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NEANDERTAL TEETH FROM ALPINE CAVES OF MONTE FENERA (PIEDMONT, NORTHERN ITALY): DESCRIPTION OF THE REMAINS AND MICROWEAR ANALYSIS

ABSTRACT: Three isolated permanent teeth from the Pleistocene deposits of two alpine caves (Ciota Ciara and Ciutarun) located on Monte Fenera (Borgosesia, Piedmont, NW Italy) are described. These caves, together with the Belvedere rock-shelter located on the same mountain, represent the most significant Palaeolithic sites of Piedmont. Both caves were essentially used by cave bears as hibernation lairs, but occasionally frequented by Neandertals. Evidence of Neandertal presence was based on recovery of Mousterian implements and confirmed by identification of a Neandertal temporal fragment (Fenera 1).

The new hominid fossils are represented by a right lower second molar (Fenera 2), a right upper first premolar (Fenera 3) from Ciota Ciara, and a right lower canine (Fenera 4) from Ciutarun. Morphological and morphometric observations and analysis of microwear of these teeth are consistent with attribution to Neandertals.

KEY WORDS: Neandertals – Teeth – Microwear – Monte Fenera, Italy

The caves Ciota Ciara (Bright Cave) and Ciutarun (Big Cave) are located near the town of Borgosesia (Vercelli, Piedmont, NW Italy), approximately 80 km NE of Turin (*Figure 1*). Their entrances open at elevations of 665 and 650 meters above sea level, respectively, at the foot of dolomite walls on the steep western side of Monte Fenera which dominates the vally floor of the Sesia river.

The main entrance of Ciota Ciara faces SW, revealing a cave formed in triassic dolomite which extends north-eastwards for about 70 m (*Figure 1*). The name of the cave is justified by the presence of a wide secondary opening (called the "window") facing W, so that the first half of the cave is relatively bright (Fedele 1966, Strobino 1981). Excavations carried out in this cave brought to light Mousterian implements mainly made out of quartzite and abundant large mammal remains mostly represented by heavily fossilized *Ursus spelaeus* bones and teeth (Isetti, Chiarelli 1965, Fedele 1966, Fedele *et al.* 1966, for references see also Strobino 1981, Guerreschi, Giacobini, in print).

Ciutarun cave, whose large entrance faces SW commanding an excellent view of the valley below, also extends north-eastwards in triassic dolomite and measures some 60 m in length (*Figure 1*). Most of its Pleistocene deposits were investigated and removed during earlier excavations. Materials collected at that time (Lo Porto 1957, Conti 1960) and data from renewed excavation (Fedele 1974) indicate close similarity to the Ciota Ciara deposit.

As in the case of several other alpine caves, available data indicate that during the formation of their Pleistocene deposits, Ciota Ciara and Ciutarun were essentially used by cave bears as hibernation lairs and only sporadically frequented by Neandertals. Another Mousterian deposit,

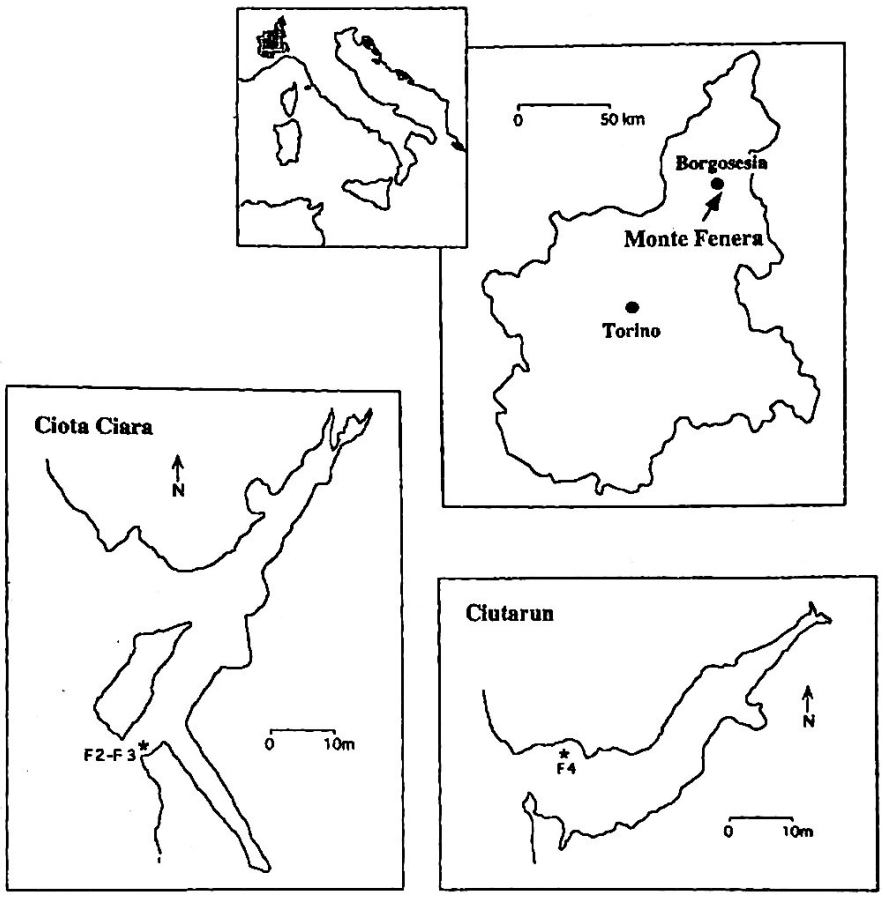


FIGURE 1. Map showing the location of Monte Fenera near the town of Borgosesia (Piedmont, NW Italy) and plans (based on plottings by A. Zanni) of the caves Ciota Ciara and Ciutarun. Asterisks mark the points where the human teeth Fenera 2 (F2), Fenera 3 (F3) and Fenera 4 (F4) were collected.

more significant from the archaeological point of view, was identified in the Belvedere rock-shelter, located approximately 100 m S of Ciota Ciara, at the foot of the same rocky wall, at 675 m above sea level (Fedele 1971). Even if not rich, these Monte Fenera deposits represent the most important Palaeolithic sites of Piedmont. This paucity probably not only reflects real scarcity of remains in the region, but also lack of research and discoveries (Guerreschi, Giacobini, in print).

Evidence of the presence of Middle Palaeolithic humans in the Monte Fenera sites is not only based on the recovery of Mousterian implements. The first hominid fossil (right temporal fragment), collected during uncontrolled excavations of Ciota Ciara deposit in 1955-56, was identified by A. Mottura during revision of a local collection (Mottura 1980). This paper is intended to describe three new fossils represented by isolated teeth collected in the Pleistocene deposit of Ciota Ciara (one right lower second molar and one right upper first premolar) and Ciutarun (one right lower canine). The morphological and morphometric characteristics of these teeth and a microscopic analysis of their surface modifications, including wear features, will be discussed. As far as the Ciota Ciara specimens are concerned, information of the discovery and a preliminary report were given earlier (Giacobini 1992, Strobino 1992-93, Villa, Giacobini 1993). The third tooth was identified only recently.

Even if, in some of the above quoted papers, hominid remains from Ciota Ciara were named otherwise, we will refer to them as follows: Fenera 1 (right temporal fragment), Fenera 2 (right lower second molar), Fenera 3 (right upper first premolar). The tooth from Ciutarun (right lower canine) will thus be indicated as Fenera 4.

CONDITIONS OF THE DISCOVERY

The two isolated teeth, Fenera 2 and 3, were collected in May, 1989, by P. Gallo and F. Strobino on the eroded surface of the Mousterian deposit located in the vestibular area of the main entrance of Ciota Ciara (*Figure 1*) (Strobino 1992-93). In close proximity to this area, excavations carried out in 1964 by G. Isetti produced the most important series of Mousterian artifacts from this deposit (Isetti, Chiarelli 1965). Recovery of Mousterian elements and associated faunal remains is frequent on the erosion surface of this part of the cave, where the Pleistocene layers are exposed. Even in the absence of precise stratigraphical correlations, the human teeth can be attributed with confidence to the Pleistocene deposit, where remains are characterized by a marked and typical fossilization.

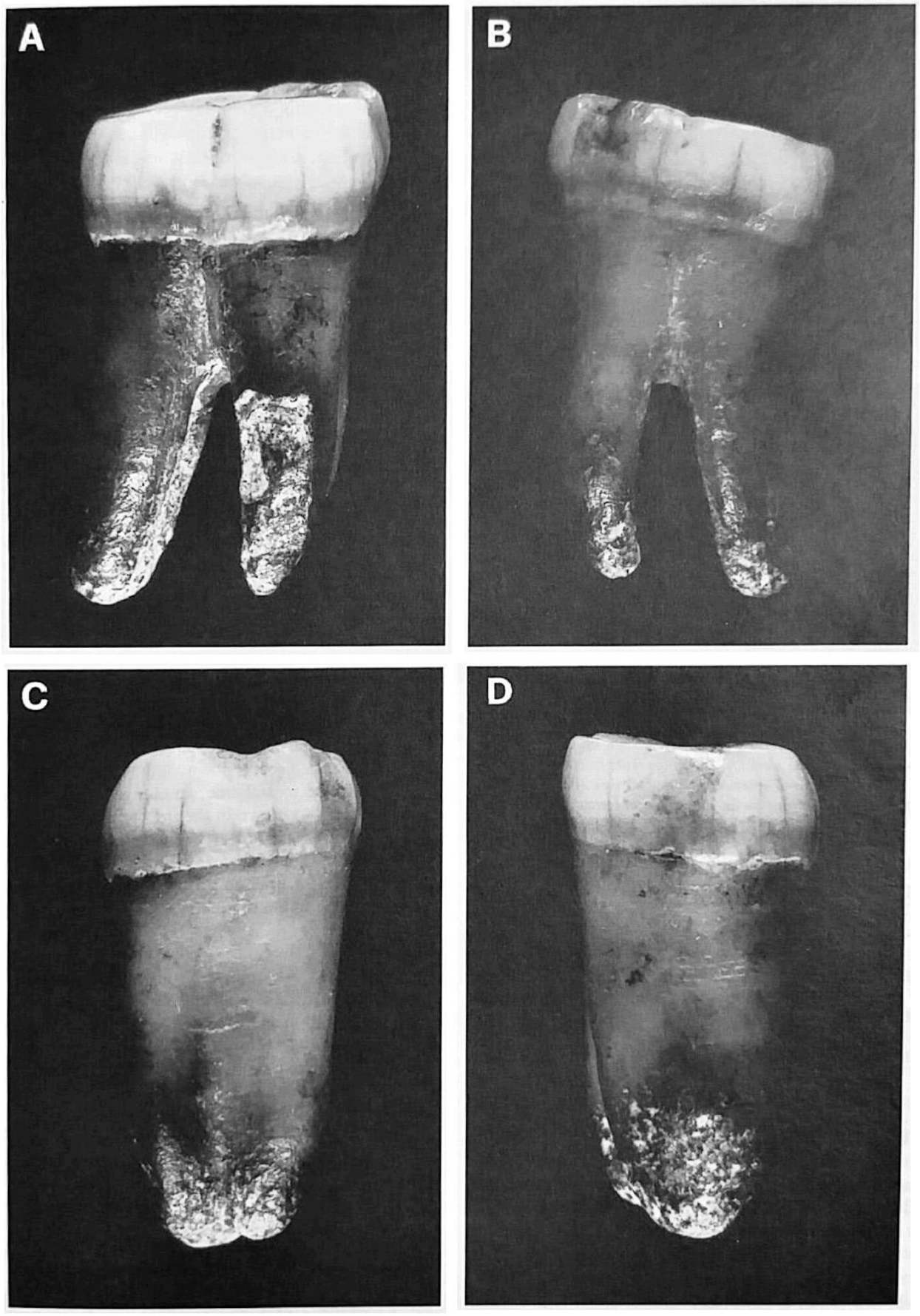


FIGURE. 2. Neandertal right lower second molar from Ciota Ciara (Fenera 2) in buccal (A), lingual (B), mesial (C) and distal (D) views.

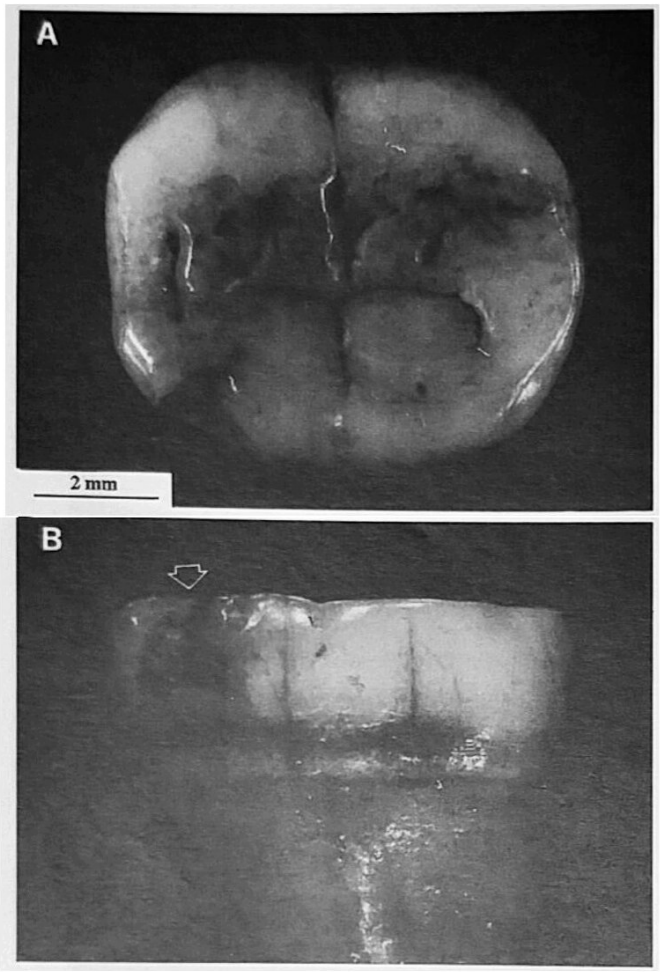


FIGURE 3. Close-up of the crown of the right lower second molar Fenera 2. The occlusal view (A) shows the wide mesial interproximal facet and the deep *fovea anterior*. The lingual view (B) shows a wide and deep hypoplastic area on the mesial aspect (arrow).

TABLE 1. Dimensions of the teeth Fenera 2, 3 and 4.

	bucco-lingual	mesio-distal	crown height	root length
FENERA 2	10.3	12.1	6.0	15.5
FENERA 3	10.6	8.3	6.8	-
FENERA 4	8.0	7.0	-	14.5

The isolated tooth Fenera 4 was recently identified among materials excavated in the 1950s by C. Conti and housed in the Museum of Palaeontology and Archaeology of Borgosesia. According to the notes of the excavator, it was found on June 18th, 1955 at the depth of 3.80 m during "excavation of the breccia underlying the large hearth, between the left wall of the cave and the big rock. Depth of the hearth's pit: 3.80 m; close to the hearth, bones and Palaeolithic artifacts were collected" (*Figure 1*).

FENERA 2 (RIGHT LOWER M2)

Fenera 2 (*Figure 2*) is a complete and perfectly preserved isolated right lower molar, except for a small erosion on the buccal aspect of the mesial root. It exhibits both mesial and distal interproximal facets, indicating that it is not a third molar. On the basis of its cusp pattern, it is probably a second molar. Adult status is indicated by the distal facet and the amount of occlusal and interproximal wear.

The crown is a pale yellowish colour with brown shades. Roots are brown with darker blackish apexes.

Crown morphology and metrics

Dimensions of the low, broad crown are indicated in *Table 1*. The occlusal surface (*Figure 3A*) shows a 5 cusp X pattern (Johanson 1979). Occlusal wear is slight, with only very small dentine exposure on the tip of the cusps. The greatest wear is on the buccal side of both buccal and lingual cusps. The wear gradient corresponds to score 2 of Brabant (1968) scale. Wear, even if slight, made it impossible to determine whether there were small accessory cusps.

A deep *fovea anterior* (*Figure 3A*) is distally delimited by a thick enamel crest joining protoconid and metaconid. A deep hole which is probably a chipping corresponding to an area of enamel hypoplasia on the lingual side of the metaconid is visible (*Figure 3B*). Microscopic examination reveals that the edges are worn and rather rounded, suggesting antemortem damage.

Lingual and buccal aspects of the crown are considerably convex with more pronounced convexity on the buccal side. On the distal side of the crown, a rounded flat interproximal facet begins at the occlusal surface. extends 3.0 mm directly downward and has a breadth of 3.4 mm. On the mesial side, an elongated interproximal S-shaped facet (concave in the upper part and convex in the lower part) (*Figure 4A, B*) begins at the occlusal margin. This facet is 5.0 mm in breadth and 4.0 mm in height. It has three shallow oblique grooves, two displaced to the buccal and one to the lingual sides (*Figure 4C, D*).

Roots

Fenera 2 shows two complete roots: one mesial and one distal. They have the same length (approximately 15.5 mm at the neck) and merge at their cervical third. Both roots show a tendency to bifurcate which is more pronounced on the mesial root with two apexes (buccal and lingual).

Radiographic examination

The pulpar cavity of Fenera 2, as shown in the bucco-lingual radiogram (*Figure 5A*), shows no significant difference compared to that of the same tooth in modern humans.

FENERA 3 (RIGHT UPPER P3)

Fenera 3 (*Figure 6*) is a right upper first premolar (P3). Except for fractures of both apexes of its bifurcated root

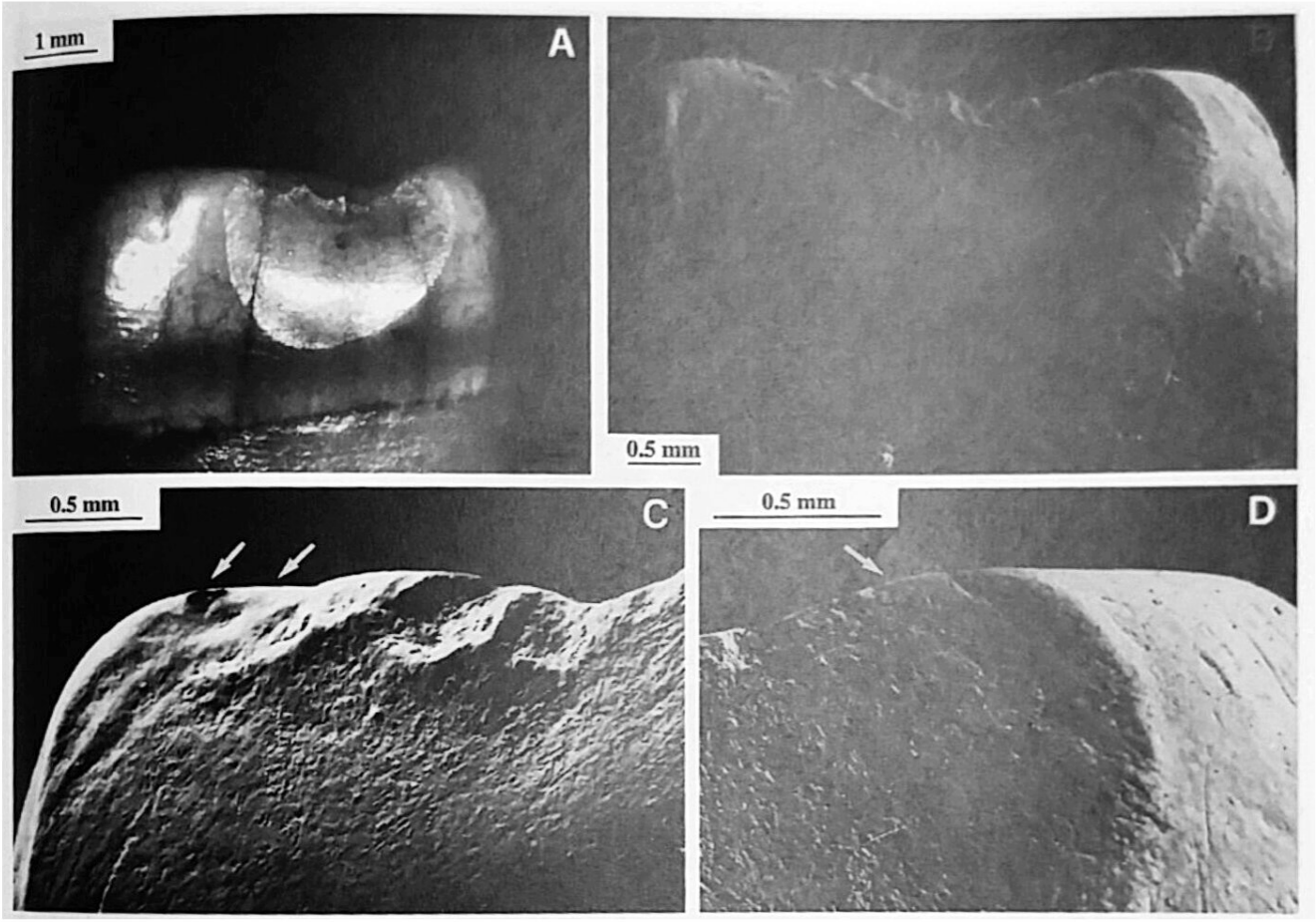


FIGURE 4. Mesial interproximal facet of the right lower second molar Fenera 2. A: close-up of the mesial aspect of the crown, showing a slightly concave facet. B: SEM image showing a uniformly pitted surface. C: SEM close-up of the buccal side of the facet showing a couple of grooves directed cervico-buccally (arrows). They seem to originate from the split occlusal margin. D: SEM close-up of the lingual side of the facet showing a single groove (arrow) directed cervico-lingually.

this tooth is well preserved. The crown is a pale yellow with a yellowish brown root.

Crown morphology and metrics

The crown shows a pentagonal outline which appears elongated bucco-lingually. Its dimensions (*Table 1*) indicate a very large tooth with a crown height of 8.3 mm buccally and 7.4 mm lingually.

The occlusal surface (*Figure 7B*) shows two main cusps. The buccal cusp is considerably larger than the lingual and is relatively squat. The lingual ridge of this cusp shows an evident splitting. Its disto-buccal and mesio-buccal ridges are markedly developed, like all marginal ridges of this tooth. Slight occlusal wear with no dentine exposure on the tip of the cusps, corresponds to score 1 of Brabant (1968) wear scale. The central sulcus is marked, but not straight as in modern humans. It is delimited by two deep sulci: mesial and distal. Mesial and distal fossae are also deep (mainly the distal). A small accessory cusp is present on the occluso-distal margin (interproximal ridge) (*Figure 7A, B*). The buccal aspect of the crown is markedly convex, mainly in its central area, showing a *tuberculum molare* (*Figure 7A*). Both interproximal facets are present. The mesial facet is hardly visible. The slightly elongated distal facet is 2.7 mm in breadth and 1.8. mm in height.

Root

Bifurcation of the root is incomplete due to a diaphragm joining the two parts until the fractured apexes.

Radiographic examination

As demonstrated by the radiogram (*Figure 5B*), the pulpar cavity of Fenera 3 appears enlarged compared to that of modern humans, representing a slight degree of taurodontism. Two large root canals are visible.

FENERA 4 (RIGHT LOWER CANINE)

Fenera 4 (*Figure 8*) is a complete and perfectly preserved isolated right lower canine. The crown is uniformly white and the root is a pale yellow with blackish small stains.

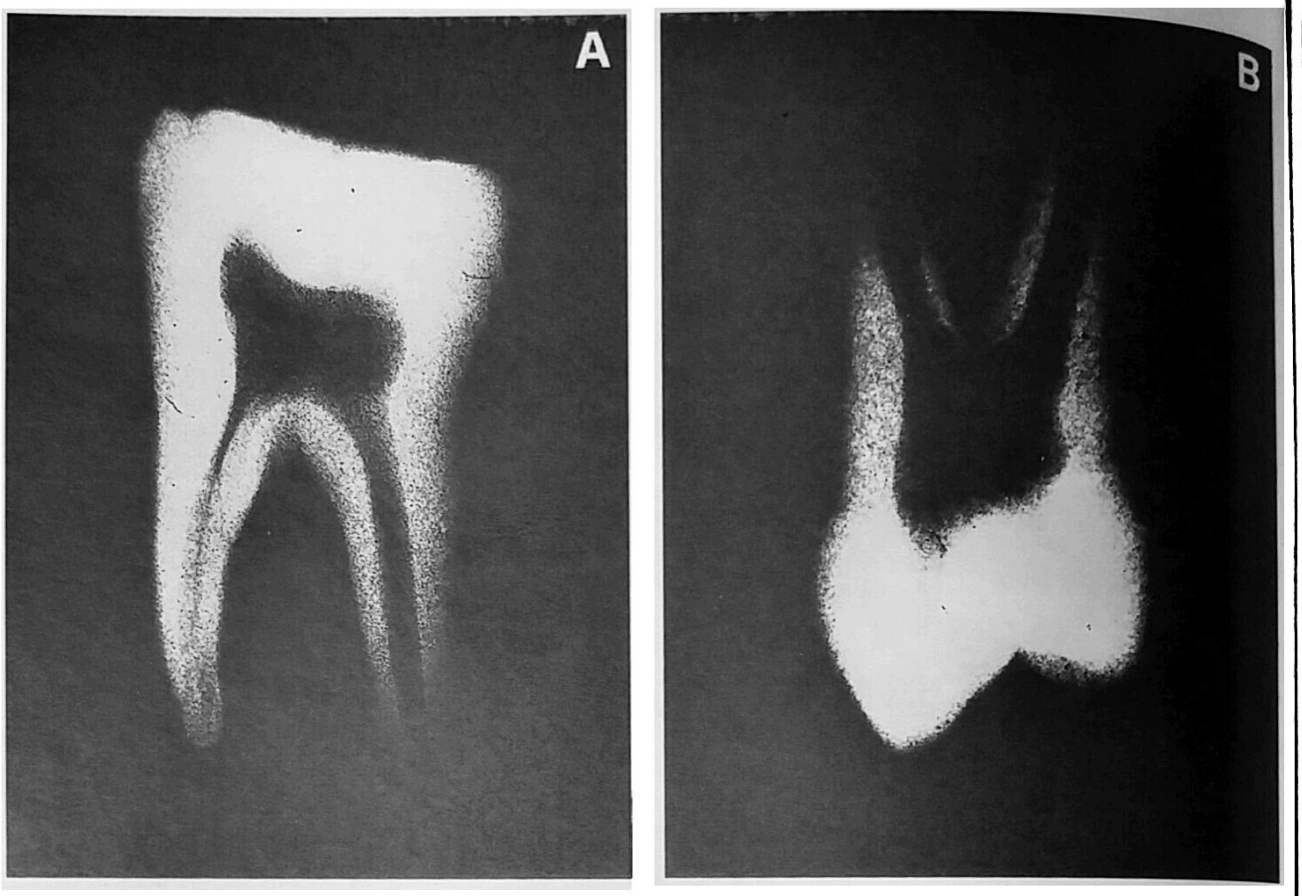


FIGURE 5. A: linguo-buccal radiogram of the right lower second molar Fenera 2. B: mesio-distal radiogram of the right upper first premolar Fenera 3.

Crown morphology and metrics

Advanced occlusal wear, partly erasing the morphological characteristics of the crown (*Figure 9A-C*), can also be responsible for imprecision of measures indicated in *Table 1*.

A broad oval, brown-yellowish, dentine area is exposed on the attritional flat, subhorizontal surface of the crown, which is slightly tilted in a cervical-buccal direction (*Figure 9B*). The lingual surface of the crown shows a trace of lingual tubercle, almost erased by occlusal wear (*Figure 9A*). Traces of pronounced marginal ridges are identifiable (*Figure 9A*). The buccal surface shows a punched-out microcavity displaced distally and crossed by an enamel fracture (*Figure 9C*). Scanning electron microscope examination shows an anomalous convergence of perikymata towards the borders of this defect (*Figure 9D*). These characteristics are typical of enamel hypoplasia. On the distal side of the crown, a rounded concave interproximal facet (2.5 mm in diameter) is present. On the mesial side, an oval-shaped flat facet of similar size appears with a less defined outline.

Root

The root has a length of 14.5 mm.

ANALYSIS OF MICROWEAR

Material and methods

Tooth surfaces were observed with a Wild M420 stereomicroscope. Silicon rubber (Provil-L, Bayer, Leverkusen, Germany) and acrylic resin (Araldite LY554 with catalyser HY956, Ciba-Geigy, Basel, Switzerland) were employed to produce replicas for scanning electron microscope (SEM) observations. A Cambridge Stereoscan 120 SEM was used for the analysis. Vernis-replique (PRESI, Eybens, France) was employed to produce varnish replicas which were observed with a Nikon Optiphot-2 light microscope.

Results

Fenera 2 and 3

Some authors stress the fact that analysis of buccal microwear of posterior teeth is more indicative of the composition of habitual diet (carnivorous or vegetarian), because of the slower wear turnover, than analysis of the occlusal wear (Baron *et al.* 1972, Fine, Craig 1981, Fox, Perez-Perez 1994, Lalueza *et al.* 1993, Puech *et al.* 1980, Puech 1983, Puech, Cianfarani 1989, Teaford, Tylenda

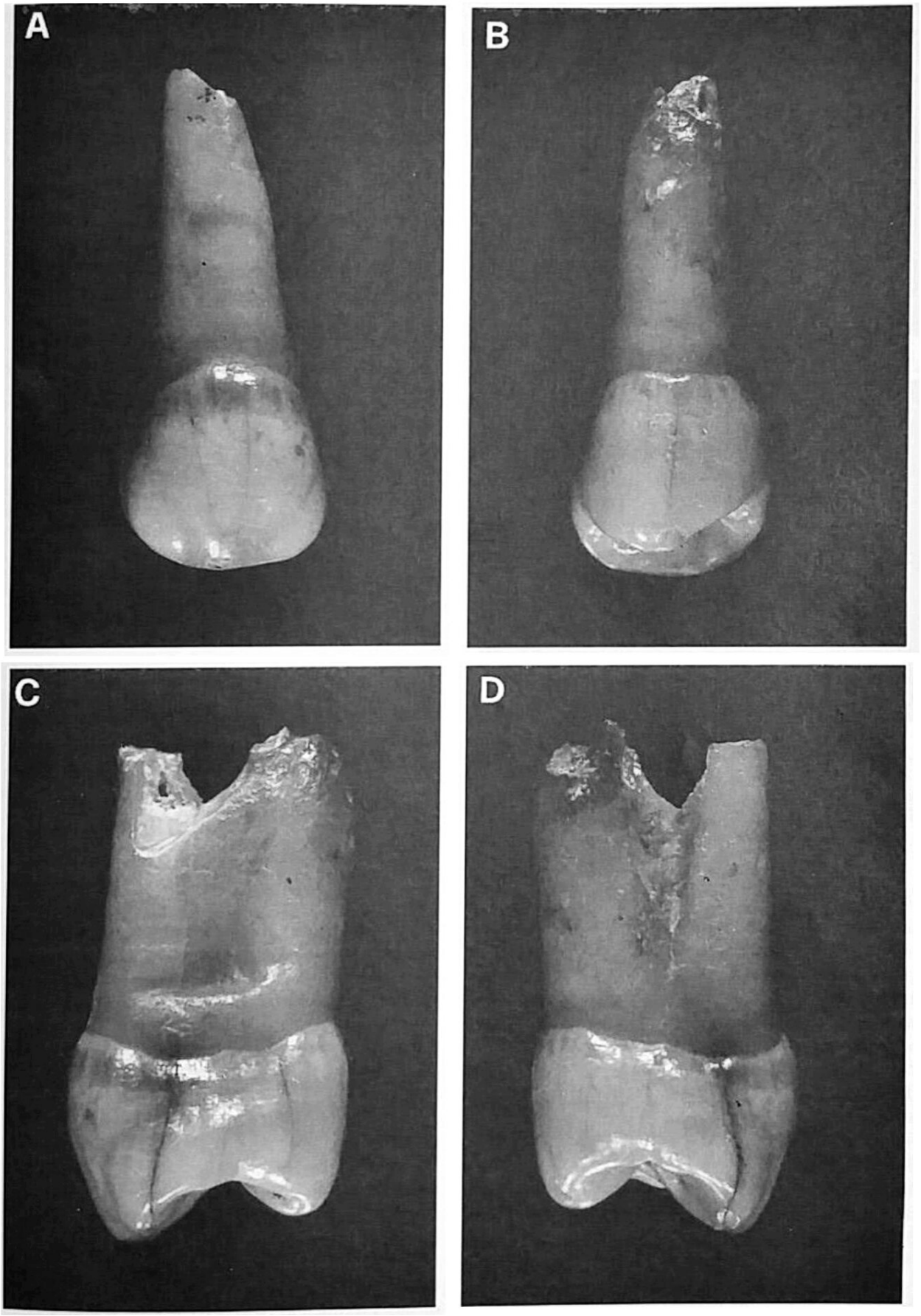


FIGURE 6. Neandertal right upper first premolar from Ciota Ciara (Fenera 3) in buccal (A), lingual (B), mesial (C) and distal (D) views.

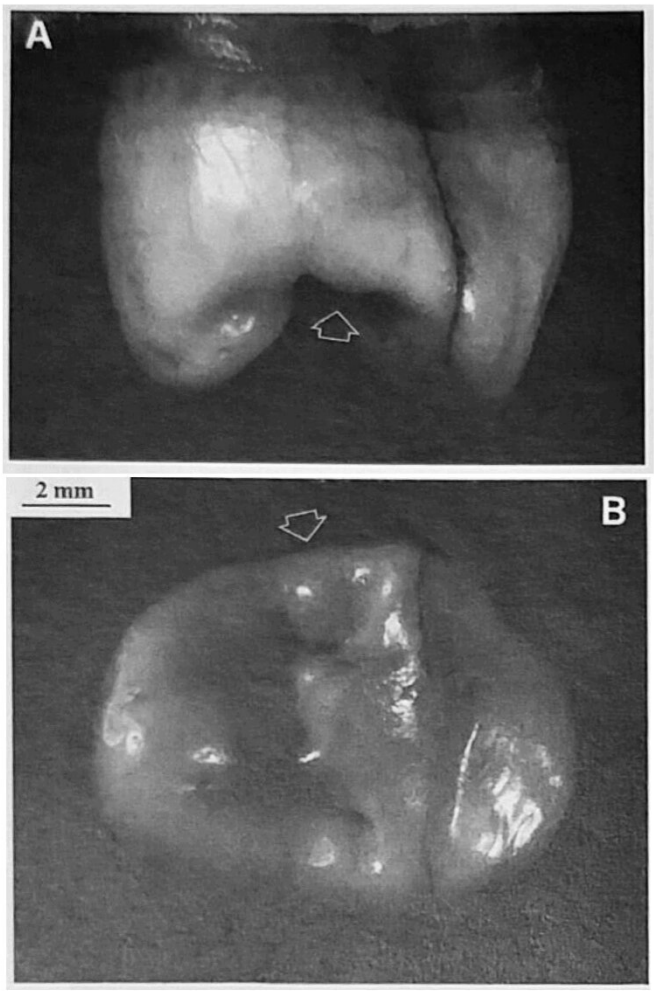


FIGURE 7. Close-up of the crown of right upper first premolar Fenera 3. A: distal aspect. B: occlusal aspect, showing the complex masticatory surface. Both views highlight a small accessory cusp on the occluso-distal margin (arrows).

1991). SEM and varnish replicas analysis of the buccal surface of the two posterior teeth from Ciota Ciara (Fenera 2 and 3) showed a few subvertical scratches. Their average length was measured in several areas according to the method employed by Puech (1983) to infer the composition of the diet of prehistoric humans. In the examined areas, both teeth showed a short average length of subvertical buccal scratches (Fenera 2 = 0.40 mm; Fenera 3 = 0.38 mm). Moreover, the occlusal surface of both teeth showed microwear characterized by marked predominance of pits (*Figures 10, 11A*) compared to scratches in all attritional facets (Fenera 2: pits = 86.7%, scratches = 13.3%; Fenera 3: pits = 100%, absence of scratches in considered areas). The interproximal surfaces of both Ciota Ciara teeth show frequent subhorizontal thin scratches. On the Fenera 2 molar, characterized by a wide attritional facet on its mesial side, these thin scratches run through the facet.

Series of subhorizontal parallel furrows were observed on the interproximal surfaces of Fenera 3 (*Figure 11B*). SEM analysis demonstrated that they were produced during the life of the individual. These furrows, grouped two to four in number, show an average length of 500 µm and well definite edges.

Fenera 4

Microwear analysis of the Fenera 4 canine showed an important degree of occlusal wear characterized by wide bucco-lingually directed scratches (*Figure 12A, B*). The average width of these scratches (10 µm) indicates that they are wider than usual masticatory scratches. Moreover, the buccal margin of the occlusal surface is rounded by wear and the lingual margin appears more sharpened. All these characteristics suggest that these scratches can be attributed to the tearing of fibrous abrasive materials between the teeth. The interproximal surfaces of Fenera 4 show frequent thin scratches directed bucco-lingually. A wide horizontal groove is present on the mesial side of the rooth, close to the cervical line (*Figure 13A*). SEM analysis showed that the surface of the groove is covered with long thin striae parallel to the main axis of the groove. These striae fit the unevenness of the cement surface (*Figure 13B*). Subhorizontal parallel furrows similar to those observed on Fenera 3 were observed on the mesial interproximal surface (*Figure 12C*).

CONCLUSIONS

Chronostratigraphic correlations of all hominid fossils from the Monte Fenera deposits are either uncertain or unprecise. In fact, the temporal fragment Fenera 1 was identified among materials from uncontrolled excavations of the Pleistocene deposit of Ciota Ciara. The isolated teeth Fenera 2 and 3 were collected on the eroded surface of the Mousterian deposit of the same cave. Only the isolated tooth Fenera 4, found during earlier excavations of Ciutarun, is accompanied by rough stratigraphical indications and can be attributed with confidence to Mousterian layers. Morphological and morphometric characteristics of all these hominid remains, however, are consistent with their attribution to Neandertals.

The temporal fragment Fenera 1, which consists of the anterior part of the *squama* of an adult individual, lacks the most typical parts where Neandertal apomorphic traits could be identified (glenoid cavity area, mastoid process, external auditory meatus; for analysis of these characteristics, see Condemi 1988). However, several features described by Vallois (1969) as typical of Neandertal temporal bones can be detected: marked thickness of the *squama* (corresponding to the highest values measured in Neandertals), low position and faint bending of the temporo-parietal suture, marked reliefs of insertion of the temporal muscle indicating strong masticatory musculature (Mottura 1980). The ascription of this specimen to Neandertals, even if highly probable, is thus essentially based on plesiomorphic characteristics

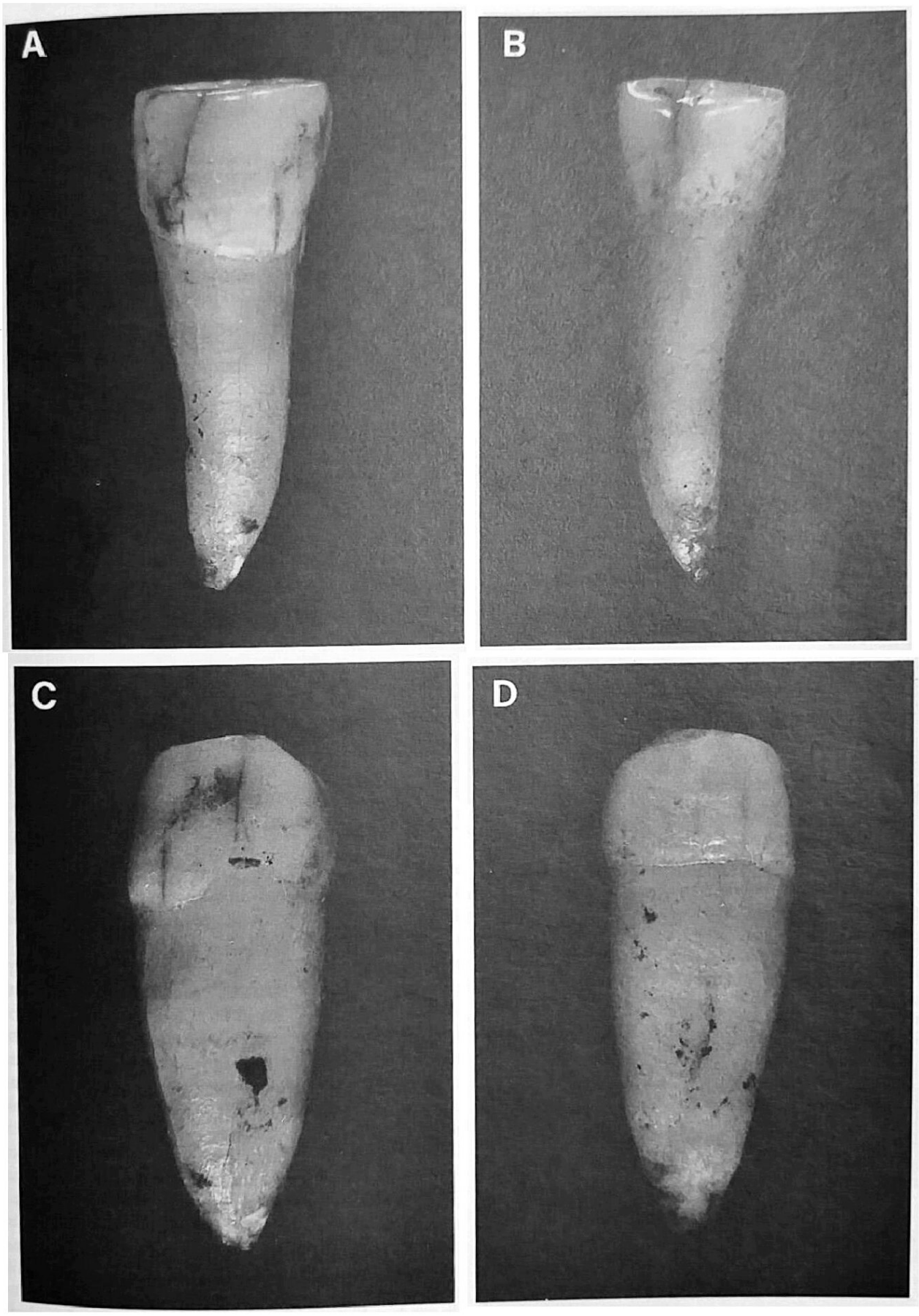


FIGURE 8. Neandertal right lower canine from Ciutarun (Fenera 4) in buccal (A), lingual (B), mesial (C) and distal (D) views.

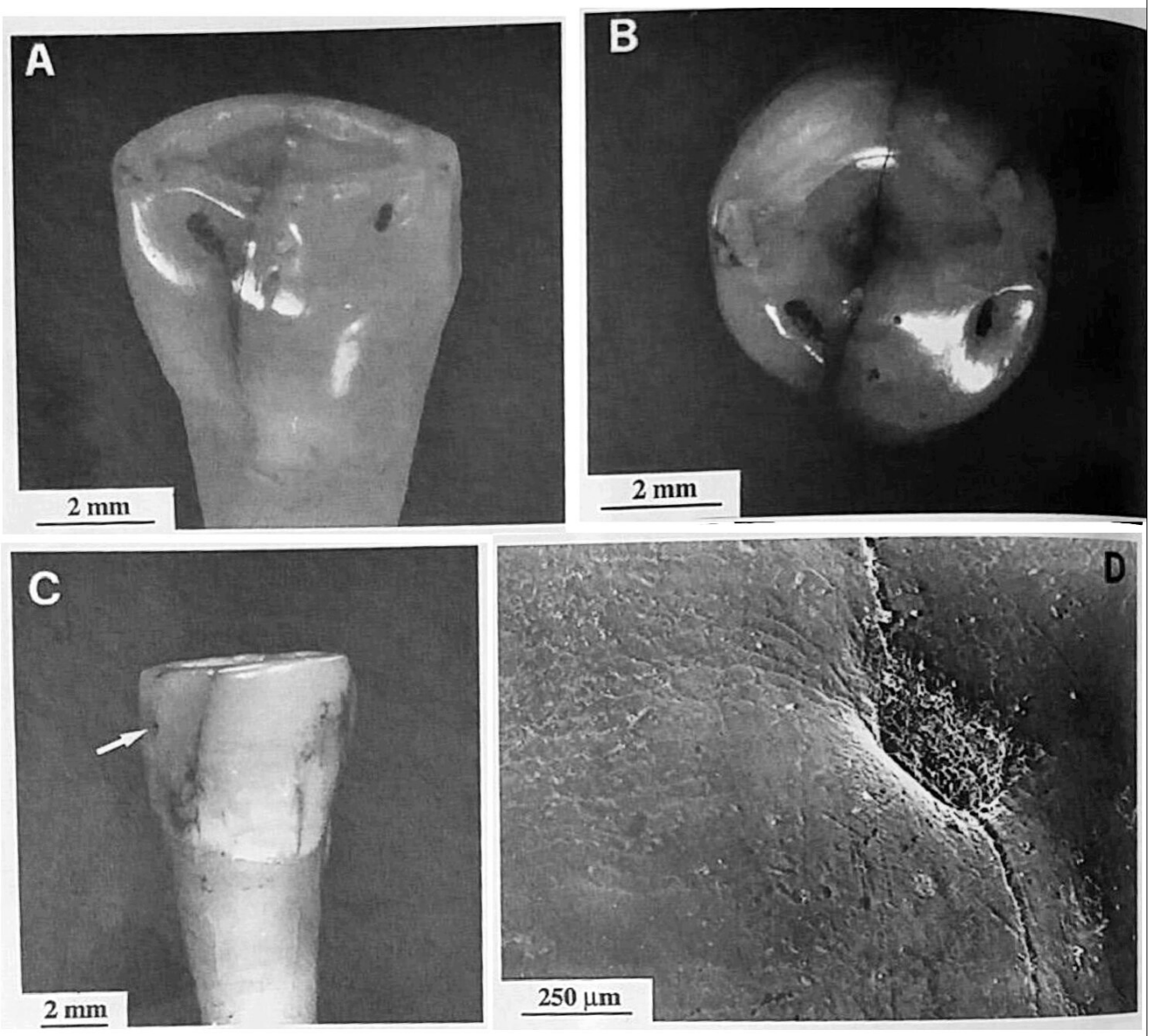
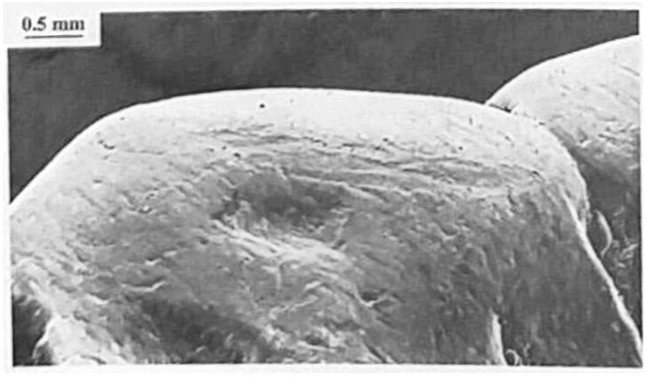


FIGURE 9. Crown of the right lower canine Fenera 4. A: lingual aspect, showing advanced occlusal wear, trace of lingual tubercle and pronounced marginal ridges. B: Occlusal view, showing a broad oval dentine area exposed by wear and rounded enamel edges. C: buccal surface. Arrow indicates a punched-out enamel hypoplasia. D: SEM close-up of the hypoplasia showing anomalous convergence of perikymata towards the hole.

FIGURE 10. Right lower second molar Fenera 2. SEM examination of the tip of protoconide shows a thickly pitted and split surface with few scratches. A small concave dentine area exposed by wear is visible in the middle.



which can also be observed on other archaic hominids (Guerreschi, Giacobini, in print).

The lower molar Fenera 2 has a broad, low crown whose dimensions and robustness index are higher than the mean values of modern humans and correspond to the lower zone of Neandertal variability (Semal 1988). Some characteristics of this tooth, such as the presence of a *fovea anterior* and tendency to apical splitting of the mesial rooth are exceptional in modern humans but frequent in Neandertals. Subvertical grooves identified on the mesial interproximal facet are more typical of Neandertals and only exceptionally observed in modern humans (for review and discussion see Villa, Giacobini 1995). Large and deep (crater-like) hypoplasias similar to that observed on this tooth are rare in modern humans. The hypoplasia of Fenera 2 is similar to that observed on a Neandertal permanent first lower

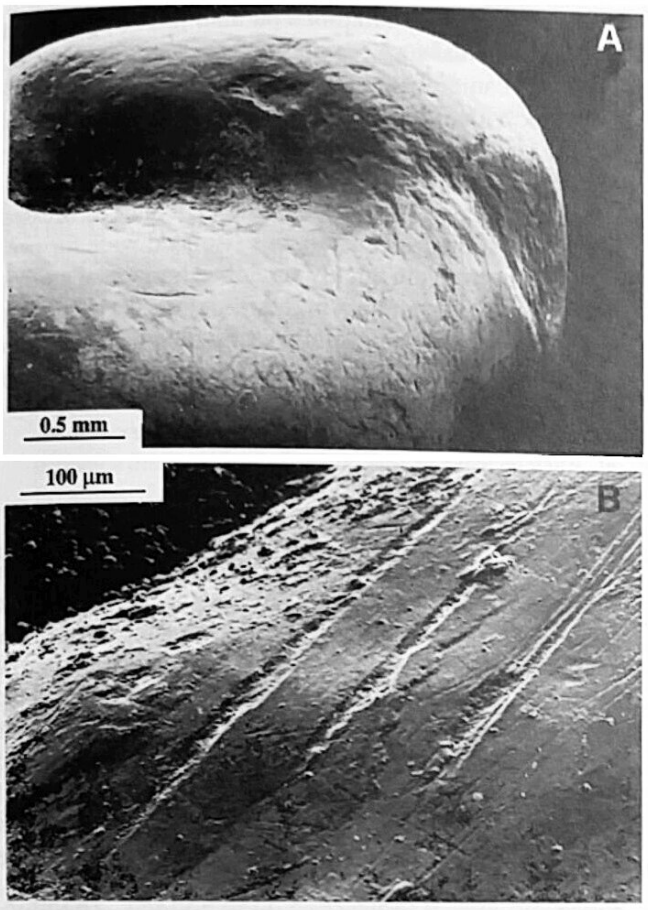


FIGURE 11. Right upper first premolar Fenera 3. SEM examination of the lingual cusp (A) shows a thickly pitted occlusal surface with few scratches. The interproximal mesial surface (B) highlights some furrows roughly parallel to the cervical line.

molar from Caverna delle Fate (Le Fate VI; Giacobini, Lumley 1988).

The first upper premolar Fenera 3 is massive compared to the corresponding tooth of modern humans. Dimensions and robustness index of its crown correspond to the mean of values measured in Neandertals (Semal 1988). The most typical feature is represented by the *tuberculum molare*, but other characteristics are either more frequent in Neandertals or exceptional in modern humans. These characteristics give some degree of molarization to this premolar: depth and complexity of the occlusal sulci, marked development of marginal ridges, depth of mesial and distal fossae, wide angle of the buccal cusp, and splitting of the lingual ridge of the buccal cusp, which is slightly lobed on its buccal aspect. Moreover, a small accessory cusp is present on the occluso-distal margin (interproximal ridge), as observed on the Neandertal upper P4 Hortus III (Lumley 1973). The slight degree of taurodontism demonstrated by the radiogram is frequent in Neandertals.

The lower canine Fenera 4 is relatively small. Its dimensions and robustness index, as in the case of many Neandertal lower canines, fit into the variability of modern humans (Semal 1988). Some Neandertal lower canines, like Hortus 2 and 4, are even smaller than Fenera 4 (Lumley 1973, Semal 1988). It must be noted that the mesio-distal dimension of Fenera 4 appears reduced by marked wear. Some features, such as the trace of lingual tubercle and marked lingual marginal ridges, represent archaic traits.

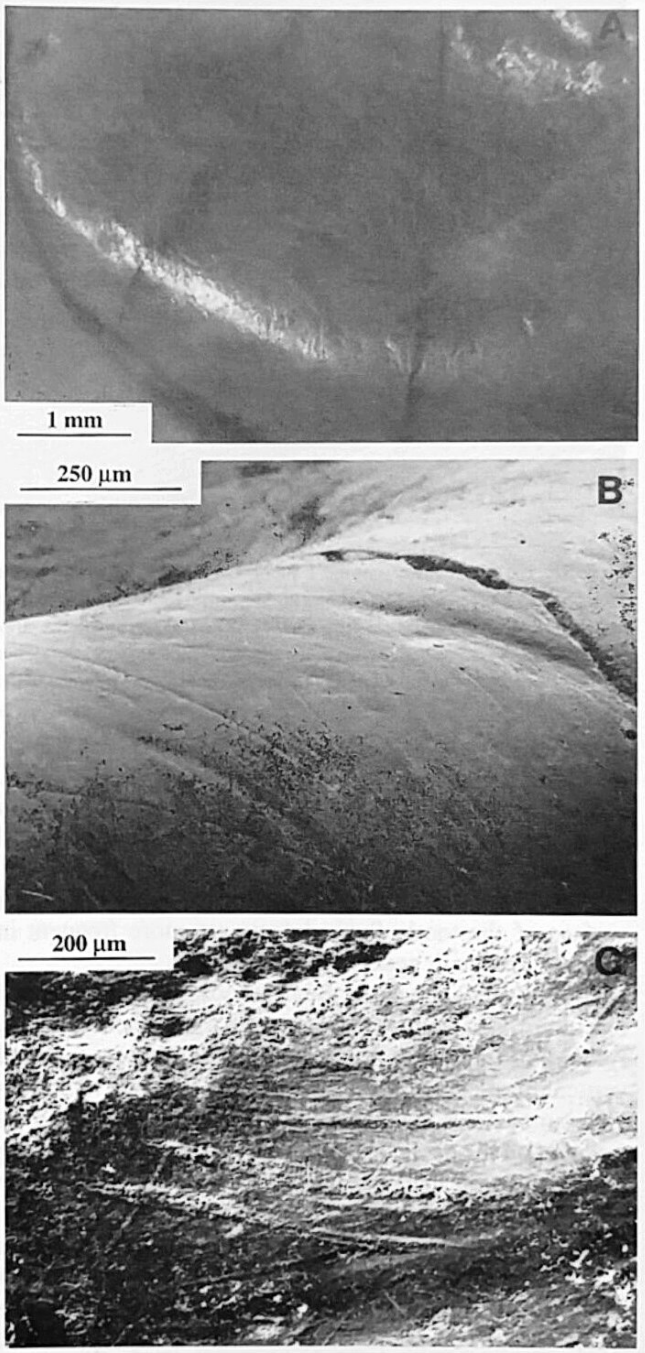


FIGURE 12. Right lower canine Fenera 4. The occlusal surface is characterized by a rounded enamel ridge (A: stereomicroscope photograph). This ridge is hardly scratched linguo-buccally (B: SEM close-up). Sub-horizontal furrows, similar to those identified on Fenera 3 are present on the interproximal mesial surface, close to the cervical line (C: SEM image).

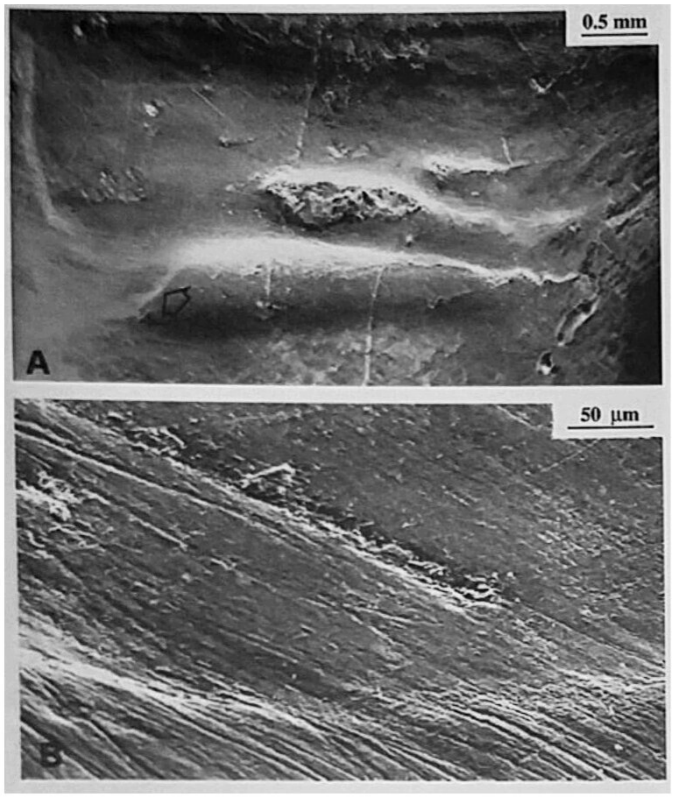


FIGURE 13. Right lower canine Fenera 4. SEM examination of the interproximal mesial surface shows a deep groove on the rooth, near and parallel to the cervical line (A). B: SEM close-up of the area indicated in A (arrow), showing a heavily scratched surface. Scratches are thin, uniformly oriented and fit the unevenness of the cement surface.

Advanced flat occlusal wear and marked antero-posterior scratches are most frequently observed in Neandertal anterior teeth (Molnar 1971).

A punched-out hypoplasia was observed on the buccal surface of the tooth. Such defects are more frequent in fossil hominids in general (Hillson 1986).

Microwear analysis of the posterior teeth Fenera 2 and 3 demonstrated short vertical striae on their buccal surfaces. According to Puech (1983), these data indicate reduced vertical masticatory movement related to a diet including large amounts of vegetable food. Moreover, pits are very frequent on the occlusal surfaces of both teeth, suggesting a diet based on hard and abrasive food, despite the low degree of occlusal wear.

The presence of frequent subhorizontal thin scratches on the interproximal facets of Fenera 2 and 3 is consistent with chewing and tearing fibrous vegetable food. The series of thin scrathes observed on the interproximal surfaces of the lower molar Fenera 2 and lower canine Fenera 4 and which fit the unevenness of the tooth surface do not support the idea of having originated by use of a rigid instrument. They were probably produced by displacement of fibrous abrasive material capable of being deformed.

The series of subhorizontal parallel furrows present on the interproximal surfaces of the upper premolar Fenera 3 and lower canine Fenera 4 were produced during the life of the individual, as demonstrated by SEM observation (*Figures 11B, 12C*). They do not seem to have been produced by tooth function, but may be related to the use of some sharpened, tooth-pick like, tool. It must be stressed, however, that their characteristics (isolated wide furrows) are different from the thickly scratched horizontal grooves observed by many authors in interproximal cervical zones of prehistoric teeth and usually ascribed to habitual tooth-pick use (Bahn 1989, Frayer, Russel 1987, Lalueza *et al.* 1993).

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