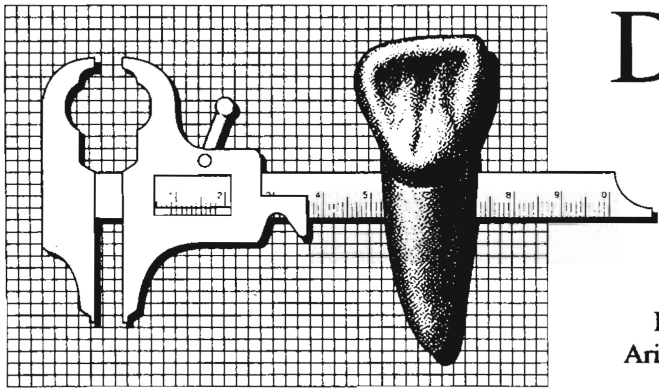

Dental Anthropology Newsletter

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THE DENTAL ANTHROPOLOGY ASSOCIATION WORLD WIDE WEB SITE

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At our annual business meeting we decided that creating a DAA World Wide Web site would be a good way to increase the association's visibility and to promote the exchange of educational, scientific, and scholarly knowledge in the field of dental anthropology. I volunteered to work on this project and have created a DAA web site that you can reach at : http://www.sscf.ucsb.edu/~walker/

I have kept the page simple so that it can be accessed easily by people with different types of computer equipment. It contains information on how to join the association, how to sponsor DAA members, how to communicate with the association's officers, and other basic information on the association's goals and activities. For the edification of the parliamentarians among us, I have included a copy of the association's constitution and by-laws. Another page is devoted to the DAA Newsletter and provides information on our editorial policies and how to submit articles for publication. There is also a page that lists articles published in recent DAA newsletters.

Although most of the information on our web site is directed towards attracting new association members, I have created two pages that current members will be interested in. One page contains links to web sites with information of interest to dental anthropologists. I especially recommend the University of Toronto Dental Faculty's "Links of Dental Interest" and the "Dental Related Resources" pages. Through them you can access hundreds of sites with information on dental pathology, periodontics, forensic dentistry, odontology, professional associations, and so on. I have also included links to sites with information on fossil hominids, human evolution, morphometrics, and sources of odontometric instruments such as digital calipers that output measurements directly to computers. If you know of other sites of interest to dental anthropologists, tell me about them so I can link them to our page.

Another area of our web site that will be of general interest is an image archive with photos of teeth you can download and use in your teaching and research. The archive includes mesial, distal, buccal, and lingual views of every tooth in the human permanent and deciduous dentitions. These images were produced for a computer program my students and I wrote to teach dental anatomy and tooth identification.

Let me know what you think about our web site and the direction we should take in developing it. I am especially interested in expanding the image archive and am looking for volunteers who are willing to help me create sections with photos of dental pathologies, dental histology, non-metric traits, and non-human primate dentitions. I have also talked to DAA members about the possibility of having an archive of tooth measurements on the web site with data bases that can be downloaded and used in odontometric research. Although the standardization of the measurements in such an archive poses some problems, it could become a very useful dental anthropological resource. I welcome your comments and suggestions concerning how we can improve our web page and make it as useful as possible for our members.

CERVICAL ENAMEL PROJECTIONS AND ENAMEL PEARLS IN A COLLECTION OF AUSTRALIAN EXTRACTED MOLARS

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ABSTRACT Cervical enamel projections (CEPs) and enamel pearls (EPs) are generally located on permanent molars. They are detected less frequently in Caucasian than in Mongoloid teeth. No data are available documenting these features in teeth collected in Australia. The aim of this study was to determine the frequency and degree of expression of CEPs and EPs in a large sample of Caucasian deciduous and permanent extracted dried molars. The molars were examined under a stereomicroscope, and only those with intact CEJ (cemento-enamel junction) and bifurcation were scored for CEPs and EPs. Scoring of CEPs was based on the classification system of Zee et al. (1991).

Genuine CEPs were observed in 19.1% of the 282 deciduous molars and 44.0% of the 2827 permanent molars examined. In deciduous molars, CEPs were regularly seen on the lingual surface of mandibular second molars, with the Grade I type being most common. In permanent molars, CEPs were generally seen on the buccal surface of mandibular second molars, with the Grade III type being the most frequent. External composite EPs were observed in 1.1% of deciduous molars and 3.3% of permanent molars examined. EPs in permanent molars were frequently detected in maxillary third molars on the distal or mesial surfaces. The results obtained in this study are in broad agreement with previous investigations of Caucasian extracted molars. However, we noted a higher frequency of CEPs in permanent molars than did other studies and found that the Grade III type of CEP occurred most frequently. A modification is proposed to the Zee et al. (1991) scoring system: inclusion of Grade IIIc being a CEP consisting of droplets of enamel streaming toward the furcation. CEPs and EPs are of clinical importance, as they have been implicated as contributing factors in localized periodontal lesions.

INTRODUCTION

Extensions of enamel from the cemento-enamel junction onto the root surface have been termed cervical enamel projections (CEPs). CEPs are divided into two basic types depending on their location in relation to the root topography (Carlsen, 1967). Genuine CEPs are found in a definite and direct topographical relationship to either a bifurcation or a root groove leading to root separation. False CEPs have no direct topographical relationship to either a bifurcation or a root groove. Genuine CEPs are the most commonly observed type, whereas false CEPs occur rarely.

Masters and Hoskins (1964) classified CEPs as follows: incipient CEP — a slight deviation of the cemento-enamel junction towards the furcation, Grade I — a distinct change in the cemento-enamel junction with enamel projecting toward the bifurcation, Grade II — enamel projection approaching the furcation but not making contact with it, Grade III — enamel projection extending into the furcation proper, Grade IIIa — a long, slender enamel projection extending into the furcation proper, Grade IIIb — an enamel projection which is interrupted or displays a discontinuous extension into the furcation proper. Figure 1 shows the different types.

CEPs are very rarely seen in deciduous teeth or in permanent incisors, canines, or premolars. Studies of extracted molars have concluded that CEPs are most commonly found in permanent molars with a greater frequency in Asian groups compared with Caucasians (Kawasaki et al., 1976; Zee et al., 1991). The majority of CEPs are of the Grade I type and often occur on the buccal surface of mandibular second molars (Masters and Hoskins, 1964; Grewe et al., 1965; Leib et al., 1967; Tsatas et al., 1973; Risnes, 1974a). However, in Asian groups the Grade III type is the most common (Kawasaki et al., 1976; Zee et al., 1991). One CEP per root surface is usually observed, but up to three genuine CEPs can occur on one tooth.

Enamel pearls (EPs) are discrete masses of enamel found on the root surface. They have been classified into two main groups: external (true and composite) and internal. External (extradental) enamel pearls are found external to

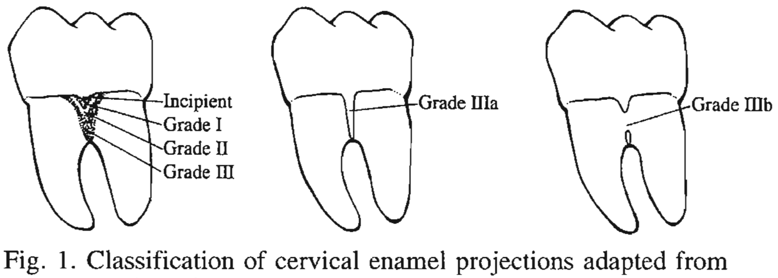

Fig. 1. Classification of cervical enamel projections adapted from Masters and Hoskins (1963) and Zee et al. (1991).

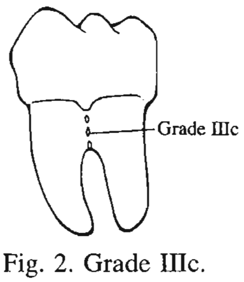

Fig. 2. Grade IIIc.

dentine on the root surface. True (simple) enamel pearls are composed of enamel only. They are less than 0.3 mm in diameter, and difficult to diagnose macroscopically. Composite enamel pearls are composed of a core of dentine covered by a layer of enamel. Pulpal tissue may or may not be found within the pearl. These are variable in size (usually greater than 0.3 mm in diameter) and are seen macroscopically. Composite enamel pearls are the most commonly described type of EP in the literature. Internal (intradental) enamel pearls are found within dentine. They occur on three surfaces: coronal, cervical and, radicular; and are not seen macroscopically.

In general EPs are rarer than CEPs. External composite EPs are very rarely seen in the deciduous dentition or in permanent incisor, canine or premolar teeth. They are usually found on permanent molars with a low prevalence in both Caucasian and Asian populations (Cavanha, 1965; Risnes, 1974b; Loh, 1980). Enamel pearls are more frequently observed in permanent third molars than on the other teeth: on the mesial and distal surfaces of maxillary molars and on the buccal and lingual surfaces of mandibular molars (Cavanha, 1965; Risnes, 1974b; Loh, 1980).

A CEP and an EP can occur together on the same surface of a tooth. A CEP may join and touch an EP or stop short of it. A CEP can also be found on one surface (e.g. buccal) and an EP on another surface (e.g. lingual) (Risnes, 1974a,b). Pedersen (1949) and Risnes (1974b) thought that EPs were closely related to a tendency toward CEPs. Most recent studies, however, show no statistically significant association between the CEP and the EP (Loh, 1980; Chan et al., 1988).

MATERIALS AND METHODS

The teeth used in this study were obtained from a large collection (The Ramsey Smith Collection) of Caucasian dried extracted teeth. They were collected predominantly from 1900 to the 1930's in South Australia. A total of 1702 deciduous and 5106 permanent teeth were examined. Only those teeth with an intact cemento-enamel junction and root furcation were examined for CEPs and EPs.

The teeth were gently cleaned with hand scalers in regions where calculus obscured the cemento-enamel junction or the furcation area. They were then classified as maxillary or mandibular molars and separated into first, second, and third molar teeth. The criteria of Jordan, Abrams, and Kraus (1992) for number and size of cusps, occlusal and proximal surface, and number and morphology of roots were used to classify maxillary and mandibular teeth as first, second, or third molars. If any molar could not be positively identified, it was classified as an "unidentified tooth," but still examined for CEPs and EPs.

The teeth were initially examined with the naked eye. The Zee et al. (1991) classification system for CEPs was a more appropriate system than that of Masters and Hoskins (1964) because the it is more descriptive than the older system. In addition, another form of Grade III CEP that did not appear in either classification was apparent in the sample. This was a series of enamel nodules directed toward the root furcation region. This type of CEP was classified as Grade IIIc (Fig. 2).

The teeth were then viewed under a stereomicroscope (Olympus) with 1.5x magnification and scored for the presence/absence of CEPs and EPs, the surface(s) on which the CEPs and EPs appeared, the number of CEPs and EPs per tooth, and the grade of CEP. A note about whether or not a CEP and EP were joined together was also made.

A randomly selected sample of 100 molars was selected and re-examined on a separate occasion. Concordance for scoring presence/absence on both occasions was 99.0%. Frequencies of both traits were similar in both the sub-sample and the main sample.

RESULTS

Genuine CEPs in Deciduous Molars

A total of 282 deciduous molars were suitable for examination. Genuine CEPs were observed in 54 teeth (19.1%), which contained a total of 68 CEPs (Tables 1a and 1b). CEPs were more commonly found in mandibular second molars (55.9%) than in first and third molars.

Table 1c shows that for all molars, most CEPs were seen on the lingual surface (47.1%). The most common type of CEP was the Grade I (98.5%). The only other type of CEP observed was one example of Grade IIIa. Table 1d shows that most molars exhibiting CEPs had one CEP per tooth (75.9%). In those teeth with two or more CEPs per tooth, most had identical types on opposite root surfaces. Two false CEPs were detected.

External Composite EPs in Deciduous Molars

Only three of the 282 deciduous molars exhibited EPs (1.1%). Each had only one EP. Two of the EP's were observed on the buccal surface of mandibular second molars, while the third EP was seen on the mesial surface of a maxillary first molar. All molars with EPs also had a CEP on the same surface. One tooth had an EP and a Grade I CEP on the buccal surface. The second tooth had an EP and a Grade I CEP on the mesial surface. The third tooth had a Grade IIIa CEP and an EP (which were actually touching) on the mesial surface.

TABLE 1a. Number of deciduous molars with CEPs.

Molars with CEPs		Molars without CEPs		Total	
N	%	N	%	T	%
54	19.1	228	80.9	282	100.0

N is number. T is total number, % is N/T or T/T.

TABLE 1b. Distribution of CEPs according to deciduous molar tooth type.

Maxilla				Mandible					
First molar		Second molar		First molar		Second molar		Total	
N	%	N	%	N	%	N	%	T	%
7	10.3	18	26.5	5	7.3	38	55.9	68	100.0

TABLE 1c. Distribution of CEPs in all deciduous molars.

	Surface									
	Mesial		Distal		Buccal		Lingual		Total	
Grade	N	%	N	%	N	%	N	%	N	%
I	11	16.2	5	7.3	19	27.9	32	47.1	67	98.5
II	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
III	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
IIIa	0	0.0	0	0.0	1	1.5	1	0.0	1	1.5
IIIb	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
IIIc	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
Total	11	16.2	5	7.3	20	29.4	32	47.1	68	100.0

TABLE 1d. Number of deciduous molars with 1, 2, or 3 CEPs.

1 CEP		2 CEPs		3 CEPs		Total CEPs	
N	%	N	%	N	%	T	%
41	75.9	12	22.2	1	1.9	54	100.0

Genuine CEPs on Permanent Molars

A total of 2,827 permanent molars was suitable for examination for genuine CEPs and external composite EPs. Of this total, 2,597 molars (1,033 maxillary and 1,564 mandibular) were positively identified and 230 molars (87 maxillary and 143 mandibular) were unidentified.

Genuine CEPs were observed in 1,245 of the total number of molars (44.0%). Some teeth had more than one CEP, making the total number of CEPs 1,649. The majority of the CEPs (69.6%) were in mandibular molars (Tables 2a and 2b). Most of the CEPs appeared on mandibular second molars (29.4%), with the maxillary third molars (7.5%) exhibiting the least number of CEPs (Table 2b).

Table 2c shows that for all molars, most of the CEPs was detected on the buccal surface (67.3%), with the least on the mesial surface (5.8%). The most frequently occurring type of CEP was Grade III (57.9% for Grades III, IIIa, IIIb, and IIIc), followed by Grade I (38.4%), with the least common being Grade II (3.6%). Examination of the different subtypes of Grade III further showed that Grade III (22.3%) was the most frequently observed, followed by Grade IIIb (21.9%), Grade IIIa (11.1%), and Grade IIIc (2.6%).

Table 2d shows that those molars with CEPs usually had one CEP per tooth (70.0%). A maximum of three genuine CEPs per tooth was seen. Those with two or three CEPs per tooth usually had identical types of CEPs on opposite root surfaces. False CEPs were also identified.

External Composite EPs in Permanent Molars

Enamel pearls were observed in 94 (3.3%) of the total number of permanent molars, with a total of 108 EPs observed (Some teeth had more than one EP). More EPs were detected in maxillary molars (88.9%) than in mandibular molars (Tables 3a and 3b). The maxillary third molar exhibited the greatest number of EPs (54.6%), with the mandibular first molar exhibiting the least number of EPs (2.8%) (Table 3b). Most of the EPs were found on the distal (45.4%) and mesial surfaces (41.7%) as shown in Table 3c. One EP was usually observed per tooth (87.3%), although up to three EPs per tooth were detected (Table 3d). If two or more EPs were seen, they were usually on opposing root surfaces.

Association between EPs and CEPs in Permanent Molars

Of the 108 EPs identified, 53 had no associated CEP on the same surface. Thirty-five EPs had no associated CEP on the same surface, but a CEP occurred elsewhere on the tooth. Twenty EPs had a CEP occurring on the same surface, but none were found to be touching. Ten of these CEPs were Grade I; five were Grade II; and five were Grade III. Thus, a CEP occurred on the same surface as an EP in 18.5% of the cases. A chi-square test showed a statistically significant association ($p<0.05$) for expression on the same tooth, irrespective of surface.

DISCUSSION

In general, the results obtained for EPs in this study are in agreement with those obtained in previous investigations for Caucasian molars (Cavanha, 1965; Risnes, 1974b). An interesting finding from this study was that the frequency of CEPs in permanent molars is 10 to 20% greater than that reported previously for Caucasian molars (Masters and Hoskins, 1964; Grewe et al., 1965; Leib et al., 1967; Tsatas et al., 1973; Risnes, 1974a). Our sample size was larger than previous studies and may, therefore, provide a more accurate estimate of the frequency of CEPs in Caucasians than do previous reports. However, difference in scoring methodology may exist between investigators. Another area of contrast was that the most frequent grade of CEP observed in this study is the Grade III.

Some similarity in the results was obtained for CEPs in both deciduous and permanent dentitions: that is, most CEPs occur on mandibular second molars. If a CEP exists, it is the only one on the tooth. However, some CEP results differ. Deciduous molars have a lower frequency of CEPs than do permanent molars. CEPs were more frequently seen on the lingual than on the buccal surface in deciduous molars. Grade I is the most frequent type of CEP seen in deciduous molars, whereas Grade III predominates in permanent molars.

Use of a stereomicroscope assisted in determining whether or not a CEP had reached the furcation entrance, as well as in providing a clearer image of CEPs and EPs than did macroscopic examination. The point at which the furcation entrance began was difficult to establish especially where roots were fused.

Differences in the distribution of CEPs and EPs in the different molar groups in this and previous studies may be attributed to the way in which the molars were identified. Many investigators do not state how teeth were identified and whether any problems were encountered. Risnes (1974a,b) is an exception. This study showed that correct tooth identification can be a difficult task, especially for a novice. Molars can be wrongly identified given variation in crown and root morphology and the condition of the teeth in the sample. Use of identification criteria (e.g. Jordan, Abrams, and Kraus, 1992) can be of great value in reducing misclassification. Incorrect identification of the different molars could lead to over- or under-estimation of the distribution of CEPs and EPs.

The Zee et al. (1991) modification to the grading of CEPs provides a more descriptive classification system than the Masters and Hoskins (1964) system alone. However, some CEPs cannot be adequately described by this classification. These are the CEPs which have an unusual shape.

Turner et al. (1991) have provided a metrically-based scoring system following Pedersen's (1949) classification. Their scores 1, 2, and 3 correspond to grades 1, 2, and 3 of the Zee et al. (1991) classification system. Although a metric system may help to reduce inter-observer variability, some problems of interpretation remain. Examples are placement of calliper beaks on curved root surfaces and determination of the precise location from which

TABLE 2a. Number of permanent molars with CEPs.

Molars with CEPs		Molars without CEPs		Total	
N	%	N	%	T	%
1,245	44.0	1,582	56.0	2827	100.0

TABLE 2b. Distribution of CEPs according to permanent molar tooth type.

	First molar		Second molar		Third Molar		Unidentified		Total	
	N	%	N	%	N	%	N	%	T	%
Maxilla	150	9.1	188	11.4	123	7.5	41	2.3	502	30.4
Mandible	277	17.0	484	29.4	259	15.7	127	7.7	1147	69.6

TABLE 2c. Distribution of CEPs on permanent molar tooth surfaces.

	Mesial		Distal		Buccal		Lingual		Total	
Grade	N	%	N	%	N	%	N	%	N	%
I	66	4.0	92	5.6	268	16.3	209	12.7	635	38.5
II	2	0.1	7	0.4	43	2.6	8	0.5	60	3.6
III	6	0.4	10	0.6	344	20.9	7	0.4	367	22.3
IIIa	6	0.4	10	0.6	159	9.6	8	0.5	183	11.1
IIIb	9	0.6	26	1.6	289	17.5	37	2.2	361	21.9
IIIc	7	0.4	13	0.8	7	0.4	16	1.0	43	2.6
Total	96	5.8	158	9.6	1110	67.3	285	17.3	1649	100.0

TABLE 2d. Number of permanent molars with 1, 2, or 3 CEPs.

1 CEP		2 CEPs		3 CEPs		Total CEPs	
N	%	N	%	N	%	T	%
872	70.0	342	27.5	31	2.5	1245	100.0

TABLE 3a. Number of permanent molars with EPs.

Molars with EPs		Molars without EPs		Total	
N	%	N	%	T	%
94	3.3	2,733	96.7	2827	100.0

TABLE 3b. Distribution of CEPs according to permanent molar tooth type.

	First molar		Second molar		Third Molar		Unidentified		Total	
	N	%	N	%	N	%	N	%	T	%
Maxilla	4	3.7	26	24.1	59	54.6	7	6.5	96	88.9
Mandible	3	2.8	4	3.7	5	4.6	0	0.0	12	11.1
Total	7	6.5	30	27.8	64	59.3	7	6.5	108	100.0

TABLE 3c. Distribution of EPs in permanent molars.

	First		Second		Third		Unidentified		Teeth	
Surface	N	%	N	%	N	%	N	%	N	%
Mesial	2	1.8	14	13.0	27	25.0	2	1.8	45	41.7
Distal	4	3.7	12	11.1	28	25.9	5	4.6	49	45.4
Buccal	1	0.9	2	1.8	1	0.9	0	0.0	4	3.7
Lingua	0	0.0	2	1.8	7	6.5	1	0.9	10	9.2
Total	7	6.5	30	27.8	63	58.3	8	7.4	108	100.0

TABLE 3d. Number of permanent molars with 1, 2, or 3 EPs.

1 EP		2 EPs		3 EPs		Total Teeth	
N	%	N	%	N	%	T	%
82	87.3	10	10.6	2	2.1	94	100.0

to measure CEP form. Furthermore, the Turner et al. (1991) classification records any extensions that are not attached to the tooth crown as being absent.

In this study the incipient form of CEP was not scored. No other previous study with which we are familiar has scored them either. The incipient form is envisioned as a slight dip in the cemento-enamel junction toward the root surface, and not a true CEP. In this study, accurately distinguishing between a Grade I CEP and an incipient form could be difficult. This problem in grade assessment could result in incorrectly scoring Grade I CEPs.

Distinguishing between Grade II and Grade III CEPs was difficult in a few cases in which the exact point at which the furcation entrance could not be established. This type of difficulty can result in an underestimation of Grade II/III or and overestimation of Grade II/III CEPs.

Use of extracted teeth did not allow determination of possible gender differences in the frequency and distribution of CEP and EP. Previous studies using skeletal material have lacked reports about sex differences. Therefore, assessment of a large sample of skeletal material would be worthwhile.

CEPs and EPs are more than just an anatomical curiosity. They have definite clinical implications in some patients. In a clinical study, Hou and Tsai (1986) found a statistically significant association between molars with Grade II and III CEPs and respective furcation lesions. Other studies report a junctional epithelial attachment to enamel on the root surface, which is seen as less favorable than a connective tissue attachment (Masters and Hoskins, 1964; Grewe et al., 1965; Hou and Tsai, 1987). Hence these anatomical features may be one of many other factors that can contribute to periodontal lesions in some individuals. Further clinical studies are required to investigate this issue.

CONCLUSIONS

First, the frequency of genuine CEPs in the sample of extracted deciduous molars was 19.1% and the frequency of EPs was 1.1%. CEPs were commonly found on the lingual surface of mandibular second molars, with Grade I the most common grade. Second, the frequency of genuine CEPs in the sample of extracted permanent molars was 44.0% and the frequency of EPs was 3.3%. CEPs were commonly found on the buccal surface of mandibular second molars, with Grade III the most common grade. EPs were commonly found on the distal/mesial surfaces of maxillary third molars. Third, a modification to the Zee et al. (1991) classification system, involving addition of a Grade IIIc, is proposed (Fig 2). Fourth, use of a stereomicroscope and well-defined identification criteria (e.g. Jordan, Abrams, and Kraus, 1992) are important for distinguishing between different molar types when recording CEPs.

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ABRASION OF TEETH IN POPULATION GROUPS FROM HISTORICAL PERIODS IN THE REGION OF FORMER YUGOSLAVIA

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ABSTRACT This study investigated the frequency, type, and degree of abrasion on permanent teeth from 694 skulls from archeological sites dating from the beginning of the first century AD to the beginning of the twentieth century in the former Yugoslavia. The conclusions are: 1) 100% of the specimens had dental abrasion; 2) the Roman Age and the Middle Ages teeth had a horizontal-vertical type of abrasion, while New Age teeth had a predominantly horizontal type of abrasion; and 3) Roman Age and the Middle Ages groups had the most severe loss of dental hard tissue.

INTRODUCTION

Dental abrasion is seen in all time periods during the development of the human race, in all geographical regions, and among all races. That the type of abrasion changed with time and that abrasion was much more pronounced in prehistoric than contemporary humans is generally accepted. This change in intensity of abrasion is supported by findings on Cro-Magnon man from Djerdap and on Neanderthal man from Krapina (Živanovič, 1984). Brothwell (1965) also stated that dental abrasion was much less pronounced in recent "civilized" groups than in ancient and contemporary primitive populations.

The idea of studying dental abrasion on historical anthropological material from the geographic region of former Yugoslavia originated from the above observations. The goal was to supplement the existing knowledge about this phenomenon and to enrich it with new information. The specific aims of the study were to evaluate the frequency, the types and intensity, and the factors which contribute to the existence of dental abrasion. An additional goal was to obtain an insight into the dynamics of this phenomenon during the last twenty centuries and to observe possible differences between the ancient and the contemporary population of Yugoslavia.

MATERIALS AND METHODS

A methodological approach to the study of dental abrasion requires a clarification of the terms abrasion and attrition, because they are variously explained and applied in literature. According to some (Shafer, 1974; Colbi et al., 1979) attrition and abrasion are not synonyms. Attrition denotes a physiological wear of the dental hard tissue caused by mastication and the abrasive effect of food, while abrasion is designated as a mechanical form of attrition. According to Hillson (1986) attrition is formation of well-defined wear facets where teeth meet in chewing, often with fine parallel scratches resulting from the abrasive in food, while abrasion is a more diffuse wear occurring outside the occlusal zone, with scratches randomly oriented. Botsher (1963), defines abrasion as the normal or abnormal loss of tooth structure, caused by physiological or pathological forces, resulting from the rubbing of teeth against one another or against abrasive substances, while attrition is defined as a normal loss of dental substance caused by physiological forces. According to Botsher's (1963) definition, abrasion has a broader meaning that of Hillson (1986). Abrasion encompasses attrition as a physiological phenomenon. Therefore this paper is based on Botsher's (1963) concept of abrasion as the starting point and reports on physiological and pathological wear of dental hard tissue.

Research was done on 694 skulls of both sexes ranging between 20 and 70 years of age. Information on sex, age, and the time period from which the specimens originated was obtained from documents. Material was grouped according to historical periods. The Roman Age is represented by 218 specimens from Viminacium near Belgrade. The Middle Ages are represented by specimens from archeological sites in the former Yugoslavia (Vinča, Knin, Skelani, and Bobovac). The New Age is represented by 160 skulls from a sizable osteological collection in the Institute of Anatomy in Zagreb.

Table 1. Types and stages of dental abrasion in former Yugoslavia samples.

Time	Type of Abrasion		Stage I Abrasion	Stage II Abrasion	Stage III Abrasion	Stage IV Abrasion
		%	%	%	%	%
Roman Era	Horizontal	55.0		87.7	8.2	4.1
	Horizontal-vertical	45.0		84.8	13.0	2.2
Middle Ages	Horizontal	41.7	47.0	53.0		
	Horizontal-vertical	58.3		84.8	13.0	2.2
New Ages	Horizontal	95.0	43.4	56.6		
	Horizontal-vertical	5.0		100.0		

Dental abrasion, if present, was categorized into three types: horizontal, vertical and horizontal-vertical abrasion. The horizontal type of abrasion is characterized by

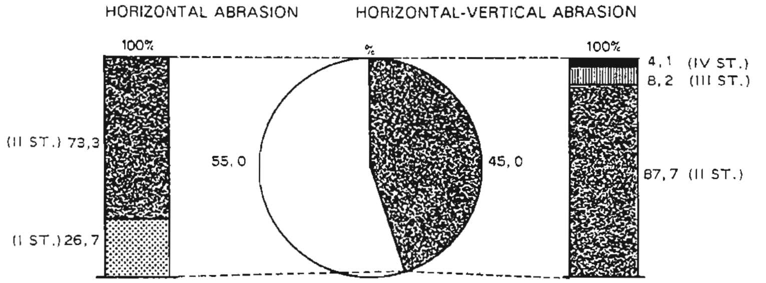

Fig. 1. Abrasion of teeth in the Roman Age sample. Numbers are given as percentages.

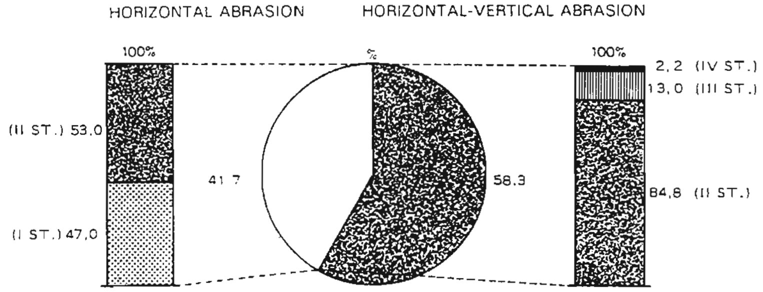

Fig. 2. Abrasion of teeth in the Middle Ages sample. Numbers are given as percentages.

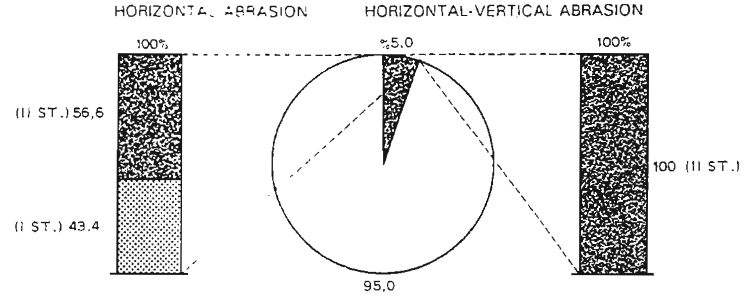

Fig. 3. Abrasion of teeth in the New Age sample. Numbers are given as percentages.

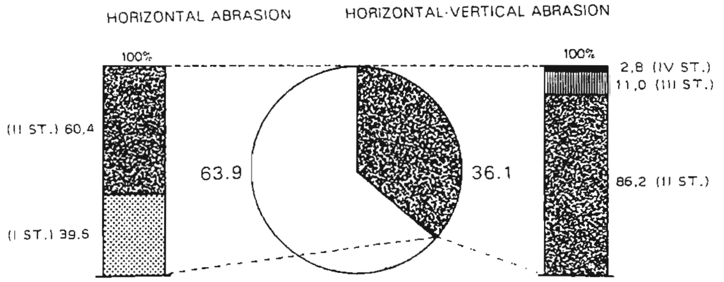

Fig. 4. Abrasion of teeth in the entire historical period. Numbers are given as percentages.

the presence of a flat abraded surface which is formed in a horizontal plane. The vertical type of abrasion is characterized by abraded facets with both a vertical and a horizontal dimension. The horizontal-vertical type of abrasion contains elements of the horizontal and vertical types on the same tooth. Abrasion is categorized into four stages: Stage I (worn enamel), Stage II (wear into the dentine), Stage III (wear involving pulp exposure), and Stage IV (completely worn tooth crown).

RESULTS

Every specimen in the entire sample (100.0%) has evidence of dental abrasion. The Roman Age sample has a higher frequency (55.0%) of the horizontal type of dental abrasion than the horizontal-vertical type (45.0%) (Table 1). The cases of horizontal abrasion are categorized into Stages I or II; whereas specimens with horizontal-vertical abrasion are separated into Stages II (87.7%), III (8.2%), and IV (4.1%) (Table 1) (Fig. 1).

In the Middle Ages, unlike the Roman Age, the horizontal-vertical type of abrasion predominates (58.3%) over the horizontal type (41.7%). Within the horizontal-vertical type of abrasion, Stage II (84.8%), Stage III (13.0%) and Stage IV (2.2%) were reported, while within the horizontal type only Stages I (47.0%) and II (53.0%) occurred (Table 1) (Fig. 2).

In the New Age sample practically all (95.0%) cases of abrasion are of the horizontal type (Stage I at 43.4% and Stage II at 56.6%). The remaining 5% are horizontal-vertical type (Stage II, 100.0%) (Table 1) (Fig. 3).

Review of the data (Table 1) shows that Stage II wear is the most frequent over the three time periods. The Roman and Middle Ages samples are similar to one another, because both have Stages III and IV abrasion. However, the New Age sample lacks these stages.

Figure 4 illustrates that over the entire period of study, the horizontal type of abrasion is present in 63.9% of the specimens and the horizontal-vertical type, in 36.1%. No cases of vertical dental abrasion were found in the entire sample. Other authors (Perović et al., 1970) have also found vertical abrasion to be less frequent than the other two types. All four stages of wear of teeth are present, with Stage II predominating.

DISCUSSION

The dominant opinion is that causes of abrasion should be sought in food quality and type and in the mode of processing. Therefore, solid, raw food with many foreign particles (sand, pebbles, bits of animal bones), which was consumed by our ancient ancestors, resulted in intensive, often excessive tooth wear. In contrast, contemporary refined, soft, well-cooked food requires little mastication and causes only a small amount of wear on such a hard substance as tooth enamel and dentin.

This observation is supported by the work of Pedersen (1949), who found abnormal dental wear in Eskimo women was caused by chewing leather. Kandić (1976) mentions that Eskimos from the northern coast of Alaska, who ate fish, which had been preserved by covering with sand and dehydrated, had very pronounced dental abrasion. Colbi et al. (1961) cite examples of populations from India, the Philippines and Indonesia, who use the fruit of a tropical palm mixed with calcium from shells and palm leaves as an agent to provoke a feeling of well-being. This combination leads to intensive abrasion of anterior teeth.

On the other hand, Kandić (1976), indicates that dental abrasion exists even in individuals who consume very soft food, involving negligible contact rubbing of teeth during mastication. In addition, functional stress caused by non-physiological factors is a key factor in superfluous dental wear. Bunting and Hill (1940) stress that nervous stress is one of the important factors in the appearance of abrasions. Perović et al. (1970) state that dental abrasion is quite prevalent in individuals whose occupation involves arduous physical labor, and that it very intensive in rural populations. All of the facts presented here suggest that dental abrasion has a complex and more complicated etiology than initially appears, and that research of abrasion as a function of food consumption is unilateral, but not negligible.

As the results of the study of the historical period show, dental abrasion is present in every specimen (100.0%). This result was to be expected, keep in mind that our research encompassed adults (20-70 years of age). Even 20-year old specimens can have Stage I abrasion on the incisal edges of anterior teeth or on protuberances of molars (Fig. 5).

Research of contemporary populations of the former Yugoslavia (Perović et al., 1970) reports the frequency of abrasion at 73.2%. This pronounced contrast may be due to different methodological criteria. More likely, the decrease in abrasion confirms the opinion that abrasion was more frequent on teeth of ancient populations than on those of contemporary people. However, individual variations in the assessment of dental abrasion by various researchers possibly lead to the difference.

A detailed analysis of the types of abrasion examined in this study (Figs. 1, 2 and 3) shows that in the Roman Age and the Middle Ages, the horizontal and horizontal-vertical types of abrasion were practically equally frequent. In contrast, the horizontal type of abrasion shown in Figs. 6, 7, and 8 was dominant in the New Age (95.0%).

Results of research on modern populations are similar, with the horizontal type of abrasion predominating (73.99%) (Perović et al., 1970). This situation is difficult to explain, considering that the type of abrasion is determined by the interrelationship of teeth within jaws during occlusion and articulation. When incisors overlap minimally, the jaw moves freely resulting in the horizontal type of abrasion. In contrast, a deep bite contributes to the occurrence of the vertical type of abrasion.

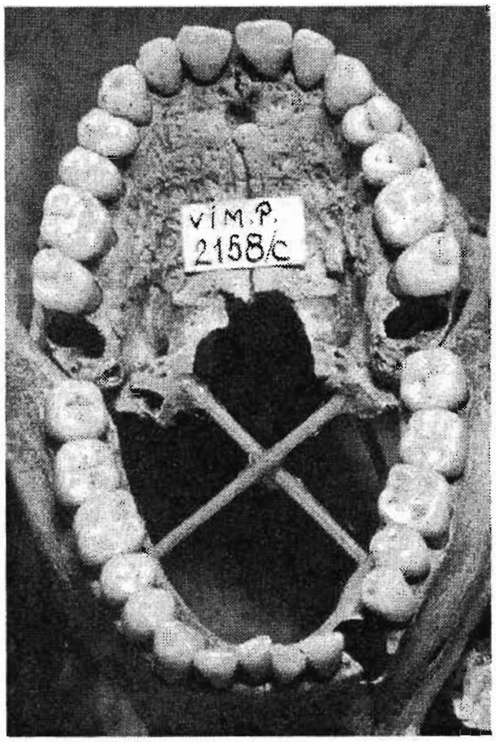

Fig. 5. Stage 1 of abrasion in an individual aged 25 years (Roman Age).

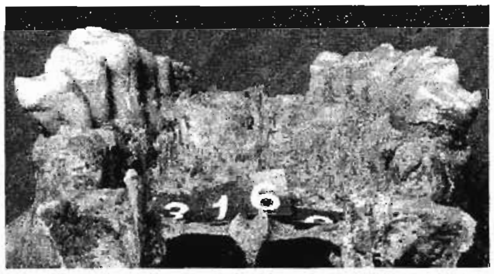

Fig. 6. Abrasion of the horizontal-vertical type, Stages II and III (Roman Age).

Fig. 7. Horizontal abrasion of teeth, Stage II (Roman Age).

Explaining that Stage III and Stage IV tooth wear is reported only from the Roman and Middle Ages samples is easy (Fig. 9). Possible causal factors in wear of these stages were the consumption of natural, crude and abrasive

Fig. 8. Horizontal abrasion of teeth, Stages II and III (Middle Ages).

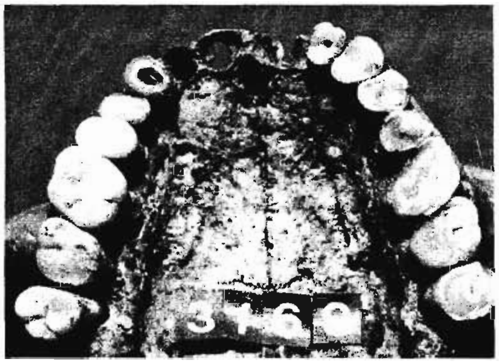

Fig. 9. Abrasion, Stages II, III, and IV (Roman Age).

food (Bisel, 1989; Trojančevič. 1986) or the presence of abrasive substances in food accompanied by powerful mastication.

Brothwell (1963) states that the baring of pulp as a consequence of attrition was present in the Stone Age, especially in the Mesolithic Era. With cultural development this phenomenon became more rare. This was confirmed in a study of Egyptian dynasties from the pre-dynastic period to the early Christian period. A similar observation was stated by Leigh (1934) and Thoma (1917).

A few remarks concerning caries and abrasion are noteworthy. Intensive tooth wear of teeth increases the susceptibility to caries development. Bisel (1989), explains the good dental health among citizens of Herculaneum based on this concept. However, caries causes destruction of the tooth crown faster than does abrasion. It may be best to consider this relationship to mean that crude food and strong mastication (which contribute to wear of teeth) assist in the self-cleansing of teeth thus decreasing the possibility of caries development. However, if the process of caries formation had already begun, the wear would be much more pronounced than if the tooth were intact. Kandić (1976) also concludes that abrasion of teeth is more frequent in individuals who have many caries, teeth with fillings, and extracted teeth.

CONCLUSIONS

Based on all of the above, the following conclusions are possible. First, the frequency of abrasion on the researched material was 100%. Second, in the Roman Age and the Middle Ages the horizontal-vertical type of abrasion predominated, and in the New Age the horizontal type of abrasion predominated. Third, no cases of the vertical type of abrasion were found on any of the skeletal materials studied. Fourth, Stage II abrasions are most common in all three periods studied. Fifth, Stage III and Stage IV abrasions were observed on teeth from the Roman Age and the Middle Ages. Sixth, more intensive dental abrasion in the Roman Age and the Middle Ages samples, as compared to the New Age, is caused by of nutrition among other factors.

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DENTAL DEVELOPMENT STANDARDS FOR THE PRE- AND POST-CONTACT ARIKARA

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INTRODUCTION

The purpose of this paper is to examine the evidence for or against the creation of dental development standards specific to the Arikara population and, by extension, to Native American samples. The research is based on radiographic and macroscopic analysis of a sample of pre- and post-Contact Arikara subadult mandibles.

A total age was determined for each specimen in this sample based on the Moorrees, Fanning, and Hunt Method (1963a,b). Four mandibular teeth for each specimen were then examined specifically to assess: 1) the degree of crown and root development with respect to one another and to tooth development patterns for a reference standard as displayed by the MFH method; and 2) the degree of dental eruption with respect to one another and the Hurme, Moyers, and Ten State Nutritional Survey Standards.

The method of Moorrees, Fanning, and Hunt, based upon a European-derived sample, is thought to provide the most discrimination and best reproducibility (Smith, 1991; Saunders, 1992; Saunders et al., 1993). In the MFH method (based on material from the Fels growth study), radiographs of six mandibular teeth (left canines to third molars) were taken on 246 North American children of European ancestry at half-yearly intervals. Diagrams were produced which specified the mean age of crown and root development and calcification to be expected at each interval. In order develop the MFH method for all eight teeth in the left lower quadrant, data for the Fels sample were pooled with those for a separate sample of 99 children from the Stuart collection of Boston. This, then, is the MFH standard to which dental development in the Arikara sample is compared. The MFH method has been used so widely that a considerable body of data has been accumulated which should permit inter-population comparisons.

A consensus in favor of creating and using individual standards for each population sampled has never developed, however. Although some authors (Davis and Hagg, 1994; Hagg and Matsson, 1985; Staaf et al., 1991) have used the Demirjian data (Demirjian et al., 1985; Demirjian 1986) to demonstrate systematic interpopulation differences, none of their results exceed the intra-sample variance. Moreover, none have done comparative studies employing the MFH method.

Owsley and Jantz (1983) suggested that variation over time in dental development is a real phenomenon and that European-derived children's dental development is qualitatively different from that of Native American populations. These workers cite evidence that the mandibular permanent second molar erupted before the mandibular second premolar in past and present Native American populations. Some of the information on which this observation is based, however, lacks data obtained by analysis of radiographs. Therefore, the degree of relationship between eruption patterns and intra-alveolar crown and root development is unclear.

In order to determine whether a population specific standard is required for historic or prehistoric European-derived and Native American samples, identical methods (specifically, the MFH method) should be applied to skeletal samples of relevant groups. If genes determine eruption times and root elongation occurs only in response to the primary eruptive force (Moyers, 1988), the presence of different eruption patterns would suggest a different genetic pattern requiring a sample-specific dental development standard.

Eruption data in living populations are based upon intraoral observations of tooth emergence through the gingiva (Steggerda and Hill, 1942; Kent et al., 1978; Mayhall et al., 1978; Smith and Garn, 1987). Whether eruption into the mouth has any distinct relationship with the initial resorption of the overlying alveolus is unclear. In fact, the intervals from alveolar resorption to occlusion vary widely from tooth to tooth (12-20 months) and within populations (Moyers, 1988).

Comparability of data for living and skeletal samples is extremely problematical. No data for time of eruption through the gingiva exist for skeletal populations in which the only comparable data are those for emergence through the alveolus. To compound the problem, the overlying alveolus may have been so fragile that taphonomic processes destroyed it, creating the impression of an earlier eruption time than had actually occurred.

Much less guesswork is involved in comparing dental development stages assessed radiographically than those evaluated visually. However, only radiographic data may be equated properly with radiographic data. Results of comparisons of actual teeth with radiographic standards for root and crown development (Owsley and Jantz, 1983; Owsley, pers. comm.) may not be accurate for two reasons. First, radiographic standards are based on visualization of root structures which are radiographically opaque, because tooth structure must be at least 70.0% calcified to be visible radiographically (Goaz and White, 1994). Thus, root structure seen macroscopically on a skeletal tooth might not be visible on an x-ray. Second, taphonomic processes, particularly in teeth avulsed from the alveolus post mortem, may have resulted in the loss of incompletely calcified root structure in quantities approximating the result of radiographic "burn out" in living patients. Unfortunately, no good studies have shown the percentage of partially calcified dentin that may be lost after burial and before recovery. Thus, determination whether or not comparable stages scored by gross examination of the burial specimen are being equated accurately with the appropriate radiographic standards is impossible.

Finally, in this study, as well as in all studies of skeletal samples for which no burial records exist, chronological age is unavailable. Therefore, while dental age is well-correlated with chronological age in modern children

(Demirjian et al., 1985; Demirjian, 1986), the correlation is not perfect. This introduces another source of inaccuracy in the equation which is, unfortunately, unavoidable. The possibility exists that both sexes are unequally represented in this skeletal sample and in others. If one sex is significantly under-represented, the assumption may be invalid that dental ages of specimens may be compared properly to averaged means of male and female attainment of comparable dental development stages (Smith, 1991; Tomkins, 1996).

MATERIALS

The sample consists of 53 subadult specimens in the Arikara collection in the Smithsonian Institution, Washington, D.C. The materials came from sites in South Dakota and date from 900 to 1832 AD. Teeth evaluated were the permanent mandibular canine, first and second premolar, and second permanent molar. Where a tooth was missing, its antimere was substituted.

This study addresses itself to the issue of whether or not the permanent second molar in this sample was significantly advanced in its development over that of the other teeth, whose developmental schedule significantly overlaps that of the second molar. Therefore, in each specimen, one representative of the permanent canine, first premolar, second premolar, and permanent second molar was also analyzed individually. The incisors and third molars were not analyzed separately because the development of the root apices of the incisors are completed early in the development of the second molar and the development of the third molar is variable.

For selection as subadults, specimens had to fulfill criterion 1, 2, or 3, and also 4 (Bass, 1987) of the following criteria: 1) the erupted third molar was unworn and had incomplete root development; 2) the third molar was in the process of erupting; 3) the third molar was unerupted; and 4) the basioccipital suture was not closed.

METHODS

The MFH system was used to determine dental age by reference to the radiographic images and of actual teeth. The male and female standards of the MFH method were averaged because previous attempts (Owsley, 1982) to determine the sex of a sample via discriminant analysis of tooth size did not produce a bimodal distribution in this sample. Moreover, the discriminant function failed to accurately identify the sex of the few specimens for whom sex determination via pelvic shape had been noted in the Smithsonian Institution archives.

For the radiographic analysis, three to four periapical radiographs were taken for each of the mandibles, depending on the size of the specimen. To obtain maximum detail and to avoid "burning out" partially calcified root structure, exposure timing was adjusted so that larger and denser mandibles were exposed at 0.30 second, while 0.25 second exposures were sufficient for smaller specimens or the anterior portion of the arch (Goaz and White, 1994). A GE100 Dental X-Ray Machine at 15 MA and 60 KVP, using Kodak DF 54 Ultra-Speed dental x-Ray film in adult and pediatric sizes were employed.

Age estimation was done by assessing the degree of crown and root development observed in the radiographs. All teeth judged to have been at less than the closed root apex stage were scored. Teeth with closed apices were assigned the mean age at apex completion for that tooth if the age was no more than 6 months younger or older than the dental age of other teeth with incomplete apices in the same specimen. Teeth with closed apices were dropped in cases where their age of completion was more than six months younger than that of teeth with incomplete apices.

When an individual had both developing permanent teeth and overlying deciduous teeth in the process of resorption, both were assigned a dental age according to the MFH methods (Moorrees et al., 1963a,b). If a discrepancy between the assigned ages of the deciduous tooth and its developing permanent successor occurred, the dental ages were averaged.

When the second molar root apices were complete, the developmental stage of the third molar was used to estimate age. Developing third molars, however, were not scored where the apex of the second molar was not complete. The third molar was evaluated only to improve age discrimination in second molars obviously older than the age assigned by root apex completion, because the developmental stages in the third molar vary broadly (Kullman et al., 1992; Mincer et al, 1992).

For the visual evaluation, the 53 cases were examined macroscopically for eruption of the mandibular permanent canine, first and second premolar, second permanent molar, and total dental age using the MFH method. Only teeth with moderate (W_2) or less wear were assessed for eruption level. Only teeth at eruption levels beyond the cemento-enamel junction of the first molar (E_3 and E_4) were deemed to have pierced the gingiva in life.

Eruption of teeth was scored as follows: E_1: crown just visible in crypt (initial appearance through the alveolus); E_2: crown erupting but the incisal edge or cusp tips had not yet reached the level of the cemento-enamel junction of the first permanent molar; E_3: crown erupted to the level of the first permanent molar's cemento-enamel junction, but was not in occlusion; and E_4: crown in occlusion with opposing tooth.

Teeth in either stage E_1, E_2, or E_3 were clearly scorable. Stage E_4 was judged to be useful to this examination only if a tooth had erupted just prior to death when minimal wear would be expected.

To determine the degree of wear which reasonably could be assumed to have occurred in less than a six month interval a new standard was created. Because other methods for determining occlusal attrition (Miles, 1963; Molnar, 1971; Scott, 1979) incorporate no means for determining minimal wear, the following criteria were created. These wear criteria are W_0: no visible wear W_1; wear in one or two planes only, comprising less than one-third of the area of any cusp; W_2: wear in 3 or more planes but comprising less than one-half the area of any cusp; and W_3: wear on more than half the area of any cusp. This minimal wear was observed visually with the aid of a 15X magnifying lens (lupe).

The 18 specimens with a permanent canine, first and second premolars, and permanent second molars in eruption stages E_3 and E_4 and dental wear stages of W_2 or less were placed in a sub-sample. Eruption stages were compared with dental development ages for the same tooth in each of the 18 specimens. Dental development ages of the sub-sample were also compared with those of the total sample.

For the entire sample and sub-sample, data were entered into and analyzed in Stata 3.1 (College Station, Texas). Student's t-tests, bivariate regression analyses, and analyses of variance were performed on the total dental development ages, individual dental development ages for the mandibular canines, first and second premolars, and second molars and eruption stages of the same teeth.

A test for intra-observer reliability through double determination of scores was done on two separate occasions. Results showed that intraclass correlation was within acceptable limits (r=.96).

RESULTS

The Wilcoxson sign rank tests of canine development compared with that of first and second premolars and second molars produced negative scores in all three comparisons. In other words, either the mean of second permanent molar dental development age was significantly advanced over that of the canine, or the canine was delayed by comparison with other mandibular teeth assessed.

Student's t-tests demonstrated that the mean of permanent second molar development stage was significantly different from that of canine and first and second premolar ages (Table 1). The Wilcoxson sign rank test clearly indicated in two out of three cases that the sum of positive ranks exceeded that of negative ranks. In other words, second molar development was advanced over that of the other teeth assessed.

In spite of significant differences in the means of the dental ages of the permanent canine, the premolars, and the second permanent molar, all the mandibular teeth assessed were shown in bivariate regressions to be significant predictors of each others' dental developmental stage (Table 2). The clearest association was between the premolars (R^2=0.98), with all other associations greater than R^2 = 0.90. In two specimens, upon visual inspection, the second permanent molar was found to have been erupting in advance of the canines and premolars.

The small size of the sub-sample with mandibular canines, first and second premolars, and second molars in the process of erupting or newly erupted conceivably could have increased the likelihood of a non-normally distributed data set. After a Scheffe multiple comparisons normalization was employed, Bartlett's test ruled out unequal variances between developmental and eruption stages.

Two way analysis of variance in which eruption stage was the predictor of the MFH dental age indicated that the eruption stages of all four teeth surveyed were significant predictors of total dental age (Table 3). By contrast, the individual dental ages of the four teeth examined separately were less consistent predictors of the eruption stage of the same tooth (R^2 between 0.36 and 0.67) (Table 4).

Graphical analysis of data produced several interesting associations. Figure 1 illustrates that the regression curve of dental development age for the four teeth displays a nonlinear distribution, with early development proceeding at a more rapid rate than later development. This may be ascribed to the well-known phenomenon in which the stages of root development appear more slowly than do the stages of crown development (Moorrees, 1963a). Canine development lags behind that of the other teeth at all ages. The premolars follow the same curve as that of the canines until approximately age 9. The slope of the second premolar development eventually overtakes that of second permanent molar development at approximately age 11.

Because of the shape of these curves, transformation of individual tooth ages to their logs was performed and these logs were regressed against total dental age. Figures 2, 3 and 4 give a clearer picture of the progression through developmental stages of the canine, first and second premolar by comparison with the second molar over the age ranges surveyed. The canine is delayed in its dental development age by comparison with that of the second permanent molar, most notably in individuals less than five years of age at death.

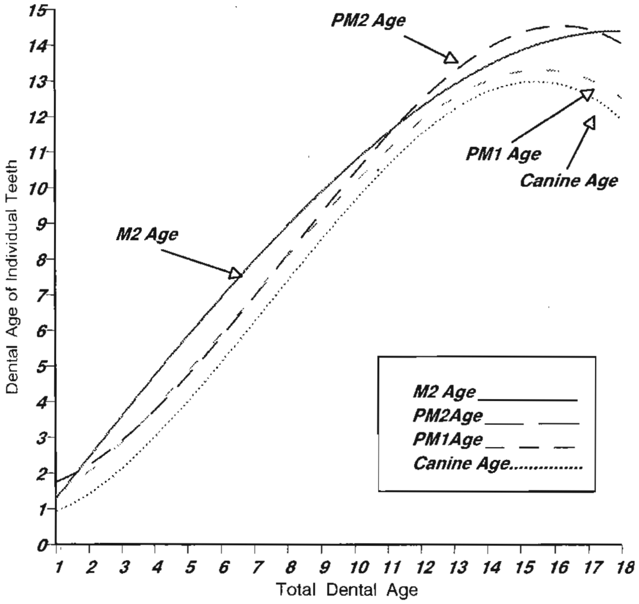

Fig. 1. Regression curves of developmental age for permanent mandibular teeth in the Arikara sample. The canine, the only tooth whose development has been determined to be sexually dimorphic, appears to lag behind the other teeth most dramatically in the youngest and oldest age ranges.

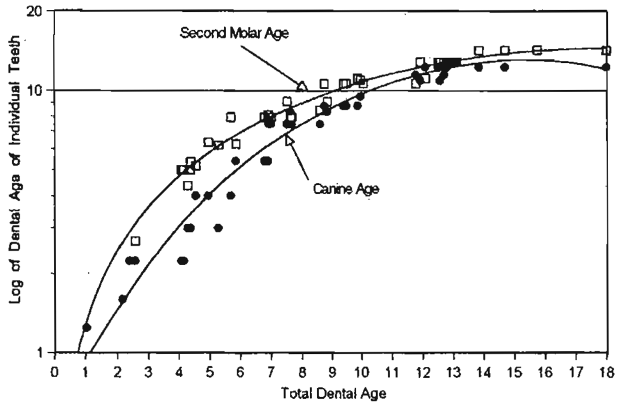

Fig. 2. The lag of canine developmental age behind the developmental age of the second molar in this sample is highlighted by plotting the log of the individual developmental ages for each tooth against total dental age. The highest degree of lag appears in the 2 to 5.5 year age range.

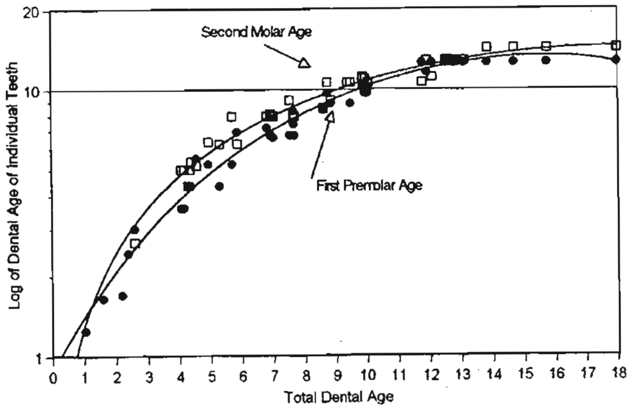

Fig. 3. Lag in first molar development is less impressive in this sample than the discrepancy between the second molar and the canine. Like the canine, the first premolar development never catches up with second molar development.

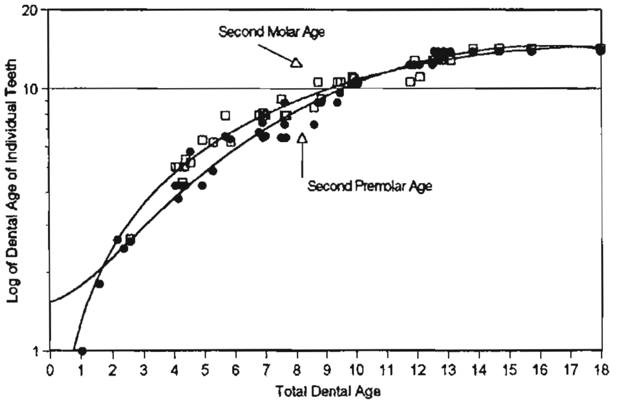

Fig. 4. The second premolar lags behind the developmental stage of the first premolar. However, the delay is less than that seen in the canine and first molar. The developmental ages of both the second premolar and the second molar follow essentially the same curve after the dental age of 10.0.

DISCUSSION

The results may be interpreted in a variety of different ways. The second premolar and permanent second molar may be significantly advanced in dental development age and eruption because the genetic program guiding the eruption schedule in this sample is different from that of the reference samples 246 European-derived individuals on which the MFH standards are based. Possibly, heavy occlusal function may have contributed to a more rapid rate of eruption in this sample than in the MFH sample and root development followed. However, explaining how occlusal loading could have been restricted to the posterior portion of the arch is difficult, if not impossible.

Alternatively, the canine and first premolar may be viewed as being significantly delayed by comparison with the dental development ages of the second premolar and the second permanent molar. This may be ascribed to the possibility that these children were ill or malnourished for some time before their death. The small amount of literature about dental development and eruption in children who are chronically ill or malnourished (Garn et al., 1973; Ghafari and Markowitz: in press) suggests that some delay may occur in canine and first premolar development. Another explanation of the results is that they indicate that most of the children in the sample were boys. However, no reports in the literature suggest that the first premolar erupts or develops any later in boys than in girls, although ample evidence exists for late male canine development and eruption (Demirjian and Levesque, 1980; Tomkins, 1996). Since the canine's development is most closely associated with that of the tooth most distal to it ($R^2=0.98$, $p<0.0005$), it is not unlikely that the first premolar would have been delayed due to a field effect (Kieser, 1986).

The possibility that the canine is significantly delayed in this sample must be examined not only for its possible causes (a preponderance of males, the effects of chronic illness and/or malnutrition, particularly in newly-weaned children) but for its effects. Calculation of the MFH dental age requires that the scores of eight individual mandibular teeth be used. Thus, delayed dental development in the canine could skew the dental age toward a younger total age. This might lead to the impression that the mandibular second molar erupted at an earlier age than it, in fact, did. A preponderance of males in the sample could produce such underestimation of dental ages.

Within the subsample, the number of teeth which had pierced the alveolus was too small for robust comparison with dental age. Nevertheless, the dental age of the teeth which were in the process of erupting or had newly erupted was very close to the median age of eruption for the four mandibular teeth taken from the Ten State Nutrition Survey (Smith, 1991). Moyers (1988) data (after Hurme) present considerably older means of eruption of the four mandibular teeth than does the Ten State Nutrition Study (Table 5). Yet, Table 5 shows that an approximately two and a half year range exists in the Hurme data. Thus, with the exception of the development seen on eruption of the few second molars observed erupting in this sample, both the Arikara percent of both root development (a rough guide to the range of stages seen at eruption) and eruption ages do not deviate from the

TABLE 1. Mean ages, t-scores, z-scores for mandibular permanent canine, first and second premolar, and second permanent molar dental development in the Arikara sample.

Variable	Number of observ- ations	Mean Age	s.d.	t- score	$p>\lvert t\rvert$	Wilcoxson sign-rank z	$p>\lvert z\rvert$
Canine age	40	7.34	3.83				
First premolar age	40	7.97	3.68				
Difference				-5.38	0.00	-4.15	0.00
Canine age	39	7.32	3.87				
Second premolar age	39	8.17	4.01				
Difference				-5.15	0.00	-4.17	0.00
First premolar age	43	8.17	3.88				
Second premolar age	43	8.46	4.24				
Difference				-2.63	0.01	-2.16	0.03
Second molar age	38	7.82	3.56				
Canine age	38	9.19	3.17				
Difference				-7.47	0.00	-4.85	0.00
Second molar age	42	9.55	3.25				
First premolar age	42	8.84	3.33				
Difference				4.82	0.00	4.08	0.00
Second molar age	40	9.55	3.32				
Second premolar age	40	9.12	3.81				
Difference				2.70	0.01	2.63	0.01

Mean is the average age of dental development; s.d. is standard deviation; $p>|t|$ is the probability that the t statistic is wrong (in other words, that the confidence interval does not include the t statistic); $p>|z|$ is the probability that the z (normalized data expressed as standard deviations from the mean) is wrong (that the confidence interval does not include the value of the z statistic).

TABLE 2. Bivariate regressions of dental development ages for four mandibular teeth.

Variable y	Variable x	Number of observ- ations	Coeff.	S.E.	t	$p>\lvert t\rvert$	R^2	p>F
Canine age	Second molar age	38	1.06	0.06	18.32	0.00	0.90	0.00
Canine age	Second premolar	39	0.93	0.04	22.72	0.00	0.93	0.00
Canine age	First premolar age	40	1.02	0.03	31.13	0.00	0.96	0.00
Second molar age	Canine age	42	0.94	0.04	21.35	0.00	0.92	0.00
Second molar age	First premolar age	40	0.84	0.04	24.31	0.00	0.94	0.00
Second molar age	Second premolar age	43	0.90	0.02	39.71	0.00	0.98	0.00

All x variables are regressed on all y variables. The purpose is to estimate how well dental ages of individual teeth will predict the dental ages of other individual teeth. Coeff. is the coefficient of the slope β ($Y=a+\beta x$); S.E. is standard error; R^2 is the percentage of error that is explained by the model; p>F is the probability that the F statistic is wrong, where F = the explained divided by the unexplained variance in the two means in an ANOVA.

TABLE 3. Analysis of variance with total MFH age as the predicted variable.

MFH age:	Tooth erupting	Number of observ- ations	Root MSE	F	R^2	p>F
Total MFH age	Canine	18	1.89	3.96	0.43	0.00
Total MFH age	First premolar	18	1.36	18.68	0.69	0.00
Total MFH age	Second premolar	18	1.54	12.46	0.59	0.00
Total MFH age	Second molar	18	1.56	6.48	0.64	0.00

The x or predictor variables are the four individual teeth. MSE is mean standard error.

range of variation normally seen in U.S. samples (Table 5). Also, personal experience of this author in 17 years of dental practice demonstrates that, while earlier eruption of the second molar is not the usual pattern, the occurrence is not rare in children of European ancestry.

The evidence for eruption sequences in non-European populations (Steggerda and Hill, 1952; Kent et al., 1978; Mayhall et al., 1978; Smith and Garn, 1987) may fail to take into account the effects of a high caries rate and poor dental care. Premature loss or extraction of the deciduous molars, as is often seen with access to refined sugar but in the absence of comprehensive dental care, can delay the eruption of the premolars (Brauer et al., 1966). Thus, studies purporting to demonstrate a routinely earlier eruption of the second permanent molar than of the permanent canine and premolar in nonindustrial populations may have failed to document delay in the eruption of the premolars.

This small subsample shows varying degrees of concordance between dental development age for each of the four teeth (particularly the canine) and the corresponding eruption time for those individuals in whom the four teeth were in the process of erupting or were newly erupted at death. The most likely explanations are sampling error and/or the less than perfect concordance between development (dental age) and eruption time in the permanent canine, first and second premolar, and second permanent molar in living patients (Table 5).

The difference in the means of dental development age at eruption for the permanent second molar between the European-derived population and the Arikara sample is just over nine months. Thus, creation of a separate standard for the second molar would be justified because of the early development of the second permanent molar, were it not for the conceivably confounding effect of the delay in the canine and first premolar.

In most of the specimens, canine and first premolar developmental stages are significantly delayed by comparison with second molar development. As the ages of individual teeth contribute to the MFH total dental age, delay in these two teeth likely has skewed the total age estimation toward younger ages. The possibility exists, then, that dental age has been systematically underestimated in this sample.

If canine development and that of its nearest neighbor, the first premolar, were affected in this sample by the ill health and possibly the poor nutrition that ultimately claimed these children's lives (Garn et al, 1973; Ghafari and Markowitz, in press), other evidence should corroborate this. Slight *cribra orbitalia*, considered an indication of nutritional stress, was observed in 13 cases in the entire sample. However, the means of the MFH dental age and comparative delay of the premolars and canine did not differ in this sub-sample (of those with *cribra orbitalia*) significantly from those of the full sample. Assuming that sampling error is not responsible for this result, *cribra orbitalia* apparently is not associated with delay in canine development in this group.

TABLE 4. Analysis of variance with individual dental ages used to predict their individual eruption stages.

Tooth Examined	Number of observ-ations	Root MSE	F	R^2	p>F
Canine eruption stage (y) dental age (x)	18	1.15	8.55	0.36	0.01
First premolar eruption stage (y) dental age (x)	18	0.57	30.13	0.65	0.00
Second premolar eruption stage (y) dental age (x)	18	0.59	30.14	0.65	0.00
Second molar eruption stage (y) dental age (x)	18	0.82	34.00	0.67	0.00

Root MSE is the variance of the estimator plus the square of its bias. R^2 is the percent of variance in y that is explained by the variance in x (estimator).

TABLE 5. Chronological ages at eruption for four mandibular teeth in modern North American whites and dental development ages at eruption stages E_3 and E_4 for the Arikara sample.

Tooth erupting	% root at eruption[1]	Minimum age[2]	Mean age[2]	Maximum age[2]	Mean eruption age Ten State Nutrition Survey[3]	Arikara % root at eruption	Arikara mean age
Canine	25.00-50.00	9.46	10.65	11.63	9.70	30.00-60.00	11.17
First premolar	50.00	9.05	10.05	12	10.00	25.00-50.00	11.26
Second premolar	50.00	9.40	11.18	12.40	10.90	25.00-50.00	12.05
Second Molar	70.00	10.50	11.89	13.25	11.24	70.00-100.00	11.07

[1]After Moyers (1988). [2]After Hurme reproduced in Moyers (1988). Hurme's data are the means of the male and female scores. Moyers also presents his own data on eruption in which eruption times are approximately six months later than those in Hurme's chart. Hurme's data are for individuals of known chronological age, whereas the Arikara means are based on MFH dental aging. Although dental age is well correlated with chronological age (Demirjian et al., 1985), the association is not perfect. [3]Data from Smith et al. (1991) are averaged means.

Because the only clinically significant difference in development rate in the teeth between boys and girls is in the canine and because the canine appears consistently delayed in this sample by comparison with other teeth, the only plausible suggestion that can be made based upon the analyses to date — particularly in the absence of positive evidence of prolonged ill health or malnutrition — is that this is a sample largely composed of boys, particularly in the absence of positive evidence of prolonged ill health and/or malnutrition. Highly detailed dental casts of each specimen should be examined for enamel hypoplasia, which would corroborate the suggestion of a prolonged period of ill health for these children before death.

CONCLUSIONS

The data, as analyzed in this study, do not justify the creation of a separate standard for Arikara dental development. The sample contains too few specimens in which the second permanent molar was actually erupting to state securely that early eruption of this tooth was the pattern in this population. Some evidence suggests that the crown and root development of the mandibular second molar in this sample may have proceeded more rapidly than that in the MFH reference sample. However, if this sample contains a preponderance of boys, normal delay in canine and premolar development, by comparison with an average of the MFH male and female dental ages for these tooth, would lead to a systematic underestimation of the total age. Mandibular second permanent molar and second premolar development then would appear relatively precocious for the assigned dental age.

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THE INCIDENCE OF *TORUS MANDIBULARIS* IN MALAY PEOPLES

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ABSTRACT The incidence of *torus mandibularis* is known to vary in world groups. The object of this study was to determine the incidence of *torus mandibularis* in Malay peoples. Comparison of the data with the known incidence in other world groups showed that the incidence of this trait in Malay people is not unusually high.

INTRODUCTION

Torus mandibularis is generally defined as an exostosis. It is found on the lingual aspect of the mandible in the premolar area above the mylohyoid line. *Torus mandibularis* may occur unilaterally or bilaterally. It can occur in a single or multiple form. Kolas and his co-workers (1953) classified *torus mandibularis*, if present, into four groups; a) single unilateral, b) multiple unilateral, c) single bilateral, d) multiple bilateral *tori*.

The definition of Malay people can be difficult, as the survey was conducted in the Sultanate of Brunei on the island of Borneo. Brown (1970) hinted at this problem when he indicated that census-takers were often faced with a wide variety of groups. The people would all be racially alike, having a virtually identical language and similar social and cultural organization. Yet, they would be named after the geographical feature which was closest to their longhouse. Moreover, the 1971 census in Brunei recorded that 66% of the population was Malay and 29% was Chinese.

Groups who form the people of Malay stock were studied. The true Brunei Malay, who were the majority of the subjects, came from four main sub-groups. These are the Brunei Malay, the Tutong Malay, the Pelait Malay (all three named after the river which drains their district), and Kedayans. Muruts and Punans are other Malay-type indigenous people within the sultanate, but none were consciously seen during the survey. Another large group of Malay-type people in Brunei is made up of Bans or Sea-Yaks, who are employed in Brunei as a labor force, but are indigenous to Sarawak. Any ethnic Malay citizen from either East or West Malaysia was also included.

METHOD

The study was done on routine dental patients, who met the above criteria of a Malay. They were examined at a petroleum company hospital in Brunei for the presence or absence of *torus mandibularis* by visual or by tactile examination. If present, the *torus* was categorized into one of the four classifications given above. Records about name, sex, and age were also kept.

The results of the study of the four grades of *torus mandibularis* are given in Table 1. The frequency is also given by sex and by the total number in the sample.

Table 2 provides comparative frequencies of *torus mandibularis* presence in 11 world groups. In his publication Yang (1995) gives a set of four comparisons from the literature. I have compared the incidence in three Mongoloid groups (Malay, Aleut, and Japanese), three White groups (Florida White, Norwegian, and Ohio White), and three Negro (Florida Black, Negro, and Bushmen) groups. I have also included Brazilian Indians. Of these samples, the data for Aleuts (Hrdlička, 1940), Japanese (Akabori (1939) and Bushmen (Drennen, 1937) were obtained from skeletal material, which may have produced a high incidence of *torus mandibularis*.

TABLE 1. Torus mandibularis in Malay.

		Unilateral Tori		Bilateral Tori				
	Number	Single	Multiple	Singl	Multiple	Total	Frequency	Age in years
Males	452	15		14	4	33	7.30	23-55
Females	428	8	1	7	1	17	3.97	16-50
Total	880	23	1	21	5	50	5.68	

CONCLUSION

Examination of Table 2 indicates that the incidence of *torus mandibularis* in living people of Malay stock is not unusually high

TABLE 2. Comparison of *torus mandibularis* in population groups.

Group	Incidence	Investigator
Malay	5.7	This study
Aleuts	63.4	Hrdlička, 1940
Japanese	26.6	Akabori, 1939
Florida Whites	24.0	King and King, 1981
Norwegians	7.3	Haugen, 1992
Ohio Whites	7.7	Kolas et al., 1953
Florida Blacks	14.0	King and King, 1981
Negroes	8.2	Austin et al., 1965
Bushmen	26.9	Drennan, 1937
Brazil Indians	0.5	Bernaba, 1977

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AN UNUSUAL MAXILLARY MOLAR FROM PREHISTORIC NEW MEXICO

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The skeletal remains of a prehistoric Native American male were inadvertently discovered during land development in Albuquerque, New Mexico. An almost full compliment of the permanent dentition was recovered, including a loose maxillary molar with four distinct roots (Fig. 1). The isolated burial was situated above the floor of a jacal (sticks and brush) habitation structure containing post holes and hearth features. Abundant ceramics suggest a Pueblo IV occupation (about 1,300-1,500 AD).

This four-rooted molar is tentatively identified as an upper left maxillary first molar. It is larger than its antimere, which was present and in occlusion (Fig. 2). Metric comparisons with the maxillary right first molar are provided. The bucco-lingual measurement of the maxillary left first molar is 12.43 mm; the mesio-distal measurement is 12.20 mm. The maxillary right first molar bucco-lingual dimension is 12.27 mm, whereas the mesio-distal measurement is 10.28 mm.

The lingual aspect of this four-rooted molar is morphologically complex (Fig. 3). This complexity suggests an additional cusp intermediate between the protocone and hypocone. It is also possible that the extra cusp is linked to a "runaway" Carabelli's trait and its associated root. Postmortem breakage of the majority of the roots prevented morphological comparisons.

Comments from readers concerning the identification of this molar and its unusual morphology will be greatly appreciated.

Fig. 1. Apical view of maxillary left four-rooted first molar on the left and its antimere on the right. The buccal roots are on the left sides of each tooth and the lingual roots are on the right. On the four-rooted molar, mesial is at the top and distal is at the bottom. On the three-rooted molar, distal is at the top and mesial at the bottom.

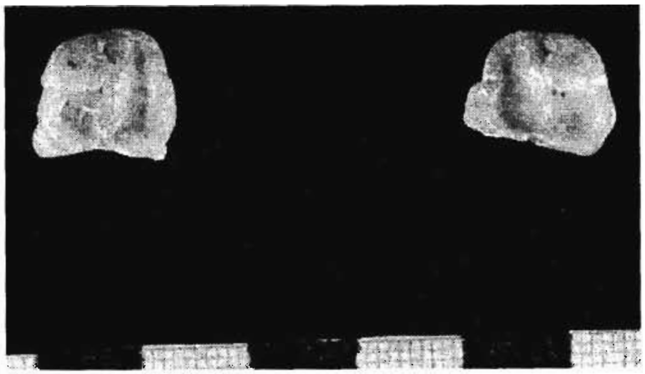

Fig. 2: Occlusal view of the left and right maxillary first molars showing size differences. Teeth are pictured left to right and oriented as follows: buccal is to the outside and lingual, to the inside; distal is at the top and mesial, at the bottom.

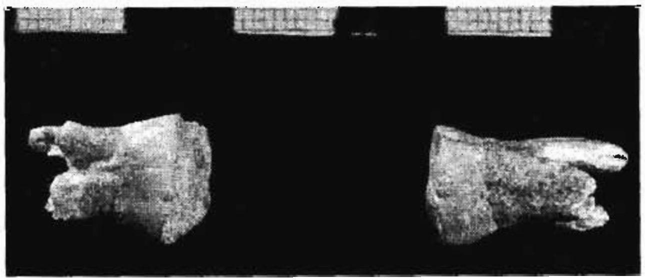

Fig. 3. Lingual aspect of maxillary left first molar, shown on the left, demonstrating complexity. In this view, mesial is at the top and distal at the bottom.

DENTAL ANTHROPOLOGY AT THE UNIVERSITY OF NEW MEXICO

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Dental anthropological research in the UNM Department of Anthropology is both pervasive and diverse. All Biological Anthropology faculty members, as well as a number of graduate and undergraduate students, are involved in studying some aspect of the field.

Jeffery Froehlich recently used fluctuating asymmetry in Sulawesi macaque dentitions to corroborate a hypothesis of hybrid dysgenesis with some success. One of Jeff's students, Jared Bousliman, is studying all of the known specimens of New Mexico and Colorado *Pelycodus*, pursuant to defining a possible third species with small but morphologically complex third molars.

Erik Trinkaus and Karen Fennell, in collaboration with Peter Ungar (University of Arkansas) and Kathleen Gordon (Smithsonian Institution), completed an article on beveling rates in central incisors relative to tooth wear in samples of Neandertals, Inuits, and Puebloan Native Americans for submission to the *Journal of Human Evolution*. They found that the degree of development of beveling differentiates Neandertals from the others.

Jane Buikstra was involved in the excavation of human remains from seven elite tombs at the Copan Acropolis in Honduras. The primary goal of the bioarchaeological project was to collect tooth samples for DNA (Anne Stone and Mark Stoneking, Pennsylvania State University), Strontium Isotope (Douglas Price, University of Wisconsin), Carbon and Nitrogen Isotopes (Lori Wright, Texas A & M), and Oxygen Isotope (Henry Schwarcz and Hilary Stuart-Williams, McMaster University) analyses. In addition to the selection of dental samples, Buikstra recorded several osteological and dental observations that reflect diet and health status. The results suggest that further systematic morphological and metric study will be productive.

Joseph Powell is continuing his research on metric and nonmetric dental variation in Paleoindian and Archaic populations. He and Valerie Haskins (Western Kentucky University) are organizing a symposium on the biology of Middle Archaic populations for the 1997 Annual Meeting of the American Association of Physical Anthropologists. Moreover, Powell and Megan Rhoads are analyzing dental wear data in Middle Archaic samples from Windover, Eva, Black Earth, Modoc, and other early sites. He and Marsha Ogilvie are in the early stages of analyzing the incidence of enamel hypoplasia at Windover.

Joel Irish's research continues to focus on African dental variation. He recently recorded dental data in the Jebel Sahaba material at Southern Methodist University, submitted a paper on North African dental variation to *Homo*, and worked with Brad Ensor (Archaeological Consulting Services, Tempe) on an article about Nubian enamel hypoplasia sexual dimorphism for the *American Journal of Physical Anthropology*. In addition, Irish is collaborating with Brian Hemphill (Vanderbilt) and with Debbie Guatelli-Steinberg and John Lukacs (University of Oregon) on two Canary Island dental studies, and with Brad Ensor on hypoplasia asymmetry for the 1997 Annual Meeting of the American Association of Physical Anthropologists. Lastly, he and Christy Turner (Arizona State University) recently had a paper on West African LSAMAT accepted for publication in the *American Journal of Physical Anthropology*. Irish also taught a course in dental anthropology last semester at UNM.

Finally, Katherine Davis is examining sexual dimorphism in dental size and shape in contemporary populations using the Maxwell Museum's documented collection for her M.A. thesis. Marsha Ogilvie and Joel Irish submitted a paper about Plains Woodland mandibular asymmetry to the *Journal of Paleopathology*. Darbi Gill, recently left for 18 months of field research in Pansing, Malaysia. She is examining the population structure of living Malaysians using dental discrete and metric traits.

DENTAL ANTHROPOLOGY AT THE UNIVERSITY OF PENNSYLVANIA DEPARTMENT OF ANTHROPOLOGY AND THE UNIVERSITY OF PENNSYLVANIA MUSEUM

ALAN E. MANN, MICHELLE LAMPL, AND JANET M. MONGE
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The skeletal collections at the University of Pennsylvania Museum are our primary data base. Emphasis is on the immature collections which number approximately 300 individuals from the populations in the Middle East, the Americas, and West Africa. Smaller collections that these came from Europe, Asia, and the Pacific.

Current projects dealing with dental anthropological topics fall into three categories. The first is documentation of variation in the relative calcification and eruption of the permanent dentition within and between these samples. The second type includes complete study of the differences in the microstructure of enamel between these samples. The third category involves recording of the differences in the dimensions of the relative enamel, dentin, and pulp area dimensions of the unworn first molar teeth of these skeletal samples. Information for these studies is collected using radiographs and a variety of microscopic techniques including SEM (scanning electron microscopy) and light microscopy.

The information collected from these studies is used for comparison to fossil hominid material where only nondestructive techniques are employed. Most recent research has focused on the immature Neanderthal remains. In these studies we collaborate with Ann-Marie Tillier and Bernard Vandermeersch, both of the Université de Bordeaux I. Studies have been undertaken on materials from St. Cesaire, Montgaudier, and Qafzeh. In addition, in conjunction with Jakov Radovčić of the Croatian Natural History Museum, the Krapina materials have been radiographed and cracked enamel surfaces have been analyzed.

Book Reviews

ASPECTS OF DENTAL BIOLOGY: PALAEONTOLOGY, ANTHROPOLOGY AND EVOLUTION. Edited by Jacopo Moggi-Cecchi. Florence: International Institute for the Origin of Man. 1995. xvii + 460 pp. (ISBN 88-86720-08-4) $80.00 or 120,000 lira for individuals and institutions, $60.00 or 90,000 lira for students (paper).

As the title implies, this book contains a potpourri of useful articles focusing on key themes in dental biology of interest to scholars and students of anthropology, palaeontology, and evolution. The volume contains research papers presented at the Ninth International Symposium on Dental Morphology, which convened in Florence, Italy in September 1992. Symposium papers are devoted to five major topics that comprise the main sections of the volume; these include: 1. Structure, 2. Function, 3. Development, 4. Morphology, and 5. Populations.

This European symposium series typically embraces an immensely broad spectrum of topics and taxa in its treatment of the dentition. Fossil fish, amphibians, and reptiles are as frequently the subject of study as primates or humans, and topical coverage is equally broad including genetics, embryology, histology, as well as pathology, morphology and odontometrics. For these reasons, anthropologists lacking a broad evolutionary perspective of human dental variation often find the proceedings of the International Symposia on Dental Morphology too diffuse in subject matter or feel they offer little of relevance to the study of human dental variation. Readers will be pleased to learn that this volume is clearly an exception to tradition. By my count, fully three-quarters of the volume (29 papers) deals directly with the analysis of human or hominid dental remains. For those with more catholic interests, 25 percent of the papers (ten chapters) are devoted to non-human dental concerns. The range includes lungfish, sharks, insectivora, bear, mole rats, equids, rhinos and proboscideans.

While each section contains valuable results of interest to dental anthropologists, I found the papers in the sections on Structure, Development and Morphology most stimulating and rewarding. In the Structure section papers by Radlanski et al. and by Macho were especially informative and worthy of study. Radlanski and colleagues review the controversy over the arrangement of prisms in human dental enamel. Scanning Electron Microscopy and geometrical analysis lead these researchers to conclude that prisms are of a fixed diameter and that their sinuous route to the outer enamel surface has complicated prior analyses of enamel prism arrangement. Multiple factors influencing variation in the thickness of hominid enamel between tooth classes, sexes, and species is the focus of Macho's paper. When viewed in the context of developmental timing and functional adaptation, the understanding of variation in enamel thickness is crucial to phylogenetic and life-history reconstruction.

Also contained in the Structure section are articles by Alvesalo and colleagues on sex chromosomes and molar morphology, and on intercuspal distances of maxillary premolar teeth of Turner Syndrome females. These papers continue the valuable investigation of how sex-linked genetic factors influence tooth size and morphology.

Part 3, the Development segment of the volume includes some very useful and insightful articles on hominoid dental maturation. Differences in dental development between human and chimpanzee are summarized by Anemone based on his longitudinal analysis of lateral head radiographs of 33 lab-reared chimpanzees. Important differences are described and their implications for understanding age-at-death of Plio-Pleistocene hominids is discussed. New data and insight into hominid crown formations times (Ramirez-Rozzi) and modern human crown formation and root extension rates (Liversidge) are also presented in this important section of the volume. A valuable critical review of the literature relating to periodicity of incremental lines in primate dentine is provided by Dean. This review sets the stage for new observations on incremental lines in humans, orangs, and macaques and tentative insights regarding root development in *Homo habilis*.

In the Morphology section, anthropologists will find much of interest, including articles on root number polymorphisms in hominid P^3s (Tobias), morphometric variation in Carabelli's trait among early South African hominids (van Reenen and Reid), a partitioning of shovel-shape variation into three separate components (Crummett), morphological analysis of teeth from Kostenki sites (Haeussler), lateral incisor variants in Tuscany (Pinto-Cisternas et al.), *tuberculum intermedium* variation in Negroid and San-hybrid groups in South Africa (Navsa), and polythelia (supernumerary nipples) and cusp number of lower molars (Heikkinen et al.). This diverse range of topics should provide something new and rewarding for everyone.

Several of the papers on the Populations section are exceptionally particularistic, concentrating on a single tooth (the Visogliano premolar; Puech and Albertini) or a single abnormal Etruscan specimen (Kocsis et al.), and two deal with non-human taxa (mole rats, insectivora). Dental paleopathologists will benefit from Clarke and colleagues use of strict criteria for assessing the status of alveolar bone which differentiates between bone damage and loss from dental vs. gingival origin. Questioning the assertion that high levels of periodontal disease typify the Carrier Mills skeletal series from southwestern Illinois, and adopting rigorous standards of evaluation permits Clarke et al. to reach conclusions very different from prior investigators of this series.

The Populations section contains a diverse array of articles that describe the dental status of skeletons from New Kingdom tombs in the Valley of the Kings, Luxor, Egypt (Swindler et al.), taurodontism and enamel hypoplasia in eighth century Hungary (Horváth et al.), double-rooted canines in osteoarchaeological samples (Kocsis and Marcsik), and dental arch dimensions in southern India (Kannappan et al.). The last two papers in this section have an odontometric focus: odontometric variation and biological affinities among Italic and Roman populations (Macchiarelli et al.) and tooth size data for Middle Eastern hominids used to address the origin of modern humans by Brace who also reaffirms the validity of the Probable Mutation Effect. Recent developments in assessing ethnic variation in tooth size, known as the tooth size apportionment technique, were developed by Harris and successfully applied to castes and tribes of India by Hemphill. This approach would have added another informative dimension to the paper by Macchiarelli et al. Finally, the absence of a light-hearted limerick from Brace's paper was as disappointing as his continued adherence to the Probable Mutation Effect as a mechanism of dental reduction.

The papers in this volume are diverse topically and variable in quality. Each article begins with a succinct and informative abstract and many have extensive and useful bibliographies. The main sections of the volume are clearly demarcated in the contents, but no subdivisions occur in pagination of the volume. The book lacks topical cross references between sections and chapters and a summary and interpretive contributions by the editor. An index, often lacking from edited conference proceedings, provides a useful guide to topics and taxa. The volume is a must for practicing dental anthropologists and aspiring students. While the price may prohibit its use as a textbook in dental anthropology courses, graduate students with career interests in the field will benefit from the student's discount offered by the publisher.

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PROCEEDINGS OF THE 10TH INTERNATIONAL SYMPOSIUM ON DENTAL MORPHOLOGY. Edited By Ralf J. Radlanski and Herbert Renz, Berlin: "M" Marketing Services. 1995, 471 pp. 120 dm.

In 1962, the Society for the Study of Human Biology organized a conference on the anthropological study of human teeth, culminating in the now classic *Dental Anthropology*, edited by D.R. Brothwell. At this meeting, Al Dahlberg and P.O. Pedersen realized the importance of bringing together scholars from around the world to share their latest findings on and passion for the study of teeth. To meet this end, they organized the "first" International Symposium on Dental Morphology held in Fredensborg Denmark, in 1965.

Regrettably, I never asked Al or P.O. if they had originally envisioned this meeting as a one-time affair or the first in a series. Thankfully, for dental research in general and dental anthropology in particular, it turned out to be the latter. These international symposia have served as a forum for investigators in genetics, embryology, paleontology, dentistry, anatomy, and anthropology to meet on a regular basis (usually every third year) and talk teeth, teeth, teeth. Traditionally, these conferences have been small, with only 50 to 60 participants and a few dozen interested onlookers. Given the size, most conferees have the opportunity to meet one another and exchange tooth-borne ideas across disciplinary boundaries. Except for those overcome by the sightseeing bug (in a spectacular series of cities where the symposia have been held), most individuals attend all the papers, including those on topics far removed from their own dental specialty.

In the 1995 fall issue of the *Dental Anthropology Newsletter* (Vol. 10(1), pp. 9-12), Haeussler and Mayhall reported on the meeting of the 10th International Symposium on Dental Morphology convened in Berlin, September 1995. As this report contains brief descriptions and summaries of papers of special relevance to dental anthropology, my review focuses entirely on the conference proceedings.

Seven of the nine dental morphology symposia held between 1965 and 1992 have associated congress volumes. The Proceedings of the 10th International Symposium on Dental Morphology, edited by Ralf J. Radlanski and Herbert Renz, differs in one significant respect from earlier volumes in the series. The editors solicited early manuscript submittals so the book could be produced in advance and made available for distribution at the conference. Due to an enormous effort on the part of the organizers, all conferees had at their disposal a 471 page volume at the meeting. This contrasts previous symposia that have had lags of two to three years between the meeting and publication of proceedings.

The Berlin volume lists 96 papers and 155 contributors. These numbers double or triple those of the 1986 Paris meeting (34/65), the 1989 Jerusalem meeting (33/56 contributors), and the 1992 Florence meeting (39/70). Of the 96 papers listed in the proceedings, 12 authors did not meet a pre-meeting deadline for manuscript submission so only their abstracts were published. Of the remaining 84 articles, the editors must have imposed a strict page limit. Papers range from three to twelve pages and 70% are either five or six pages in length. If it were not for the inclusion of figures and/or tables, most of the papers could be viewed as extended abstracts with short bibliographies.

Haeussler and Mayhall note the symposium had sessions dealing with ontogeny, dental genetics, dental morphology, technological advances, dental evolution, dental anthropology, and the functional correlation between teeth and jaws. This organization did not extend to the proceedings volume. Papers listed in the table of contents are not set off by subheadings to distinguish topical areas. Given the multidisciplinary nature of these symposia, previous editors have used subheads such as ontogeny, phylogeny, dental genetics, and the like to distinguish logical groupings of papers. In the Berlin proceedings, there is some sequential ordering of paper topics but the order is not consistent throughout — one could not simply insert subheadings but would have to reorder papers under appropriate heads. Topics covered from most to least often are: hard tissue research, with an emphasis on enamel (23), the morphology and size of teeth of recent human populations (15), paleontology, mostly primate and hominid (15), ontogeny (12), human growth and development/genetics (8), research on mandibles (8), methods (5), and occlusion (3). Seven residual papers do not fall under any of these headings. Content-wise, the most significant departure (from previous symposia) of these proceedings is its great emphasis on enamel structure.

A striking inclusion in the Berlin volume are several color figures of excellent quality (Leica, a major sponsor of the meeting, may have played a role in this). Paradoxically, dozens of black and white figures are of marginal quality, apparently reproduced xerographically. The volume is beset by spelling and typesetting errors, no doubt attributable to the haste in its production prior to the conference. The soft cover of the book is of relatively light stock and shows a definite propensity to "curling"; a short shelf-life seems likely.

Previous volumes of the International Symposium on Dental Morphology are a must in any dental anthropologists library. They include landmark papers in dental anthropology and related areas of research, especially ontogeny, phylogeny, and genetics. While the current work covers a comparable set of topics, it does not cover them in the same way. Too many papers are included and these are too brief. The volume contains many good ideas and presents interesting lines of investigation. However, authors have not been allowed the space to adequately develop and illustrate their research. The advantages associated with producing a volume available for distribution at the time of a meeting are short term only. In the long run, this book will not stand the test of time as have its predecessors. At a price of 120 dm. (ca. $80 US), I would not recommend this book as a "must" for a dental anthropologist's library. Few individuals want to cram months or years of work into four or five pages so I can only surmise that most of the articles in this book have been or will be published in extended versions elsewhere.

In the *Journal of Dental Research* supplement that includes the proceedings of the very first dental morphology symposium, Al Dahlberg remarked in the introduction that a special feature of the symposium was the distribution of a 400 page folio to all participants one month in advance of the meeting. This folio included abstracts, reports, and even previously published materials. If participants feel it is urgent to disseminate results before or at the meeting, future organizers should contemplate the original "folio model." Following the meeting, manuscripts could be revised, expanded, and published in a book more substantial than the proceedings of the 10th Dental Morphology Symposium.

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ERRATUM: A. Cucina, et al. (1996) Stress impact in central Italy during the Iron Age: Evidence of linear hypoplasia. Dental Anthropology Newsletter *10(2)*:6-9. (1996).

In Tables 3 and 4 and in Figs. 2 and 3 the labels "Camerano" and "Tarquinia" have been reversed. In Table 5 and Fig. 4 the correct sequence of headings is Alfedena, Camerano, Campovalano A, Campovalano B, and Tarquinia.

REMINDER FROM THE SECRETARY/TREASURER

Shara E. Bailey

Membership fees for 1997 are due January first. Beginning on January first, dues are $15.00 for regular members and $8.00 for student members. Please take time now to check your membership status indicated on your address label. If the year following your name is 1996 or earlier, please remit your annual fee in order to remain an active member. If you no longer have your address label you can contact me via e-mail at azsbs@imap2.asu.edu and I will update you on your status.

DENTAL ANTHROPOLOGY NEWSLETTER GUIDELINES

A.M. Haeussler

Manuscripts for the next issue are due on December 15, 1996. The newsletter generally follows the style of the *American Journal of Physical Anthropology*. Beginning with the upcoming issue, authors are asked to include a brief abstract with articles, but not with news items or reviews. Photographs enhance articles, and will be returned on request. Manuscripts on diskette (IBM format), accompanied by a paper copy, are especially welcome.

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