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Age-related variability in buccal dental-microwear in Middle and Upper Pleistocene human populations

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ABSTRACT Infants are thought to present a different buccal microwear pattern than adults and these, therefore, are generally analyzed separately. However, El-Zaatari & Hublin [2009] showed that occlusal texture in Neandertal and modern human juvenile populations did not differ from their elders. The microwear patterns of a sample of 193 teeth, corresponding to 61 individuals of *Homo heidelbergensis*, *H. neanderthalensis* and anatomically modern humans (AMH), were analyzed revealing that AMH infants up to 14 years old differ from older individuals in having fewer scratch densities, whereas the Neandertals have a much more variable microwear pattern. Age-at-death and dental age since emergence showed similar though somewhat diverging results, especially in the infant and subadult samples. Differences observed between the Neandertals and modern humans could be reflecting differential wearing patterns or distinct enamel structure and resistance to hard food items consumption. Interpopulation differences in striation densities were not apparent in either subadult or adult individuals, only adult Neandertals (26-45 yrs. old) showed fewer striations than the younger age groups. The AMH sample revealed a gradual cumulative pattern of striation density with age, suggestive of a non-abrupt change in diet.

KEY WORDS: microwear, age, teeth, Neandertals, humans

Dental microwear analysis has been applied both to occlusal surfaces [Ungar *et al.* 1999, King *et al.* 1999], including confocal roughness/texture analysis [Scott *et al.* 2005, El-Zaatari & Hublin 2009, Merceron *et al.* 2010], and buccal surfaces [Pérez-Pérez *et al.* 1994, Romero & De Juan 2007, Pinilla *et al.* 2009, Galbany *et al.* 2009]. Buccal dental microwear analyses on the post-canine dentition have provided valuable information about feeding behavior on both extant primates [Galbany *et al.* 2009] and extinct hominid species [Pérez-Pérez *et al.* 2003, Estebaranz *et al.* 2009]. Unlike

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occlusal surfaces, on which both pits and scratches can be observed, buccal enamel surfaces only show scratches, since tooth-to-tooth contact is lacking. In addition, dentine exposure does not affect microwear feature preservation on buccal enamel surfaces. Enamel *post-mortem* damage affects microwear patterns on both occlusal and buccal enamel surfaces [King *et al*. 1999]. However, *ante-mortem* microwear features on buccal surfaces, caused by food-to-enamel contact, can be easily distinguished [Pérez-Pérez *et al*. 2003], whereas on occlusal surfaces microwear can be produced also by tooth-to-tooth contact, and thus the biomechanics of chewing may affect occlusal microwear patterns. Finally, occlusal microwear patterns seem to be indicative of short-term food consumption, commonly known as “the last supper effect” [Teaford & Oyen 1989], since occlusal microwear is affected by a fast turnover [Teaford & Tylenda 1991]. Thus, seasonality in food consumption also needs to be taken into consideration [Merceron *et al.* 2010]. On the other hand, buccal microwear patterns have been suggested to depend on long-term dietary practices and, thus, might be less sensitive to short or seasonal changes in food consumption [Romero *et al*. 2009]. Therefore, for interpopulation comparisons among groups with distinct dietary-related habits, the inter-group variability of the buccal microwear pattern is expected to be greater than intra-group variability [Pérez-Pérez *et al*. 1994], with the exception, perhaps, of highly stratified populations with significant intra-group dietary differences, such as those observed between males and females of an Islamic population from Spain [Romero & De Juan 2007].

Buccal microwear research has focused mainly on interpopulation differences and studies on intra-individual and intra-group variability are scarce. Intragroupal differences in buccal microwear patterns have been detected in the Spanish medieval site of La Olmeda (12th-18th century AD, Palencia) by Pérez-Pérez *et al.* [1994], showing that buccal microwear patterns can be used to trace both age- and sex-related differences in diet. Age-related analyses have shown that the buccal microwear pattern tends to stabilize at around 13-15 years of age. Romero & De Juan [2007] have also shown that microwear densities tend to increase with age in early prehistoric (Chalcolithic and Bronze Age periods), Islamic (900-1200 AD) and contemporary populations, with ages ranging from 17-25 to 25-35 years old, though differences appeared to be significant only for the Islamic group. However, El-Zaatari & Hublin [2009] found no age-related differences in enamel roughness on either Neanderthals or modern humans (AMH), and so age groups were subsequently analyzed together [Gamza 2010]. However, data on age-related variability in microwear patterns is still lacking, especially for buccal microwear patterns of Middle and Upper Pleistocene human populations, which limits the use and interpretation of microwear patterns. Age-at-death in ancient human populations tends to be low and fossil samples frequently include subadult individuals. Therefore, the aim of this paper was to test if buccal microwear patterns (striation density and average length) of patterns of three Middle and Upper Pleistocene populations (*Homo heidelbergensis*, *Homo neanderthalensis*, and *Homo sapiens*) are dependent on age (both the individual’s age at death and dental age since emergence). If no age related patterns were present, subadult and adult individuals could be grouped in order to increase sample sizes for intergroup comparisons. If it were shown that microwear patterns are age-dependant this limitation to comparisons of buccal microwear patterns needs to be taken into account.

Materials and methods

Sample studied

The hominin fossil specimens studied came from the cast collection housed at the University of Barcelona. The total analyzed sample included 836 teeth corresponding to 174 individuals from Middle to Upper Pleistocene sites, mostly from Europe, and belonging to three distinct hominin species: *Homo heidelbergensis* (N=15, including Kabwe), *Homo neanderthalensis* (N=77, including Tabun 2), and anatomically modern humans (AMH) (N=75, including Skhûl, Border Cave and Cave of Hearths). Negative moulds of the teeth were made using *President MicroSystems*™ (Coltène®, Regular Body) polyvinyl-siloxane and *Feroca*® polyurethane resin (parts A and B) was used to obtain the positive casts. All casts were sputter-coated with a 400 Å gold layer. Age determinations of the fossil specimens studied were obtained from the literature. Since not all fossil specimens initially considered showed both well-preserved buccal microwear and age-at-death determinations, the final available sample used to test for age-related differences in buccal microwear patterns included only 193 out of the 836 analyzed teeth (23.1%), corresponding to 61 out of the 174 initially studied individuals (35.1%). This final sample (Table 1) did not include teeth that were damaged *post-mortem*, and the anterior dentition was not included because the buccal microwear in these teeth can be affected by cultural rather than dietary-related striations [Lozano *et al*. 2008]. As not all teeth erupt at the same age within a given individual, enamel surfaces could have different functional life spans since emergence (microwear patterns can only be formed during the period that the tooth is exposed to abrasive food items) and, thus, microwear densities could be more strongly correlated with age since emergence than with the individuals' age at death. Therefore, tooth age since emergence was computed following Skinner [1997] and teeth were analyzed as independent cases to determine the relationship between age and buccal microwear densities.

Methods

The age-since-emergence of each tooth was computed by subtracting the individual's age-at-emergence from the age-at-death (obtained from the literature). It was beyond the scope of this analysis to speculate on the differences in timing of dental development and emergence between Neandertals and modern humans [Wolpoff 1979, Ramírez-Rozzi & Bermúdez de Castro 2004, Macchiarelli *et al.* 2006, Reid and Dean 2006, Guatelli & Reid 2008, Olejniczak *et al.* 2008, Bayle *et al*. 2009], not to mention *H. heidelbergensis*. Although most studies on dental eruption are based on emergence standards of modern humans [Ubelaker 1978, Williams 2006], a Neanderthal emergence standard [Granat & Heim [2003] was used for both the Neanderthal and *H. heidelbergensis* samples. All the statistical analyses were performed twice, using the two procedures. Age intervals were then established according to previous studies of buccal microwear variability [Pérez-Pérez *et al*. 1994, Romero & De Juan 2007], from which 4 age categories were derived: A1 (0 to 5 years old), A2 (6 to 13 years old), A3 (14 to 25 years old) and A4 (25 to 45 years old).

Table 1. Individuals analyzed in this study for which buccal microwear was preserved and age-at-death established in the literature.

	Site	Specimen	Teeth	Age (yrs.)	Reference	Density
Homo heidelbergensis	ARAGO	A16, A21, A36 (Ind. 1)	$LP^3,M^1,M^2; RP^3, M^2, M^3$	20-25	[Pérez-Pérez *et al.* 2003]	274
		A13 (Ind. 3)	RP_3-M_3	16	[Wolpoff 1999:530]	315
		A40, A68 (Ind. 5)	RM_1-M_2	25-30	[Tautavel Museum]	183
		A6 (Ind. 6)	RM_2	18-20	[Tautavel Museum]	256
		A54 (Ind. 7)	RM^1	18-20	[Tautavel Museum]	386
		A69 (Ind. 8)	RM_2	15-18	[Tautavel Museum]	197
		A7, A25 (Ind. 9)	RP^3, RM_1	10	[Tautavel Museum]	251
	MAUER	MA	RP_3-M_3; LM_1-M_3	18-25	[Kraatz 1992]	231
	PONTNEWYDD	PN4	Rm^2-M^1	8	[Green 1984]	365
	STEINHEIM	ST	RP^4-M^3	25	[Street *et al.* 2006]	141
Homo neanderthalensis	BANYOLES	BA-1	LM_3,RM_3	40	[De Lumley 1973]	189
	GIBRALTAR	GB2	Lm_1-m_2; Rm^1-m^2	5	[Tillier 1982, Williams 2006]	264
	GROTTA BREUIL	GB-2	LM_1	30	[Manzi & Passarello 1995]	262
	GUATTARI	GT-2	RM_3	35-40	[Mallegni 1991, 40; Williams 2006]	300
		GT-3	LM_1-M_2; RM_1-M_3	18-20	[Mallegni 1991]	284
	KULNA	KU-1 A 17 092	RP^3-M^1	14	[Jelinek 1966]	259
	LA QUINA	H-5	LP_3-M_3; RP_4-M_1; LP^3, M^1; RM^1,M^2	< 30	[Trinkaus 1980, 20; Williams 2006]	333
	LE MOUSTIER	LM-1	LP_4-M_2; RP_4-M_2	15.5-16	[Thompson & Bilsborough 1997]	134
	MALARNAUD	MA	RM_1	11.2	[Granat & Heim 2003]	105
	MONT-GAUDIER	MG4	LM_1	12-14	[Duport & Vandermeersh 1976]	179
	MONTMAURIN	MM1	LM_1-M_3; RM_1-M_3	15.5	[Granat & Heim 2003]	277
	OCHOZ	OC-1	LP_3-M_3; RP_3-M_2	25	[Williams 2006]	175
	SAINT CESAIRE	SC1	LP_3;RM_1-M_2; LP^4-M^2; RP^4-M^1	36	[Wolpoff 1999: 689]	197
	SUBALYUK	S-1	RM_1-M_3	25-35	[Pap *et al.* 1996, 25; Williams 2006]	113
	TABUN	TB-1	LP_4-M_2; RP_3,M_1,M_2; LP^4,M^2; RP^3,P^4	30-35	[McCown & Keith 1939]	114
	VINDIJA	VI-11.39 (206)	RM_1	15	[Wolpoff *et al.* 1981]	389
		VI-11.40a (226)	LM_1	19	[Wolpoff *et al.* 1981]	229
	ZAFARRAYA	Z-16	RP_3	12	[Barroso *et al.* 2006]	262

Anatomically modern humans	ABRIC PATAUD	AP1	LM_1-M_2; RP_3,M_1-M_2; RM^1	14-15	[Billy 1975]	222
	ALMONDA	AMD Cisterna 3	Rm_1	2	[Trinkaus pers. com.]	297
		AMD Cisterna1	RM^1	8	[Trinkaus pers. com.]	240
	BARMA GRANDE	BG- 3	LM_1-M_2	12-13	[Fornicola 1989]	210
		BG- 4	LP^4-M^2	14-15	[Fornicola 1989]	358
	BRASSEMPOUY	BR-96/884	LM_2	10	[Gambier *et al.* 2004]	195
	CALDEIRAO	CA11	Rm_2	2-6	[Trinkaus *et al.* 2001]	194
		CA2	Lm_2	10-12	[Trinkaus *et al.* 2001]	209
	CAVE OF HEARTHS	CH005	RP_3, M_1-M_2	12	[Tobias 1971]	274
	COMBE CAPELLE	CC-2	LM_1-M_2; RM_1; LP^4-M^1,M^3	40-50	[Hoffmann & Wegner 2002]	364
	DOLNI VESTONICE	DV-13	LM_2; RP_4,M_2-M_3; LP^3,M^2; RP^4-M^2	21-25	[Trinkaus & Svoboda 2006: 34]	228
		DV-14	RP_3-M_2; LP^3	13-15	[Trinkaus & Svoboda 2006: 35]	225
		DV-15	LP_3-P_4; RP_3-P_4; LP^3-M^1; RP^3-M^2	21-25	[Trinkaus & Svoboda 2006: 37]	218
		DV-31	RM_3	21-25	[Trinkaus & Svoboda 2006: 40]	318
		DV-37	LM_2	16-20	[Trinkaus & Svoboda 2006: 41]	299
		DV-III	LP_3-P_4; LP^3,M^2	36-45	[Trinkaus & Jelínek 1997]	271
	FARINCOURT	Farincourt 1960-7	RP_4	11	[Skinner 1997]	234
	LACHAUD	Lachaud 1980-6 Lachaud 3	LM_2	18.6	[Skinner 1997]	247
		Lachaud 1980-8-1 Lachaud 5	LM_2	15.8	[Skinner 1997]	187
	LE MOURIN	Le Mourin2	RM_1	11-12	[Bouvier, 1971]	124
	LES ROIS	Les Rois A 1958-148-1	RM_1	10-11	[Mouton & Joffroy, 1958]	260
		Les Rois B 1965-148-2	LP^4	11	[Mouton & Joffroy, 1958]	302
	MLADEC	Mladec 1	RM^2	16-17	[Wolpoff *et al.* 2006]	364
		Mladec 2	LM_1-M_3; RM^1	17	[Wolpoff *et al.* 2006]	284
		Mladec 8	LM^1,M^2	35	[Frayer *et al.* 2006]	331
	PAVLOV	Pavlov 1	LP^3; RM^2	36-45	[Trinkaus & Svodoba, 2006: 42]	306
		Pavlov 2	LM^1; RP^3-P^4, M^2	26-35	[Trinkaus & Svodoba, 2006: 42]	377
		Pavlov 28	LM_3	18-35	[Trinkaus & Svodoba, 2006: 44]	293
	PŘEDMOSTI	A17088	LM_1-M_3; RM_2	25-30	[Veleminska & Bruzek, 2008]	323
	SKHUL	Skhul 5	RM_1, M_3	30-40	[Johanson & Blake, 1996]	138
	SOLUTRE	Solutre 1956-49	Lm_2	5	[Skinner, 1997]	190
	ST. GERMAIN LA RIVIÈRE	St. Germain La Rivière B3	Rm_2	7	[Skinner, 1997]	203
	ST. GERMAIN LA RIVIÈRE	St. Germain La Rivière B5-7	Lm_2	5	[Skinner, 1997]	165

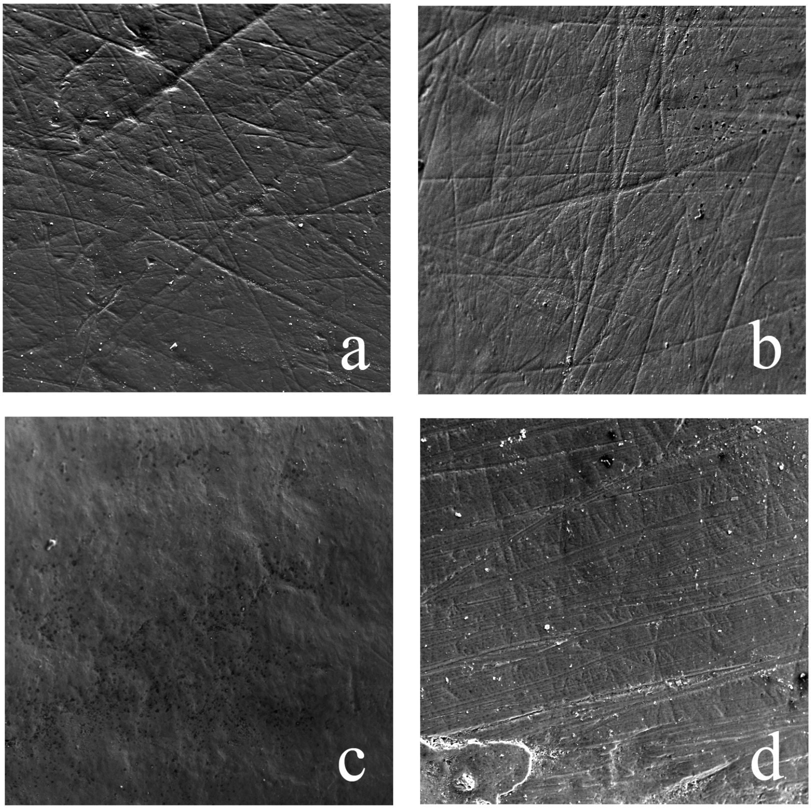

Fig. 1. Buccal microwear surfaces: a) Neandertal well preserved enamel surface of specimen VI-11.39 206 from Vindija (Croatia), RM_1; b) Neandertal well-preserved enamel surface of La Quina V (France), RM_1; c) Unemerged tooth from Engis (Belgium), RM_1 (lacking enamel microwear features); d) Modern human enamel of a *post-mortem* damaged enamel from Dolni Vestonice (Czech Republic), specimen III, LP^4.

Scanning electron micrographs were taken using Leica 360 (*Parc Científic de Barcelona*) and Hitachi S3000N (SSTT *Universidad de Alicante*) scanning electron microscopes (SEM), following standardized microwear procedures [Pérez-Pérez *et al.* 2003, Galbany *et al.* 2009]. SEM images (Fig. 1), taken at 100X magnification and processed in Adobe Photoshop CS-5, were cropped to exactly cover 0.56 mm^2 square enamel patch and grey levels were automatically adjusted to increase image contrast. Scratch density and length (in µm) were measured with *Sigma Scan* 5.0 (SPSS Inc.). A total of 15 variables were derived, including the density (NT), average length (XT) and standard deviation of the length (ST) of all observed striations by orientation categories: horizontal (H), vertical (V), mesio-distal (MD) and disto-mesial (DM)), as well as for all the scratches (T) (see Pérez-Pérez *et al.* [2003] and Galbany *et al.* [2009] for a detailed description of variable definitions). All images were analyzed by the same researcher (BP) in order to prevent interobserver errors [Galbany *et al.* 2005].

All statistical analyses were performed with SPSS 15 for Windows™. Kolmornov-Smirnov tests were used to check for the Normality of the analyzed variables and one-way ANOVA and MANOVA tests were used to check for significant differences ($P<0.05$) among age groups. Principal Component (PCA) and Discriminant analyses (LDA) were used to describe group similarities in buccal microwear patterns.

Results

If dental emergence ages were taken into account, no significant differences in total striation density were observed in either the *H. heidelbergensis* (N=31, F=0.723, P=0.494) or the modern humans (N=90, F=1.772, P=0.159) samples. For the *H. heidelbergensis* sample age groups A2 (N=4), A3 (N=27) and A4 (N=1) were represented, while for the AMH sample all four age groups were represented (A1, N=4; A2, N=13; A3, N=48; A4, N=25), as was also the case for the Neandertal sample (A1, N=4; A2, N=3; A3, N=48; A4, N=25). However, significant age-related differences were observed only in the Neandertal sample (N=80, F=7.470, P=0.000). The *post-hoc* test within the ANOVA showed that differences in striation densities were exclusively due to differences between A3 and A4 (P=0.000), with the A3 (14-25 years old) group showing significantly higher striation densities than A4 (>25 years old). Interestingly, the subadult groups (A1 and A2) did not show significant differences in striation density compared to the adult ones (A3 and A4) in any of the groups compared.

If a combined factor of population group (*H. heidelbergensis*, *H. neanderthalensis* and *H. sapiens*) and age-at-death was used to test for differences in striation density, an overall significant ANOVA value was obtained (N=201, F=3.518, P=0.000), indicating that in addition to the already detected age difference between A3 and A4 for the Neandertals, interpopulation differences were also detected. In fact, the *post-hoc* tests showed that the only significant differences in striation density observed were between groups A3 (NT=289.98) and A4 (NT=188.32) for the Neandertals (P=0.000), already discussed above, and between the Neandertal A4 group and the AMH A3 (NT=269.88, P=0.009) and A4 (NT=293.80, P=0.001) groups. Thus, the Neandertal A4 (26-45 years old, N=25) group showed a distinct but characteristically small striation density (Fig. 2).

Finally, if the median number of striations of all available teeth per individual was selected as representative of the striation density of each studied specimen, as a microwear methodological standardization [Pérez-Pérez *et al*. 2003 Galbany *et al*. 2009, Pinilla *et al*. 2009, Estebaranz *et al*. 2009], ages-at-death group comparisons of the 59 studied individuals showed no significant differences between the groups. In summary, the Neanderthals and *H. heidelbergensis* samples did not show significant age related differences in striation densities, which may support the hypothesis that the Neanderthals infants, and for the same reason also those of *H. heidelbergensis*, could have had a wider dietary range, overlapping that of older individuals, than modern humans (AMH), as suggested by El-Zaatari & Hublin [2009]. A consistent increase in scratch density from infancy to adulthood can be observed for the modern human sample (Fig. 2). Striation densities tend to increase, or at least stabilizes, in older groups, with younger individuals having fewer scratches – a pattern not seen in either *H. heidelbergensis* or Neandertals. The *H. heidelbergensis* sample was not represented by individuals younger than 6 years

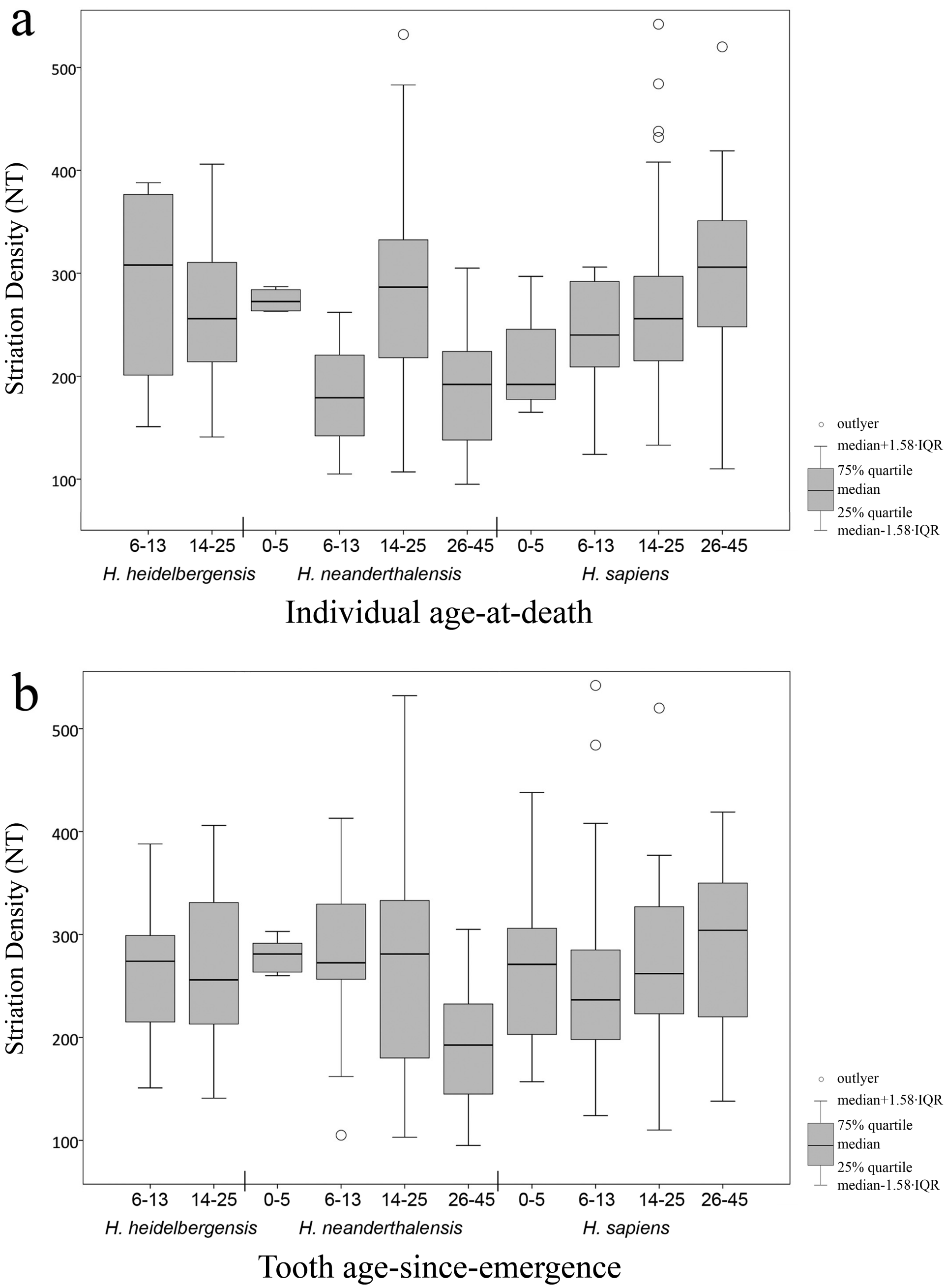

Fig. 2. Box plots showing the variability of striation density (NT) for the 3 populations considered (*H. heidelbergensis*, *H. neanderthalensis*, and *H. sapiens*) by age groups (0-5, 6-13, 14-25, 26-45 years old): a) striation densities by individual age-at-death, b) striation density by dental age-since-emergence; inter-quartile range (IQR) = 75% quartile - 25% quartile.

old or by individuals older than 25 years, and thus a detailed age analysis could not be made. The Neanderthal sample was well represented and individuals older than 25 years had fewer scratches than the younger groups. This decrease in striation density with age needs to be carefully considered since the available samples for each age group are still small. However, in the AMH group a steady increase of striation density with age-at-death was observed (not so clear-cut if dental age since emergence was considered), which clearly differentiates AMH infants (with less scratches) from elder individuals – a pattern not observed in *H. heidelbergensis* or Neandertals. The consistent increase in striation density in AMH from 6 to 45 years of age is consistent with the described cumulative nature of the striation pattern, in which striations are added one on top of the other until the more recent ones 'erase' the older ones as the enamel turnover maintains the stability of the microwear pattern.

Discussion

Intrapopulation comparisons of striation densities were necessarily limited, since not all teeth were preserved in all individuals and not all age groups were represented in all populations. However, this research provides relevant information about buccal microwear formation rates by age groups in ancient human populations. The buccal microwear pattern is a characteristic trait of a population that depends on its dietary habits, food processing techniques, and feeding behavior [Pérez-Pérez *et al*. 1994, Romero & De Juan 2007]. Age-related variability might be linked to changes in food consistency in infants and elders as Pérez-Pérez *et al.* [1994] pointed out. Moreover, concerning children, dietary changes at the end of weaning are likely to have relevant consequences in microwear densities. Neandertal infants from 2 to 5 years showed larger striation densities than those from 6 to 13, which could be indicative that weaning occurred at an early age in this group, with young infants having a significantly abrasive diet compared to subadults; an alternative explanation would be that enamel of deciduous teeth is less resistant to abrasion than that of the permanent dentition. Only in the AMH sample does the microwear density increase from infants to subadults, which could reflect a progressive increase in harder foods consumption, perhaps after weaning, as has already been shown by Pérez-Pérez *et al.* [1994]. However, this may have been due to shorter life expectancies within the nomadic prehistoric hunter-gatherers studied here than in a sedentary medieval population.

Although Pérez-Pérez *et al.* [1994] suggested that the buccal striation pattern might be dependent on both the individual's age-at-death and tooth age-since-emergence, as expected if the pattern is a dynamic, cumulative process during the individual's life, the results found here fail to show such clear cumulative microwear formation process in the archaic humans, and only in modern humans did the age-at-death analysis of striation density show a clear cumulative pattern. In the ancient groups, once erupted, a tooth seems to quickly attain its functional microwear pattern. However, enamel structure, biomechanical and functional factors are likely to be responsible for a larger fraction of the variability observed. A more detailed investigation, with larger samples, is still needed to understand the pattern formation of the buccal microwear and how differences in age of emergence may affect the microwear in more recent populations. Macrowear and dentine exposure results [Skinner 1997] have suggested that Neandertal infants might have had more abrasive diets than modern human infants. Striation densities of infants were shown to be larger in Neandertals than in humans only if age-at-death, instead of dental age since emergence, was used (Fig. 2). If these lower striation densities in AMH is confirmed, cultural differences in modern humans, such as stone boiling practices and soup consumption in the Upper Paleolithic humans [Hadingham 1979, Pfeiffer 1986], or still later in the Late Upper Paleolithic [Nakazawa *et al*. 2009], might explain the results obtained.

Conclusions

The buccal microwear striation pattern is a characteristic trait of a population reflecting long-term dietary shifts. Results from this study indicate that infants have a consistently high-density microwear pattern, similar to that of the adult individuals in all three populations studied: *Homo heidelbergensis*, *Homo neanderthalensis* and *Homo sapiens* (anatomically modern humans). The shift towards adult dietary behavior appears to have taken place at around 13 years of age. From this age onwards, age did not seem to affect the microwear pattern observed in the archaic humans, whereas in modern humans a cumulative pattern with age was observed. Therefore, the individual age-at-death should be taken into account when analyzing buccal microwear, especially in children. When analyzing the same ages, infant feeding behavior appears to have been different among the species, especially in AMH, whose infants seem to have less abrasive dietary habits compared to their predecessors. However, these results need to be considered along with changes in geography [Pinilla *et al*. 2009], chronology and climate [Pérez-Pérez *et al*. 2003, Pinilla *et al*. 2009], all of which might have played an important role in food availability and consumption in Paleolithic hominins.

Notes

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Streszczenie

Policzkowe mikrostarcie zębów wykazuje charakterystyczne, trwałe i zależne od diety cechy. Na materiałach historycznych wykazano [Pérez-Pérez *et al.* 1994], że w analizie trzeba uwzględniać również wiek osobnika, szczególnie u dzieci, które mają zarówno zęby mleczne, jak i świeżo wyrżnięte zęby stałe. W populacjach górnoplejstoceńskich zbadano jednak tylko mikrostarcie na zgryzowych powierzchniach zębów. Ostatnio El-Zaatari & Hublin [2009] stwierdzili brak związanych z wiekiem różnic w nierównościach szkliwa, i to zarówno w populacjach neandertalskich, jak i u człowieka anatomicznie nowoczesnego (AMH), wobec czego grupy reprezentowane zębami mlecznymi można analizować łącznie ze stałymi [Gamza 2010].

Dla populacji historycznych wykazano, że wzór mikrostarcia stabilizuje się około 13 roku życia, niezależnie od zęba (m2, M1, M2). Nie próbowano jednak badać procesu tej stabilizacji u prehistorycznych łowców-zbieraczy. Celem tej pracy jest ustalenie, w jakim wieku wzór policzkowego mikrostarcia stabilizuje się u środkowo- i górnoplejstoceńskich osobników i przetestowanie różnic między wzorem mikrostarcia u dorosłych oraz u dzieci i osobników dorastających. Badana próba zawierała 836 wysokiej rozdzielczości odlewów zębowych, dostępnych na uniwersytecie w Barcelonie. Zęby należały do 174 osobników z trzech populacji: *Homo heidelbergensis*, *H. neanderthalensis* i *H. sapiens* (AMH). Zęby, na których nie zachowało się policzkowe mikrostarcie lub od osobników o nieustalonym wieku wyeliminowano, podobnie jak wszystkie zęby przednie. Ostatecznie próba liczyła 193 zęby 59 osobników. Wiek zębowy od momentu wyrżnięcia obliczano za Skinnerem [1997]. Dla AMH wiek wyrzynania przyjmowano za Ubelakerem [1979] i Williamsem [2006], a dla *H. neanderthalensis* i *H. heidelbergensis* – za Gramat & Heim [2003].

Powierzchnie policzkowe zębów były skanowane SEM zgodnie ze standardową procedurą [Pérez-Pérez *et al.* 2003, Galbany *et al.* 2009]. Z obrazów SEM wycięte zostały fragmenty szkliwa o powierzchni 0,56 mm^2, na których zliczano rysy przy pomocy półautomatycznego oprogramowania. Uwzględniano gęstość, długość i odchylenie standardowe długości wszystkich zauważonych prążków w kategoriach ich orientacji (pionowe, poziome, mezjo-dystalne i dysto-mezjalne oraz wszystkich orientacji łącznie. Przedstawiana analiza dotyczy jednak tylko ogólnej gęstości prążkowania. W analizie statystycznej wykorzystano SPSS 15.

Ponieważ gęstość prążkowania ma rozkład normalny, do porównań międzygrupowych zastosowano testy parametryczne (ANOVA). We wszystkich trzech badanych populacjach osobniki w wieku poniżej 5 lat wykazywały gęstość prążków podobną do osobników dorosłych. Choć u neandertalczyków w wieku 6-13 lat gęstość prążkowania wyraźnie malała, co mogło korespondować z wyrzynaniem się M1, w grupie AMH dzieci miały rzadsze prążki niż starsze osobniki i wykazywały ciągły wzrost gęstości z wiekiem. Zmienność mikrostarcia u osobników w wieku dziecięcym może być związana z procesem przechodzenia na pokarm stały, który u AMH polegał na stopniowym włączaniu do diety twardszych składników, jak również obróbki termicznej [Hadingham 1979, Pfeiffer 1986, Nakazawa *et al.* 2009].

Z tej pracy płyną następujące wnioski: Wzór policzkowego mikrostarcia jest charakterystyczny dla każdej populacji i odzwierciedla długotrwałe zwyczaje żywieniowe. Uwzględniać należy wiek w chwili śmierci, szczególnie dla osobników przed 13 rokiem życia. Przejście od diety dziecięcej na dorosłą mogło zachodzić stopniowo u AMH, podczas gdy u neandertalczyka wcześnie ujawnia się wzrost gęstości prążków, prawdopodobnie odzwierciedlając przechodzenie na dietę z produktami wywołującymi większą abrazję. Zmienność wewnątrzpopulacyjna – czasowa, geograficzna i klimatyczna – może oznaczać, że te czynniki mogły wpływać na dostępność różnych składników pokarmu.