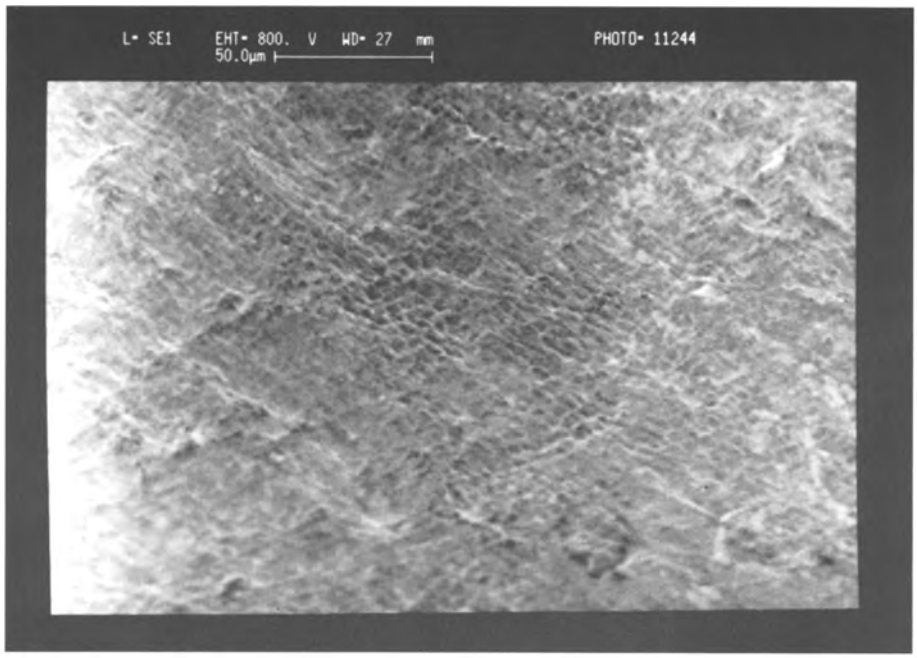
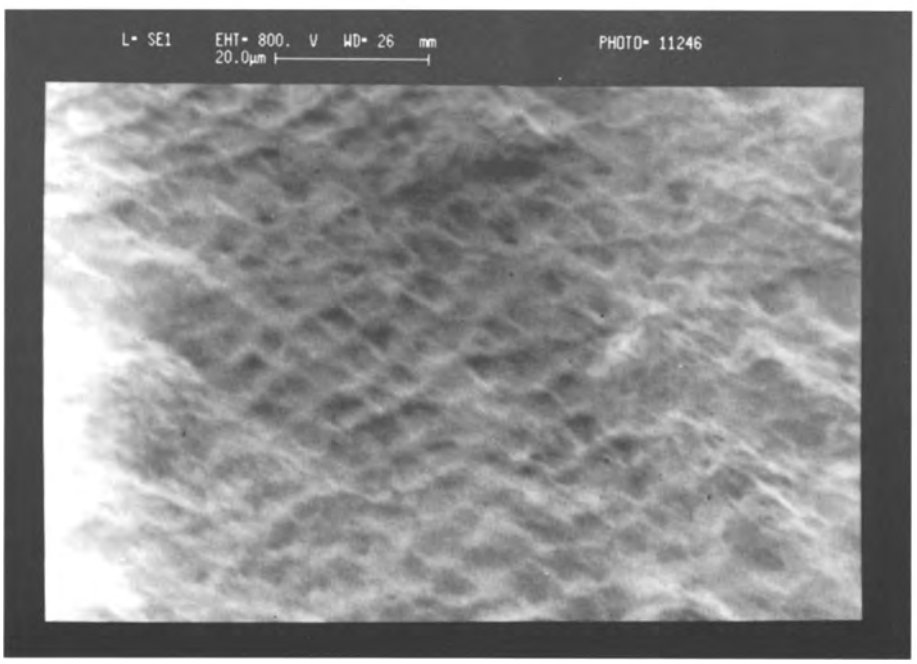


*Fig. 8 Arrangement of last imbricate stria in **BL5-0**, early human and modern human teeth, according to the criteria of Beynon & Wood (1986)*

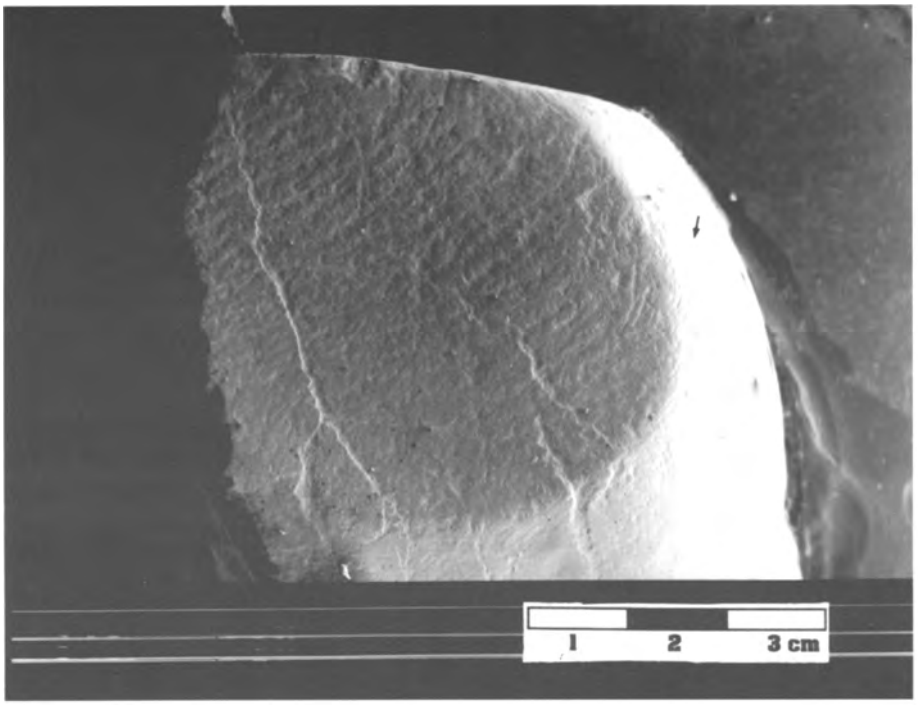


A

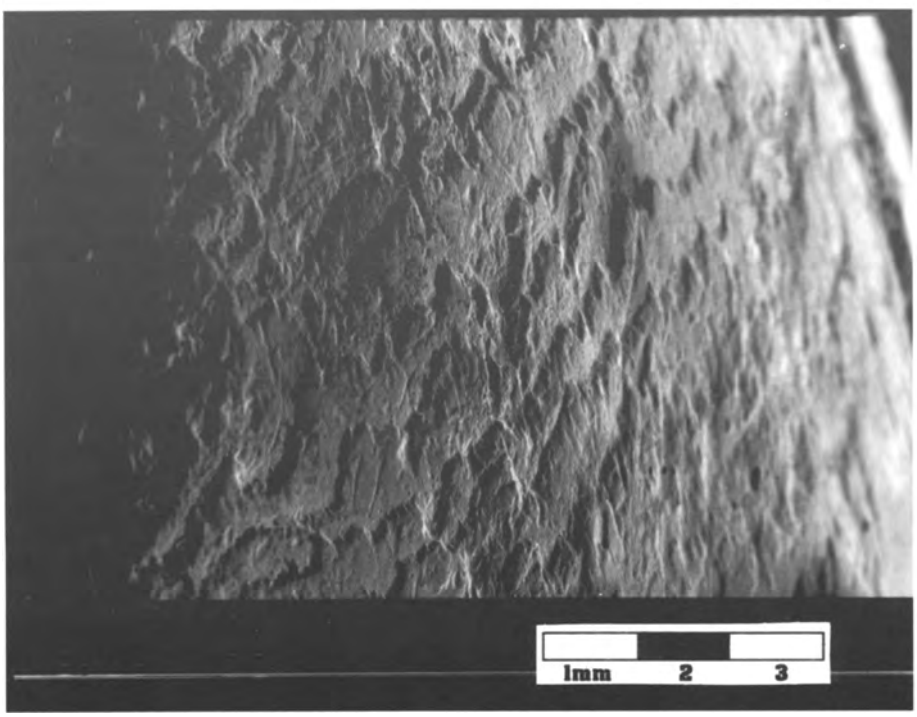


B

Fig. 9a,b ***BL5-0****: scanning electron micrographs to show type-3b prism enamel pattern.*



A



B

Fig. 10a,b Scanning electron micrograph of a cast of ***BL5-0*** *to show (a) perikymata on mesial surface. and (b) perikymata on the mesiolingual surface eroded by transport.*

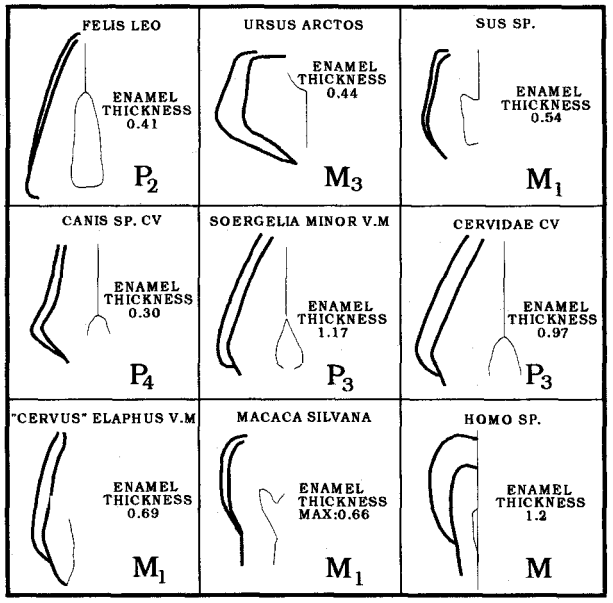


Fig. 11 Schematic representation of enamel thickness in cross-sections of teeth of different mammals. Maximum enamel thickness is indicated. CV = Cueva Victoria; VM = Venta Micena.

										ENAMEL THICKNESS	Taxa presents in the Orce Plio-pleistocene
											Little and uniform thickness along of the crown
											Increase in the thickness from the Cervix to the Crown
											The enamel thickness increases towars the middle part
										POLARIZED LIGHT	Parallel H-S bands
											Waved H-S bands or not parallel
III B	III B	II	III	III	III	III	II	II	II	S.E.M	Arrangement of prism pattern
											Presence of Perikymates

Fig 12 Presence or absence of perikymata

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