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# Frequency and variation of three-rooted lower first permanent molars in precontact Easter Islanders and in Pre-Conquest Peruvians

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**ABSTRACT** The purpose of this study was to evaluate the prevalence of mandibular first molars featuring a distolingual root in two archeological collections. A total of 172 teeth from Pre-Contact Easter Islanders and 281 teeth from three Pre-Conquest Peruvian sites were examined looking for the presence of three-rooted lower first permanent molars (3RLM1). The Easter Island teeth were recovered during the Ahu Tongariki excavation Project 1993-2001: we identified 70 M1s, 62 M2s and 40 M3s. The sample contained 20 lower molars with an extra root, meaning that there is 29% with 3RLM1. The Peruvian teeth are from three archeological sites: Nasca (Proyecto Nasca, n = 100), Arequipa (Proyecto

Condesuyos, n = 28), and Tablada de Lurín (Proyecto Loma de Lesix, n = 153). We found 8% of 3RLM1 at Nasca, 1.2% at Tablada de Lurín, and 9% at Condesuyos (total frequency = 6%). The percentage of 3RLM1 in Easter Island, very high compared to the whole Polynesia and the Peruvian sample, shows the effect of a genetic bottleneck (accidental reduction of a population), which the settlers went through as they reached the island they named Rapa Nui. We conclude that founder effect and genetic drift have played an important role in regulating the past and present mosaic distribution of 3RLM1 in insular populations. *Dental Anthropology* 2009;22(2):1-6.

Three-rooted mandibular first molars were, as far as we know, first described in England by A. E. Taylor (1899). Since then, investigators have reported 3RM1 in various frequencies in human populations, and it was noticed that 3RM1 was higher in most Asian populations (Tratman, 1938, 1950; Pederson, 1949; Turner, 1971; Loh, 1990; Ming Gene Tu *et al.*, 2007). In a worldwide survey of 11,318 individuals from 286 prehistoric skeletal and recent populations, Turner and Benjamin (n.d.) found 3RM1 most common in Asian and Asian-derived populations, especially in the Arctic and North Asian populations (ca. 25-30%) and least common (ca 1%) in European and African groups. It should be noted, however, that their survey included only one sample of Africans south of the Sahara. In Polynesia, the average is about 8.5% while the world average is approximately 10%. This paper deals with two teeth samples, one from Polynesia (Easter Island) and one from Peru: the aim of the study is to offer a contribution concerning the three-rooted mandibular first molars frequency and distribution.

Easter Island is one of the world's most isolated inhabited islands. Human penetration into the Pacific commenced about 60,000 to 45,000 years ago when humans reached Australia and crossed the land bridge connecting Queensland Australia to New Guinea (Green, 1991). Easter Island (Rapa Nui; Fig. 1) is in an extreme windward position as the easternmost of

some 287 islands forming the cultural entity known as Polynesia. Easter Island has an area of only 64 square miles and is rather triangular in shape. It is situated in the Southern Hemisphere at 27° 9' south latitude and 109° 26' west longitude, about 2,300 miles west of Chile and some 1,400 miles east of Pitcairn, the nearest inhabited island. The original Easter Islanders are believed to have been Polynesians ultimately derived from Asia who spoke a Austronesian language, specifically an eastern Polynesian dialect related to Hawaiian and Marquesan. Indeed, Captain James Cook recognized that the Easter Islanders spoke the Polynesian language when he visited the island in 1774. Human penetration into the Pacific had commenced by about 60,000 to 50,000 years ago when humans reached Australia, and it appears that New Guinea has been occupied for at least 40,000 years. Many islands of the Western Pacific (Near Oceania), however, have been inhabited less than 5,000 years while those in the Central and Eastern Pacific (Remote Oceania) have been occupied for less than a 1,000 years. It now appears that the Polynesian islands were populated by what is called the Ancestral Polynesian Society, which, in turn, was part of the Eastern division

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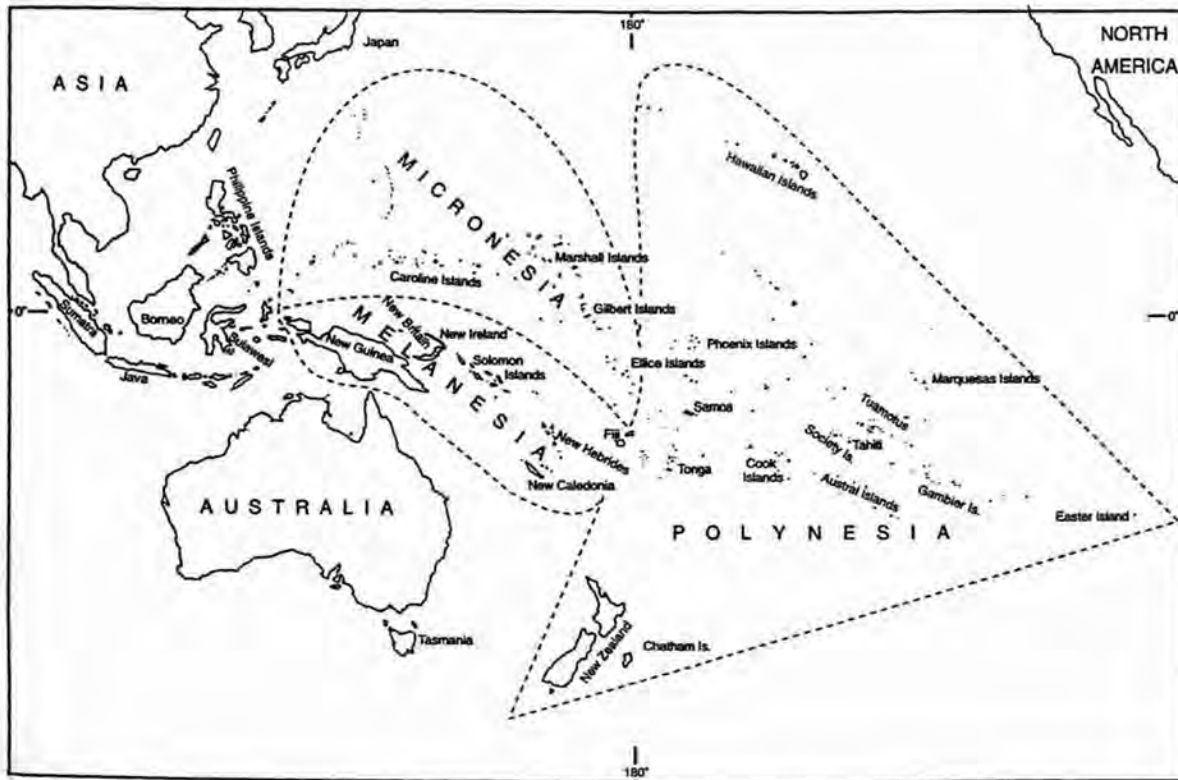


Fig. 1. Easter Island located at an extreme windward position in the Pacific.

of the Lapita Cultural Complex (Kirch, 1984; Van Tilburg, 1994). There is good evidence that these Austronesian speaking people had started moving out of Southeast Asia by about 3,000 BC, and interestingly, there is still a genetic link (deletion of a short section of the DNA in the mitochondria, or mtDNA) between the Polynesians of today and Southeast Asian populations (Jones, 1994). The nucleus of the Ancestral Polynesian Society was settled in the Fiji-Samoa-Tonga region of Western Polynesia by about 1,500 BC. From here the more eastern Polynesian Islands were gradually colonized. Easter Island, the easternmost of the islands of Polynesia, was settled near the end of the first millennium AD, probably between 400 and 800 AD (Van Tilburg, 1994; see also Bellwood 1987; Bahn, 1993; Bahn and Flenley, 1992). Finney (1993) has suggested three possible settlement routes based on seasonal patterns of winds, currents, and weather conditions. Route 1 is from the Marquesas and would have required an El Niño with westerly winds. Route 2 is from the Tuamotus/Mangareva islands and would have been undertaken during a period of winter westerlies. Route 3 is the most southerly route and comes through the Australs via Rapa to Easter Island. (Note: westerlies are more common below 30° south latitude). It is not certain which of these routes was used or, in addition, whether there was a single or multiple migrations. Van Tilburg (1994) says that some Easter Island traditions suggest two early migrations but there

is no indication as to the amount of time separating them. Rapa Nui tradition, although undoubtedly limited in its usefulness, states that there were probably two canoes carrying the original settlers with anywhere from 25 to 100 people aboard (Van Tilburg, 1994). It is also speculated that the party was composed of related individuals of various ranks and abilities and that they landed in the vicinity of Anakena on the north central coast of Easter Island, probably sometime between 600 and 800 AD (Van Tilburg, 1994).

This pattern of migration has probably characterized the peopling of the Pacific islands for the last 5,000 years, *i.e.*, relatively small groups of individual representing various degrees of genetic relationships, particularly in Polynesia. Where descent-groups are never completely exogamous, genetic affiliations may have been rather close among the members of a migrating group. Of course, all voyages were unplanned for there were certainly accidental, unintentional migrations of individuals blown into unknown seas who happened to land on an island with only their genomes. Such migration patterns are ideal for the operation of the founder effect, genetic bottlenecks, and genetic drift. The percentage of 3RLM1 in Easter Island, very high compared to the whole of Polynesia and our Peruvian sample, shows the effect of a genetic bottleneck (accidental reduction of a population), which the settlers went through as they reached the island they named Rapa Nui. Founder effect

and genetic drift seem to have played an important role in regulating the past and present mosaic distribution of 3RLM1 in insular populations.

## MATERIALS AND METHODS

In 1993, during the Ahu Tongariki excavation directed by Claudio Critino and co-directed by Giuseppe Orefici, the molars that form the basis of this investigation were collected (Orefici and Drusini, 1993). The Ahu Tongariki is situated on the southeastern coast of the island. The human skeletal remains of the Tongariki 14-548 site were found scattered in an area of some 5,000 square meters. The skeletons were mostly incomplete and fragmented, the bone tissue was generally dry and brittle, and the in situ physicochemical erosion had given the periosteal surface a heavily weathered appearance. Only the teeth were in a fairly good condition. The bone assemblage was always related to collective secondary burials of pre-contact islanders (before 1,722 according to preliminary  $C^{14}$  dating). Since the reconstruction of individual skeletal complexes was impossible, the analysis was performed on the isolated bones and teeth. While examining these teeth we noticed that several of the lower molars possessed three roots rather than the usual two roots. In view of the prevalence of three-rooted lower first permanent molars (3RM1) in Asian populations we thought it would be of anthropological interest to review the pattern of 3RMs in the Pacific islands and determine if there is a west-to-east cline in their distribution, and attempt an explanation for the rather high incidence of 3RMs in pre-contact Easter Islanders.

Human lower molars usually have two roots, one mesially and one distally placed transversely to the mesiodistal length of the tooth crown. The roots of the second and third molars are more variable in length and inclination than those of the first molar. Additionally, the roots of the second and third molars may fuse together, especially those of the third molar, which may also have more than two roots. Crown size, morphology, contact areas, and root anatomy were used in identifying the molars. There were 172 permanent lower molars consisting of M1 = 70, M2 = 62, and M3 = 40. We tried to be as careful and accurate as possible in identifying the lower molars as to M1, M2 or M3 but some misidentifications are always possible when dealing with isolated teeth, especially between M1 and M2.

The second sample of teeth belongs to three archeological sites of Peru: Nasca, South Coast of Peru (Proyecto Nasca, n = 100), Arequipa (Proyecto Condesuyos, n = 28), and Tablada de Lurín (Proyecto Loma de Lesix, n = 153). As far as the Nasca Project is concerned, the study was based on skeletons and mummies belonging to 582 individuals excavated at sites of Pueblo Viejo, Cahuachi, Estaqueria and Atarco

in the Nasca valley, South Coast of Peru. Archaeological evidence distinguishes three cultural phases: Nasca (400 BC-550 AD), Wari (600-1100 AD) and Chíncha (1100-1412 AD). Since the Chíncha human remains were too exiguous (27 individuals), only Nasca and Wari were considered. For the Nasca population, sex ratio was 113 men to 100 women (53% males); for the Wari population, sex ratio was 117 men to 100 women (54% males). Life tables with zero growth and with a natural increase of 2.5% per year were created. Paleodemographic data show that first infancy was a critical age for survival: considering a natural increase of 2.5% per year, mortality between birth and 5 years was 22.4% for Nasca and 25.1% for Wari. Infant mortality rate was 33‰ for Nasca and 105‰ for Wari. Death percentages in all the age groups increased from Nasca to Wari phase. The paleodemographic study of the Nasca valley skeletal populations confirmed the archaeological hypothesis of worse conditions of the Wari population in comparison with the previous Nasca people (Drusini *et al.*, 2001). All teeth belonging to the Andes (Proyecto Condesuyos, Tablada de Lurín (Proyecto Loma de Lesix) were stored in the Arequipa University Museum.

## RESULTS AND DISCUSSION

We have identified 20 lower first permanent molars with supernumerary distolingual third roots (3RM1) in the Easter Island sample. In the Peruvian sample, we found 7.8% of 3RLM1 at Nasca, 1.2% at Tablada de Lurín, and 9% at Condesuyos. Supernumerary distolingual roots can occur on any of the three lower permanent molars, but they are much more common on M1 than on M3, and appear more frequently on these two molars than on M2 (Tratman, 1938, 1950; Pedersen, 1949; Turner, 1971; Loh, 1990); according to all investigators, it is extremely rare on M2. The distolingual root also occurs in low frequency on the deciduous first and second molars (Tratman, 1938; Jørgensen, 1956): Tratman (1950) says that if it occurs on dm2 it may be expected on M1. There are no deciduous molars in the present sample. Of all lower molars, 3RM1 is present on M1 in much greater frequency than on M2 or M3, which led Turner (1971:233) to suggest that the permanent first molar is the location for a "field-affecting gene(s)" controlling the development of the third root. To our knowledge, there is no study of the mode of inheritance of 3RM1 but because of its diachronic and population variation, Turner and Benjamin (n.d.) suggest that there is a "substantial genetic component in occurrence and expression."

The incidence of the distolingual root on M1 in the sexes as well as its presence on the left or right side is variable in the populations investigated to date (Tratman, 1938, 1950; Turner, 1971; Turner and Benjamin, n.d.; Loh, 1990). Moreover, some studies suggest it is a sex-linked dominant character (Tratman, 1938; Curzon and

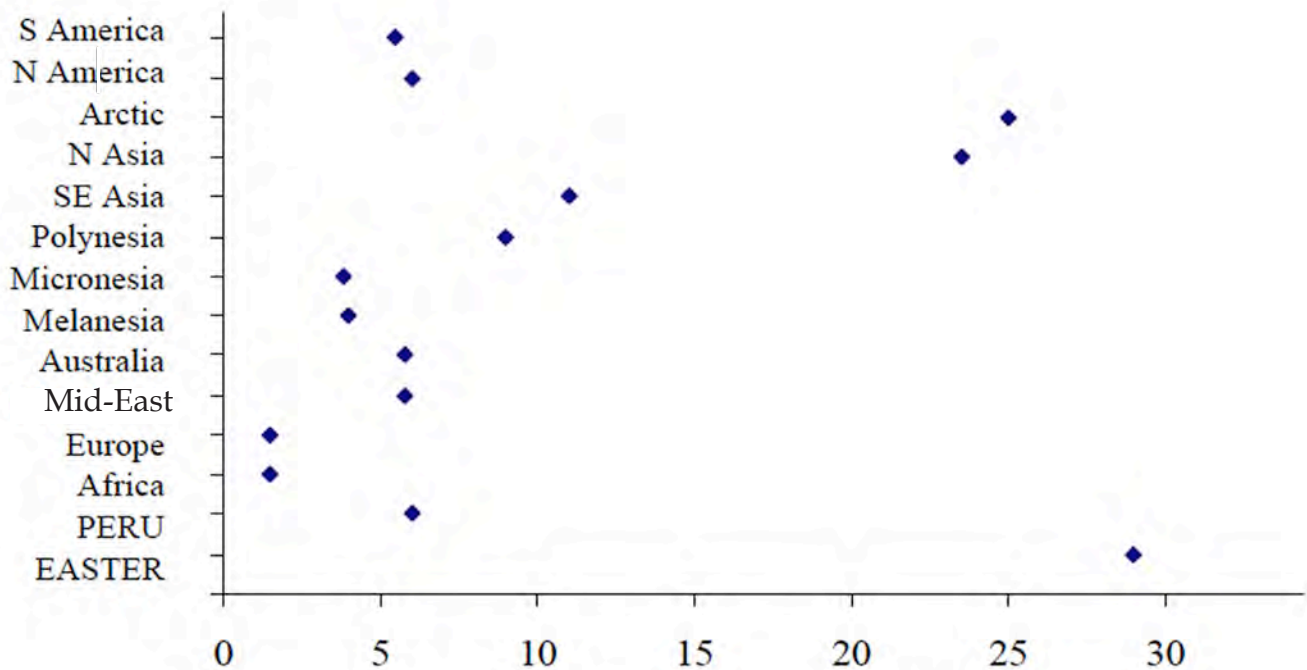


Fig. 2. Mean and range percentage of 3-rooted lower first molars (modified from Turner and Benjamin, n.d.).

Curzon, 1971; Hochstetter, 1971), while others claim that there is no sex predilection (Walker and Quackenbush, 1985; Loh, 1990). The third root originates from the lingual side of the distal root below the cervical border and appears to be a true supernumerary root in the Easter Island sample, which is in accord with Tratman (1938, 1950) and Turner's (1971) findings regarding the development of the distolingual root. The third root tends to be slender, somewhat conical in shape, divergent, and usually curved at the apical end towards the longer distal root; it is rarely as long as the distal root, although it varies in length and form. According to Tratman (1950) in his Asian sample, the distolingual root is only present on M1 when there are five cusps. Turner (1971) does not mention the number of cusps present on 3RM1s. In the Easter Island sample there is one 3RM1 with only four cusps. When the extra root is present on M3 there may be a reduction in the number of cusps, however the four cusped three-rooted molar just mentioned cannot be a third molar since there are two well formed contact areas on the mesial and distal surfaces of the crown. The extra root rarely appears on M2 but when it does, the crown is well formed and the fifth cusp is well developed.

The precontact Easter Island sample contained 20 lower molars with an extra root. As mentioned, we identified 70 M1s, 62 M2s and 40 M3s. This equates to 29% with 3RM1. If we add M2s to M1s the figure drops to 15% and if we add M3s to M1s it is 18%. These are all high percentages for Polynesia, and we believe

the more correct figure is around 29%. It is obvious that precontact Easter Islanders, based on the present sample, had a high incidence for Polynesia of 3RM1s. The 29% frequency for 3RM1 is considerably beyond the range for Polynesia except the sample of Easter Island skulls (of uncertain antiquity) that Turner and Benjamin (n.d.) studied, which had 21.8% 3RM1. It appears that Easter Islanders had, and still have, one of the highest frequencies of 3RM1 of all Polynesian populations studied to date.

The percentages of 3RM1 frequencies shown in Fig. 2 for the major cultural areas in the Pacific are the averages from Turner and Benjamin (n.d.). Within each of these areas the percentages for several different islands are shown and unfortunately, there are still many gaps in our information regarding the incidence of 3RM1s for many of the islands: there appears to be no west-to-east cline in the distribution of 3RM1. Rather, the frequencies are variable from island to island and tend to support the thesis proposed here of the importance of the founder principle and its effect on subsequent generations of new populations with few colonizers. In southern China and Southeast Asia, the average frequency of 3RM1 is 10 to 15%, although in historic samples from Sumatra and Java the frequencies are 23% and 16%, respectively. In Australia, the average is 10% and represents samples from various parts of the continent. In Micronesia (3%) and Melanesia (3%) the condition is virtually absent, in fact, it has not been found in New Guinea but is present in nearby New Britain (5%). In Fiji, the most easterly

group of islands in Melanesia, 3RM1s have the highest incidence in all of Melanesia, about 10%. This higher frequency may be associated with the stronger ethnic, cultural, and linguistic concordance between Fiji and Polynesia.

The three-rooted lower first permanent molars are found in a montage of frequencies in Polynesia. The trait is apparently absent on some islands (Samoa, Gambier, New Zealand/Chatham Islands, and the Tuamotu Islands [all historic samples], and a late prehistoric sample from the Marquesas islands). On Tahiti (historic) it is 10%, Mokapu (prehistoric) it is 12%, Society Islands (historic) it is 8%, Cook Islands (historic) it is 9%, and in the Loyalty Islands (historic) it is 7%. In a second sample of prehistoric-to-recent Marquesans, Turner and Benjamin (n.d.) report an incidence of 2.7%, while on Easter Island (uncertain of antiquity) it is 21.8%. It is interesting to note that a relatively high incidence of 3RM1 – comparable to Easter Island – is found routinely in the Arctic (average = 30%) and Northern Asia (average = 25%). In several of the indigenous populations of both North and South America frequencies ranging into the teens and low twenties are present even though the averages are 8 and 7% for the two regions.

It seems likely that the discovery of Easter Island was an accidental event from which return voyages were unlikely (Houghton, 1996). Such migration patterns are ideal for the operations of founder effect, genetic bottlenecks, and genetic drift. It is well known that such random factors can produce alteration of gene frequencies, especially in small populations. Also, it was not necessary for such small groups to have differed a great deal from the larger populations from which they became detached because when a new closed population is formed it can develop a unique genetic system of its own. Once established these genetic systems tend to persist. Because of this type of population deployment throughout both Near and Remote Oceania, there is the present mosaic pattern of genetic complexes, for example the variable incidence of 3RM1 or the variation of haplotype B, we find represented today in the Pacific.

### CONCLUSION

Except for the continent of Australia and the island of New Guinea, the Pacific Islands only started to be occupied some 5,000 years ago; some of the more easterly Polynesian islands little more than a 1,000 years ago. It is generally agreed that the major direction of migration has been from west to east, although there have been dissenting views from time to time (Heyerdahl, 1952; Bellwood, 1987; Terrell, 1990; Irwin, 1994). The mosaic distribution of 3RM1s in the Pacific islands is, in our opinion, the result of many genetic bottlenecks, which the settlers went through as they crossed the Pacific Ocean. The survivors of a bottleneck may have a very different genetic composition from the population prior

to the bottleneck, and in turn may become the settlers (founder effect) on another island. Such chance events result in genetic drift and have undoubtedly played important roles in regulating the past and present mosaic distribution of 3RM1s in these insular populations, an hypothesis first enunciated by Turner and Benjamin (n.d.).

*Note:* This paper is dedicated to the memory of Daris R. Swindler (August 13, 1925 – December 6, 2007).

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# Supernumerary Teeth from Two Mesoamerican Archaeological Contexts

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**ABSTRACT:** Supernumerary teeth are uncommon but have been well documented clinically. The majority of cases are isolated anterior teeth; examples of multiple or posterior supernumerary teeth are less common. This paper describes two examples of supernumerary teeth from archaeological contexts in Mesoamerica. The first case is of three individuals with supernumerary posterior teeth found in skull rows and pairs in a Postclassic Maya temple at the site of Ixlú in northern

Case studies of supernumerary teeth have been recorded clinically at least since the Paul of Aegina discussed their treatment in the 7th century among the Greeks, the 10th century in Persia, and the 18th century in France and Germany (Guerini, 1909). Although a rare trait, constituting a deviation in normal dental development, case studies of isolated supernumerary teeth are not uncommon in the clinical literature from around the world (Garvey *et al.*, 1999; Orhan *et al.*, 2006; Rajab and Hamdan, 2002; Scheiner and Sampson, 1997; Solares and Romero, 2004; see Yusof, 1990; Zhu *et al.*, 1996 for review articles). Case studies have also been reported in archaeological (Alt, 1990) and paleontological contexts reaching back to earlier hominids (Ripamonti *et al.*, 1999). Finding examples of nonsyndromic multiple supernumerary teeth is rarer however. In this paper I review what is known about frequency, nosology, location, ontogeny, function, and mode of inheritance of supernumerary teeth and describe cases from two archaeological contexts in Mesoamerica. The first context is a Postclassic Maya temple at the site of Ixlú in northern Guatemala in which there were 21 skulls arranged in rows and pairs. Three of these individuals had supernumerary mandibular teeth and 2 individuals exhibited them bilaterally. The second context is from Oaxaca, Mexico. An individual had one supernumerary tooth that was unerupted but visible due to broken mandible. I conclude the paper by discussing the cases' relevance to biological distance analyses.

## BACKGROUND

Supernumerary teeth are typically classified with reference to number of teeth, morphology (Kalra *et al.*, 2005), and location. The number of teeth is clinically meaningful because multiple supernumerary teeth are

Guatemala. Two of these individuals exhibited bilateral supernumerary mandibular teeth. The second context is a Zapotec burial from the Jalieza site in Oaxaca, Mexico. This individual exhibited a single supernumerary tooth. The paper reviews supernumerary teeth with regard to frequency, ontogeny, and mode of inheritance and discusses the cases' relevance for biological distance analyses. *Dental Anthropology* 2009;22(2):39-46.

typically syndromic (Fernández Montenegro *et al.*, 2006; Garvey *et al.*, 1999) and because increased numbers of teeth are more likely to require intervention (Högström and Andersson, 1987). Fernández Montenegro *et al.* (2006) classify morphology as eumorphic (retaining the normal features of a member of the tooth field in which they develop) and heteromorphic. They divide heteromorphic teeth into conical, tuberculate, molariform, and infundibular. Garvey *et al.* (1999) divide morphology into conical, tuberculate (having multiple cusps, which includes invaginated or barrel shaped teeth), supplemental (eumorphic), and odontome (further classified as either complex or compound). The last category, odontomes, is not universally agreed upon as a supernumerary tooth class (De Oliveira Gomes, 2008; Garvey *et al.*, 1999). In addition to normal tooth fields, location is frequently categorized as mesiodens, distomolars, or paramolars (Fernández Montenegro, 2006). However, some teeth that are inverted can also be classified as nasal (Alt, 1990; Hiranandani and Melgiri, 1968).

Assessments of population percentages exhibiting supernumerary are fairly consistent in the literature and range from 0.1-3.6% when including all teeth (Brook, 1974; Liu, 1995; Hopcraft, 1998; Scheiner and Sampson, 1997; see Luten, 1967 for review of earlier studies). Separating permanent and deciduous teeth suggests that the phenomenon is more common in the former (0.5-3.8%) than the latter (0.3-0.6%; Fernández

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Montenegro *et al.*, 2006; Scheiner and Sampson, 1997). The majority of these cases are single teeth (77-86%; Orhan *et al.*, 2006; Scheiner and Sampson, 1997; Rajab and Hamdan, 2002). Cases of multiple supernumerary teeth are less common and most often associated with syndromes, such as Gardner syndrome, or cleft lip and palate, or cleidocranial dysplasia. Orhan and colleagues (2006) note that over 20 conditions have been associated with supernumerary teeth.

Nonsyndromic cases of supernumerary teeth (hyperdontia) have been reported occasionally in the literature as well, though they are rarer (Bayar *et al.*, 2008; Desai and Shah, 2007; Gündüz and Muğlali, 2007; Kalra *et al.*, 2005; King, 1993; Leite *et al.*, 2007; Leslie, 1984; Moore *et al.*, 2002; Manrique Morá *et al.*, 2004; Mopager *et al.* 2002; Rosenthaler and Beideman, 1983; Ruhlman and Neely, 1964; Orhan *et al.*, 2006; Refoua and Arshad, 2006; Sasaki *et al.*, 2007; Sharma, 2001; Yusof and Awang, 1990; Yusof, 1990; Zhu *et al.*, 1996; see references therein for earlier case studies and Açıkgöz *et al.*, 2006 in particular for review). It should be noted that some researchers quantify supernumerary teeth as single teeth, doubles, or multiples, but count the latter category as having more than 5 extra teeth (*e.g.*, Arathi and Ashwini, 2005; Scheiner and Sampson, 1997), although it is unclear if this classification has any etiological basis. The highest number of nonsyndromic supernumerary teeth I have seen in the literature is 22, in a 10-year-old male (Rizzuti and Scotti, 1997). Açıkgöz *et al.* (2006) found a frequency of 0.06% of all cases of supernumerary teeth exhibited multiple teeth in a retrospective study. De Oliveira Gomes *et al.* (2008) found 37% of individuals with supernumerary teeth had more than 1, but only 2% had 5 or more.

Males are more affected by supernumerary teeth than females, and the reverse is true for congenital absence of teeth (Brook, 1974). Rajab and Hamdan (2002) report a male to female ratio of 2.2:1. Similar numbers were found by other studies (Mason *et al.*, 2002; Mitchell, 1989), but higher and lower estimates exist. Davis (1987) found a ratio of 6.5 males to every female in a sample of 1,093 Hong Kong school children (2.74% with a 95% confidence interval of  $\pm .9604\%$ ). Brook (1974) however found a male to female ratio of 1:0.7 among 1,115 white British school children (2.1% with a 95% confidence interval of  $\pm 0.83\%$ ). Given the overlapping confidence intervals in the estimates, the difference in sex ratio may be due to variation between populations or sampling fluctuation. There is some variability reported regarding the overall frequency of supernumerary teeth among populations. Brown (1990) and Zhu *et al.* (1996) report that Subsaharan African and Asian populations exhibit somewhat higher prevalence (between 2.7% and 3.4%) than that found in Brook (1974) and Luten (1967). That said, the relative population frequencies among the different categories and locations of supernumerary

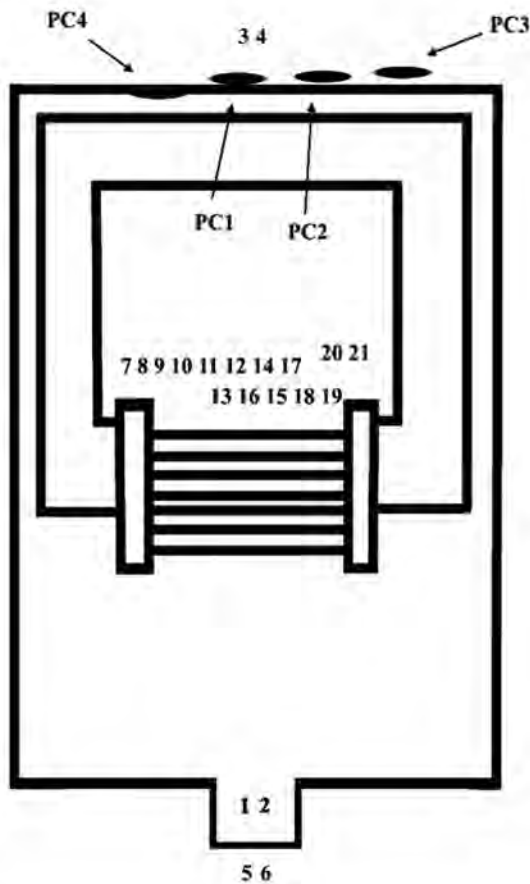
teeth are still unknown, so accurately characterizing interpopulation variability remains difficult.

Some studies report the most common supernumerary teeth are mesiodens (see Garvey *et al.*, 1999; Refoua and Arshad, 2006), which may reflect a high representation of European data in the literature because variation exists. Luten (1967) found the most common locations (in decreasing order) to be upper lateral incisors, mesiodens, upper central incisors, and premolars when both permanent and deciduous dentitions were combined. Orhan *et al.* (2006:891-892) note that the most common supernumerary teeth are mesiodens, followed in descending frequency by "maxillary fourth molars, maxillary paramolars, mandibular premolars, maxillary lateral incisors, mandibular fourth molars, and maxillary premolars." Also, Fernández Montenegro *et al.* (2006) found lateral incisors and canines to be rare relative to other, distal positions. Thus, while most studies find increased frequency in maxillary and anterior position, there is variability. There does seem to be agreement that when multiple nonsyndromic supernumerary teeth are present, they are most often premolars (Açıkgöz *et al.*, 2006; Solares and Romero, 2004).

As noted, multiple supernumerary teeth frequently are associated with syndromes. The actual mechanism resulting in supernumerary teeth is often attributed to independent, hyperactivity of the dental lamina in a localized context (Solares and Romero, 2004). Another explanation is that after supernumerary teeth could emerge from a dichotomized tooth bud (Brook, 1984; Leite, 2007; Moore *et al.*, 2002; see D'Souza and Klein, 2007 for review). A third, but less cited explanation is an atavistic origin (Hattab *et al.*, 1994; Marya and Kumar, 1998). Development of supernumerary teeth can happen at different times in life. Järvinen (1976) documented a case in which supernumerary teeth were extracted in a child and later X-rays disclosed that more supernumerary teeth had developed. What does seem clear is that although there may be some non-genetic or epigenetic involvement (Suda *et al.*, 2007), there is a genetic component (Batra *et al.*, 2005; Becker *et al.*, 1982; Desai and Shah, 2007; Langowska-Adamczyk and Karmańska, 2001; Marya and Kumar, 1998; Mercuri and O'Neill, 1980; Umweni and Osunbor, 2002) and it does not appear to be the result of simple Mendelian inheritance (Yusof, 1990). Studies have suggested that transmission of supernumerary teeth may be autosomal dominant (Batra *et al.*, 2005) or sex linked (Hattab *et al.*, 1994), the latter scenario might account for the higher frequencies in males.

### Case 1 – Ixlú

At the Maya site of Ixlú, in northern Guatemala, 21 skulls were found in pairs and rows in a Postclassic temple (Structure 2023; Fig. 1). The skulls were visually examined and were not radiographed. Three of these



**Fig. 1.** Position of skulls in pairs and rows at Structure 2023 in Ixlú, Guatemala. Locations are denoted by positions of the numbers, 1 through 21. PC stands for postcranial remains.

individuals exhibited supernumerary teeth (skulls 1, 7, and 16). All of these teeth were erupted with the exception of the left side supernumerary tooth on individual 1 (see below). Six skulls had been placed in pairs on the midline on the east and west sides of the building (skulls 1, 2, 3, 4, 5, and 6) in a late construction stage. Postcranial remains of 4 individuals were placed on top of this floor as well on the west side of the building perpendicular to the skull pairs. The postcrania lacked hand, foot, or cranial elements and exhibited cutmarks at the joints of the long bones. The long bones were placed on top of the axial skeletons in bone bundles (Duncan, 2005). The other skulls were placed in rows above the skull pairs, above a lower floor in the center of the building. It should be noted that there were two episodes of deposition and that skulls 1 and 2 appear to have been interred at the same time as the skull row (Duncan, 2005). Skulls 3, 4, 5, and 6 likely correspond to the four postcrania found behind the temple, though individuation proved impossible. All of the skulls were seated on the floors and faced east except for those clearly

overturned by root action. All skulls except for 2, 10, 11, 15, 18 had articulated cervical vertebrae underneath them. It should be noted that skulls 10 and 11 were only represented by fragments of cortical bone and could not be identified as separate skulls osteologically in laboratory analysis. However, they intersected a looter's trench, and it is parsimonious to include them in the final count of 21. It is likely that other skulls were also part of the rows and were originally located to the south of skull 13 prior to looting (Fig. 1). Sex was assessed by the use of standard anthroposcopic features described in Buikstra and Ubelaker (1994), with the omission of the mastoid process, which may be artificially hypertrophied in this culture area due to tumpline use. Three of the skulls in pairs and 8 of the skulls in rows could be assessed for sex, all of which were male (including skulls 1 and 7). Poor preservation precluded using cranial suture closure to assess age, but all of the skulls that could be observed were either late adolescent to adult in age on the basis of dental eruption. Markers that may have been used to distinguish young versus older adulthood (the sphenoccipital synchondrosis and the palate sutures) were not observable. Two of the skulls (2 and 5) exhibited frontooccipital cranial modification and skull 13 exhibited dental modification (Romero [1970] III-6 Style).

Skull 1, an adult male, exhibited bilateral supernumerary mandibular teeth. On the left side, the tooth was found between P4 and M1 and was lingual to the tooth row (Fig. 2). The tooth was tuberculate with a dominant buccal cusp and a weak lingual cusp. A small accessory mesial cusp was visible as well (Fig. 3). No occlusal wear was visible on the tooth, and it would not have been in contact with maxillary teeth. The alveolar bone was broken around this tooth, but it may not have been emerged in life. There is no evidence that it displaced



**Fig. 2.** Supernumerary teeth in skull 1, Ixlú, Guatemala. There is an extra premolar lingual to the distal premolar on the specimen's left side. Note that there also is a extra, conical tooth on right side of the jaw.



**Fig. 3.** Supernumerary tooth on left side from skull 1, Ixlú, Guatemala. Occlusal view from the buccal side. Scale 5 mm. Photo courtesy David Long.

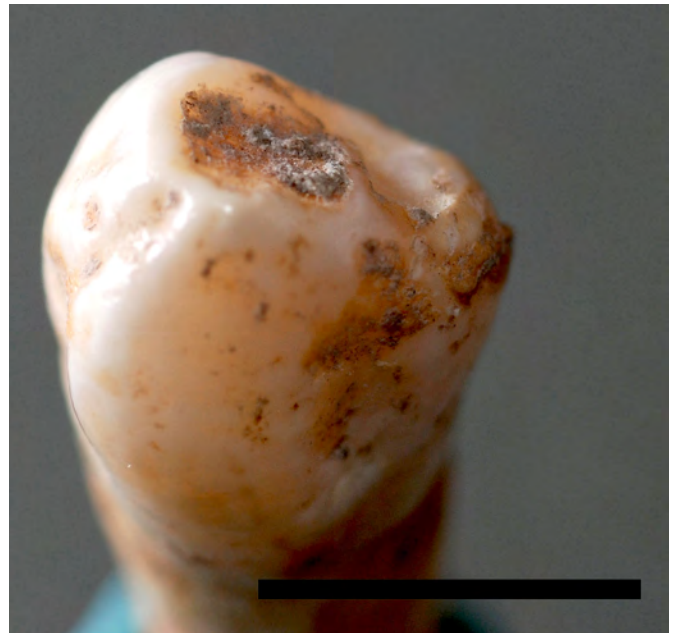
other teeth. The root appears to be incisiform, and no radicals were visible. The right side supernumerary tooth was between the canine and P3 and was also lingual to the tooth row (Fig. 2). It was conical with slight lingual invagination and had no occlusal wear. The tooth root was broken near the cemento enamel junction. Poor preservation precluded assessing if the adjacent teeth would have been displaced. There is no evidence that other teeth were altered in size.

Skull 7, an adult of unknown sex, exhibited bilateral supernumerary mandibular teeth. The left supernumerary tooth was lingual to P3, displacing it buccally (Fig. 4). The supernumerary tooth was molariform, exhibiting 5 cusps and had a talonid. It was in occlusion and the roots could not be observed. No wear was present, and it would not have made contact with maxillary teeth unless other teeth had worn down considerably more. The right supernumerary tooth was between P3 and P4, though mesial to the tooth row (Fig. 5). It was tuberculate, exhibiting a single primary cusp and an accessory distal cusp. The tooth was not well preserved and the apex of the root was broken. It was not in occlusion and it is unclear if it would have displaced other teeth. There is no evidence that other teeth were altered in size.

Skull 16, a late adolescent to adult of unknown sex, exhibited a single supernumerary mandibular tooth (Fig. 6). The tooth was mesial to the other premolars and between P3 and P4 on the right side. The tooth was tuberculate with a dominant buccal cusp and 2 lingual cusps of roughly equal size. The buccal side exhibited



**Fig. 4.** Supernumerary tooth on left side from skull 7, Ixlú, Guatemala.



**Fig. 5.** Supernumerary tooth on right side from skull 7, Ixlú, Guatemala. Occlusal surface from lingual view. Distal cusp is on the right. Scale 5 mm. Photo courtesy of David Long.



**Fig. 6.** Supernumerary tooth from skull 16, Ixlú, Guatemala. Scale is 5 mm. Photo courtesy of David Long.

2 grooves on it. The tooth was not in occlusion and no wear was evident. The root was longer buccolingually than mesiodistally and exhibited no radicals. The apex of the root was not closed. Preservation precluded observing whether or not other teeth were displaced because of the supernumerary tooth, though it is likely that it did given its size and location. The third molars were bilaterally somewhat smaller than the other teeth, though it is unclear if this stems from the supernumerary tooth.



**Fig. 7.** Supernumerary tooth from individual at Jalieza, Oaxaca, Mexico. This tooth (unerupted) is visible in the alveolus because it has resorbed the buccal aspect of the bone adjacent to it. Its position is between the roots of the two erupted premolars. Scale 5 mm.

**Case 2 - Jalieza**

The second context that yielded a supernumerary tooth was a Late Classic period burial from the Zapotec site of Jalieza in the Oaxaca valley. The individual was an adult male. The supernumerary tooth was unerupted and was only visible because the surrounding alveolar bone was broken. The dentition was visually assessed and was not confirmed with an X-ray. The tooth was visible on the left buccal side of the mandible and was between P3 and P4 (Fig. 7). It was superior and mesial to the mental foramen. Neither the crown nor root morphology was visible. There was no evidence of displacement of any of the teeth but the third molar on the left side was absent (Fig. 8).

**DISCUSSION**

The Ixlú case stands out primarily because of the likelihood of finding three individuals in such a small sample with supernumerary teeth is so low. There have been no studies on the frequency of supernumerary teeth in Mesoamerican populations, but two Maya biodistance studies have found them. Jacobi (2000) found 3 cases of supernumerary teeth at Tipu out of over 500 burials. Two were single teeth and 1 individual had 2 supernumerary teeth. All were maxillary. Lang (1990) found a total of 13 supernumerary teeth in her study at Lamanai out of 89 individuals. Six of these were maxillary and resemble Jacobi's description. However, 7 were mandibular and resemble what I found at Ixlú, based on Lang's (1990) description. In a clinical context Hopcraft (1998) found that 1.6 to 3.1% of people have supernumerary teeth but only 3 to



**Fig. 8.** Absence of left mandibular third molar from individual at Jalieza, Oaxaca, Mexico. Scale 5 mm.

10.9% of supernumerary teeth are in the premolar field, a range consistent with aforementioned citations. If one accepts the interval of 1.6 to 3.1% as the range of frequencies for some manifestation of supernumerary teeth (and there is no current evidence to think it is more common among the Maya than that) the average is 2.35%, and the average of 3% and 10.9% is 6.95%. 6.95% of 2.35% is 0.16% or a 1 in 625 chance of having this trait. I used the resampling software (and modified the "birthday program"; Simon, 1990) to estimate the likelihood of finding 3 of 17 individuals having mandibular supernumerary teeth with this frequency. Only 17 individuals were observable for the trait. If the likelihood of finding mandibular supernumerary teeth is 1 in 625, then one can randomly select 17 numbers from 625. This was repeated 10,000 times, out of which 17 times or 0.2% that the same number came up 3 times, which is statistically significant and suggests that the individuals were likely related, although at what level remains unclear.

The two cases described here also highlight three potential problems with using supernumerary traits in biodistance analyses. The first problem, highlighted by the Jalieza case, is that many supernumerary teeth are subclinical in life and invisible in death because they do not emerge so including them in such analyses may actually obscure relationships. This is consistent with Açıkgöz *et al.* (2006) who found 30 of 37 supernumerary teeth they studied to be impacted. Certainly such traits have utility, but are other people in the skull rows and pairs who have supernumerary traits just not being counted? The second problem, also highlighted by the Jalieza case, is that there may be interactions between tooth fields. The congenital absence of the third molar on the same side may or may not be due to the supernumerary tooth, but accounting for the correlation if you are using both as separate traits is necessary. This may mimic examples in which supernumerary teeth were found in conjunction with atypical morphodifferentiation (Manrique Morá *et al.*, 2004). Finally, the Ixlú cases suggest that supernumerary teeth likely should be scored as present or absent in biodistance analyses. The fact that the left supernumerary tooth is highly molariform and the right is much simpler in skull 7 at Ixlú may suggest that influences reflect environmental influence. Similar heterogeneity has been found in individuals with many more supernumerary teeth as well (So, 1990). This could be true whether they are attributable to the splitting of the tooth bud or localized or independent activity of the lamina.

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# Dental Morphology Symposium at the Baltic Sea Coast of Northern Germany

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The International Dental Morphology Symposia have been held since 1965, when P. O. Pederson invited enthusiastic scientists to Fredensborg, Denmark. As the most recent meeting, the 14th International Symposium on Dental Morphology (14th ISDM) was held in Greifswald, a small town on the Baltic Sea Coast of northern Germany. Despite its somewhat remote location in Germany, Greifswald is quite well known as the birthplace of the famous German Romantic landscape painter Capar David Friedrich (1774-1840). Hosted by Thomas Koppe (Greifswald), Georg Meyer (Greifswald) and Kurt W. Alt (Mainz), the 14th ISDM took place from August 27 to 30, 2008, at the Department of Anatomy and Cell Biology of one of the oldest universities in northern Europe. Over 150 dental scientists attended it from 27 countries throughout the world, notably 25 students.

Over the years, the Dental Symposia have been inspired and supported by a number of outstanding individuals. Due to their exceptional contribution to dental morphology, the recent Dental Morphology Symposium in Greifswald was dedicated to the memory of Daris R. Swindler, Stanley M. Garn, and Coenraad F. A. Moorress. In a special lecture, B. Holly Smith (University of Michigan) remembered these three greats of dental anthropology.

Like the former dental morphology symposia, the recent symposium was designed as a single-session, four-day meeting. The 14th ISDM was organized around sessions on (1) dental evolution, (2) dental morphology, (3) dental tissues, and (4) dental growth and development. Due to the recent advances in dental medicine and archaeology, sessions on clinical aspects of dental morphology, as well as on teeth and reconstruction of the past were also included in the recent Dental Symposium. Finally, extensive time was given to a well-attended poster session. In an early stage of preparation of the 14th ISDM, B. Holly Smith (Ann Arbor, MI), Mark F. Teaford (Baltimore, MD), Moya M. Smith (London, UK), Inger Kjaer (Copenhagen, Denmark), Alan Brook (Liverpool, UK), and John R. Lukacs (Eugene, OR), all leading experts in their field, were approached to act as chairpersons. These chairpersons had a great impact on the organization, e.g. by allocating suitable papers to the individual oral



**Fig. 1.** Alan Brook (Liverpool, UK), who chaired the session on Clinical Aspects of Dental Morphology, and Richard N. Smith (Liverpool, UK).

and poster sessions. Each session was composed by a keynote lecture, followed by two invited talks, and a number of contributed oral presentations. A total of 72 oral papers and 50 posters were presented in Greifswald.

A jury, formed by all chairpersons (see above), awarded two poster prizes. The best student poster was presented by Cyril Charles (University of Poitiers, France) for the study "Comparison of jugal tooth morphology in Tabby/eda and Downless/edar mutant mice", co-authored with S. Pantalacci, P. Tafforeau, V. Laudet, and L. Viriot. The Faculty Poster Prize was awarded to Gary T. Schwartz (Arizona State University, USA) for the study "The ontogeny of masticatory system

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**Fig. 1.** Inger Kjær (Copenhagen, Denmark), who chaired the session on Growth and Development of Teeth, and Georg Meyer (Greifswald, Germany).



**Fig. 1.** Moya M. Smith (London, UK), who chaired the session on Dental Tissues, talks with colleagues.

configuration in humans and its influence on the timing of molar eruption," co-authored with M.A. Spencer.

The Dental Morphology Symposia have always been most enjoyable meetings because of their special atmosphere. As it was the case in the former symposia, the organization of the present symposium was driven by the idea to provide as many as possible opportunities for the participants to meet and to discuss subjects that sparked their interest with like-minded researchers. It was quite rewarding for all of us to enjoy the keynote talks from Ottmar Kullmer (Frankfurt, Germany), Callum F. Ross (Chicago, USA), Christopher Dean (London, UK), Tanya M. Smith (Leipzig, Germany), W. Paul Brown (Stanford, USA) and Simon Hillson (London, UK), or simply to watch the participants chatting while enjoying coffee and cake (handmade and donated by members of the Department of Anatomy and Cell Biology) throughout the day. The more than 150-year-old Department building proved to be a most suitable place as all conference facilities were on-site. Several researchers took the chance to walk around the comparative anatomical collection of the Department of Anatomy, quite a number of them equipped with callipers and high-class digital cameras.

Apart from the scientific sessions, each day was filled with activities such as an informal welcome party on the eve before the opening, a welcome reception at the new dental school of Greifswald University, and a barbecue party in conjunction with the poster sessions. As a good tradition of the dental symposia, a half-day was reserved for a tour that included a guided walk through the city of Greifswald, a cruise on the Baltic Sea, and a visit to the monastery remains of Eldena (extensively silhouetted by Caspar David Friedrich). In the evening, the participants were invited to a dinner at the Pomeranian State Museum. Superior food, classic music presented by the Auris-Quartett (Berlin, Germany) and several guided tours through the exhibitions of the museum was certainly a highlight of that day.

After a vivid discussion about the next venue, the majority of participants decided to stay within Europe and voted for Newcastle or London as the next meeting place in 2011.

The results of the 14th ISDM will be published at the end of 2009 as Volume 13, entitled "Comparative Dental Morphology" (in the series *Frontiers of Oral Biology* at Karger, Basel, Switzerland). Those who had been chairpersons serve as co-editors of the volume that will contain a maximum of 30 papers allocated around the six topics of the symposium.

The organization of the symposium was kindly supported in many ways by the staff and students of the Department of Anatomy and Cell Biology, Ernst Moritz Arndt University Greifswald, who worked hard to run everything smoothly.



**Fig. 4.** Ottmar Kullmer (Frankfurt, Germany), one of the keynote speakers, talks with colleagues.



**Fig. 5.** Yukishige Kozawa (Matsudo, Japan).



**Fig. 6.** Group photo of the participants at the 14th International Symposium on Dental Morphology, Greifswald, Germany.



**Fig. 7.** Impression of the lecture hall during a talk. In front is Kurt W. Alt (Mainz, Germany), one of the hosts of the Dental Morphology Symposium.



**Fig. 8.** Thomas Koppe (Greifswald, Germany), one of the hosts of the Dental Morphology Symposium, together with Thor-Magnus.



**Fig. 9.** Christopher Dean (London, UK), who delivered the keynote talk on Dental Tissues, together with Thomas Humme (Berlin, Germany), and Thomas Koppe (Greifswald, Germany).

## Case Report: Patent Mandibular Symphysis with Congenital Absence and Ankyloglossia

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**ABSTRACT** The mandible develops prenatally as left and right halves (hemimandibles) that meet at a suture in the anterior midline. This suture normally is obliterated in the first year of life. We describe a 4-year-old girl in whom (A) this suture (*symphysis menti*) is only partially fused, (B) the primary lower left central incisor is congenitally absent (and also its permanent successor), and (C) there is pronounced

ankyloglossia. These midline problems share a common etiology, namely incomplete fusion of the halves of the first branchial arch. No cause is suggested, but the embryological problem seems to stem from inadequate streaming together of the mesodermal cores of the first branchial arches. Similar cases with the dental and bony aspects of this condition should be identifiable in skeletal remains. *Dental Anthropology* 2009;22(2):54-58.

As is well known, the human mandible develops from the first branchial arches, and it ossifies before birth as separate left and right hemimandibles that meet ventrally at the mandibular symphysis (*symphysis menti*). Overviews of the embryology of the mandible are provided in Arey (1965), Corliss (1976), Scheuer and Black (2000), and most textbooks on mammalian embryology. At birth (Fig. 1), the mandibular midline is patent, though this suture normally fuses and is obliterated during the first year of life (Fig. 2). After symphyseal fusion, the mandible is rigid, and masticatory forces from the working side are transmitted through the chin to the balancing side. The need for resistance to torsion has been cited as a cause of development of the uniquely human chin (*e.g.*, Sicher, 1947; DuBrul and Sicher, 1953; Schwartz and Tattersal, 2000), which occurs principally in adolescence (Ricketts, 1972).

Rarely, the mandibular symphysis fails to fuse, and the present case report describes such an anomaly in a 4-year-old girl who also exhibits congenital absence of a primary incisor in combination with ankyloglossia. Persistent patency of the *symphysis menti* is an easily observed condition in skeletal material, so this report may be of interest to skeletal biologists. Moreover, it may stimulate readers to share similar findings.

### CASE DESCRIPTION

The subject is a healthy American black girl who was 4.0 years of age at examination. She was seen in a pediatric dental setting for routine restorative work. Examination revealed 19 primary teeth with apparent congenital absence of the primary mandibular left central (tooth 71 in the FDI system; tooth O in the Universal system). Decay was seen clinically on the occlusal surface of all 8 primary molars and interproximally on bitewing radiographs. Mesial caries can be seen radiographically on the primary left maxillary

central incisor (tooth F).

The girl was treatment-planned for stainless steel crowns on the 8 primary molars, a mesial lingual resin on tooth F, and a lingual frenectomy. Due to her young age, her multiple treatment needs, and her acute situational anxiety, it was recommended that the procedures be performed under general anesthesia. However, the patient moved out of state before treatment could be performed.

The prominent frenum that ties the tip of the tongue to the floor of the mouth (and limits tongue mobility) is



**Fig. 1.** Occlusal view of the left and right hemimandibles of a near-term infant showing (A) the independent development of the two halves of the formative mandible and (B) the rough surfaces where they meet at the ventral midline.

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**Fig. 2.** Lingual view of a deceased infant's mandible showing incomplete but on-going fusion of the hemimandibles.



**Fig. 3.** Extraoral photograph of the girl showing the partial ankyloglossia with prominent soft tissue attachment (frenum) encroaching on the space of the missing left central primary incisor.

an obvious feature in this girl (Figs. 3 and 4), but what caught our attention was the persistent mandibular suture that is evident on X-ray (Fig. 5). The hemimandibles are effectively fused together, but patent remnants of the suture are evident on the cranial and caudal aspects of the midline, and the open suture extends at least half a centimeter down through the mandibular alveolus.

### Mandibular symphysis

Textbooks routinely note that the suture between the two hemimandibles fuses "within the first year of life," though we have been unable to find more definitive statistics. Molleson and Cox (1993) studied the Spitalfields collection and found that the two hemimandibles were always separate before 3 months of age, but most

had initiated fusion by 6 months of age. At 4 years of age, the girl's suture described here is clearly delayed, if indeed fusion is still ongoing.

### Ankyloglossia

The tongue develops from the presumptive floor of the mouth (branchial arches I and III), and endoderm immigrates around the developing tongue during post-conception week 5. The apoptosis (selective cell death) of this endoderm is necessary for the mobile region of the tongue to be freed from the base (Fig. 5). Some of these cells persist in the midline and form the frenulum of the tongue, which is the membranous strand that ties the anterior, mobile portion of the tongue to the floor of the mouth. It is not uncommon for this tissue (the lingual frenum) to be prominent in infants and children, which can limit tongue mobility. This typically is of little concern because the frenulum regresses and stretches with age, particularly during infancy (*e.g.*, Wright, 1995; Lalakea and Messner, 2003). However, the prominence and extent of the ankyloglossia in this girl (Figs. 3-4) clearly is outside of normal limits. This is obvious (Fig. 4), where the girl is incapable of protruding here tongue because it is tethered to the floor of the mouth, with the frenum being continuous with the lingual gingiva (Fig. 3). On the other hand, the girl's labial vestibule (*i.e.*, separation of the lower lip from the gingival ridge) is normal, and there is no hint of notching or clefting of either lip.

True ankyloglossia (fusion of the whole tongue to the floor of the mouth) is a particularly rare event—to the point that clinician's commonly use "ankyloglossia" to refer to the lesser "tongue tie" condition, where it



**Fig. 4.** Extraoral photograph of the girl showing how her ankyloglossia prevents normal tongue movement.

is just the persistent midline fibrous band that limits tongue mobility (which can interfere with chewing, swallowing, and speech). For example, Kotlow (1998) proposed a 5-grade scale to score the extent of ankyloglossia, ranging from a normal range of function (grade 0) up to “complete” ankyloglossia (grade IV) where less than 3 mm of the ventral tip of the tongue is mobile. This system may be useful clinically, but it ignores the developmental scenario where apoptosis (selective cell death) fails altogether and the tongue remains fused to the floor of the mouth.

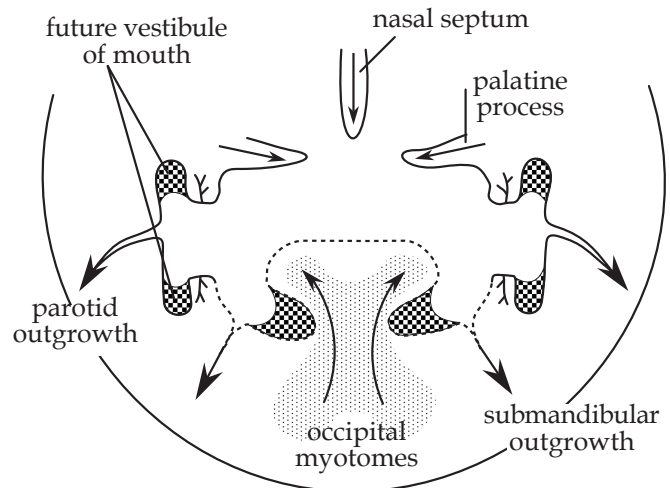
Clinically, treatment of ankyloglossia (*i.e.*, excision of the frenum) seems unwarranted in most cases. Treatment should be limited to cases with documented speech, functional, occlusal or periodontal problems. The tongue is always short at birth, but, with growth, the tongue becomes longer and thinner at the tip. Many cases are self-correcting (due to frenum stretching and tongue growth), which accounts for the comparatively low frequency of ankyloglossia in adults.

### Congenital absence

Figures 3 and 6 show that the lower left primary central incisor is absent. This tooth normally emerges around 6 to 8 months of age (Tanguay *et al.*, 1984), and there is no suggestion from inspection of the alveolus that it might have been exfoliated in this 4-year old. Moreover, the mother stated that this tooth was never present, so we conclude that the tooth is congenitally absent. The claim for absence of the primary left central incisor is supported by the congenital absence of its permanent successor (Fig. 6). Since a primary tooth’s successor develops from a lingual offshoot of the primary tooth bud (*e.g.*, Avery, 1994), the absence of a primary tooth greatly increases the risk of its successor also being absent (*e.g.*, Grahnén and Granath, 1961).

We suspect that it more than coincidental that the prominent frenum (Fig. 3) is located right at the site of the incisor’s congenital absence. It is speculative, but the developmental disorder that failed to remove the presumptive frenum from the ventral midline may also be responsible for the incisor’s agenesis (or aborted development).

Dahlberg (1945, 1951) probably was the first to describe the reversal of the morphogenetic field in the mandibular incisors, where the central incisor is smaller, and more variable metrically and morphologically than the lateral incisor—but he provided no interpretation of the reversal, which is unique (all other fields exhibit greater variability of the distal tooth). Other studies (reviewed in Endo *et al.*, 2007) suggest that simple hypodontia is tied to craniofacial issues of development, such as short cranial base and maxillary lengths, mandibular prognathism, and diminished anterior facial height. Kjaer (1980) suggests that the poorer vascularity at the *symphysis menti* enhances the variability of the

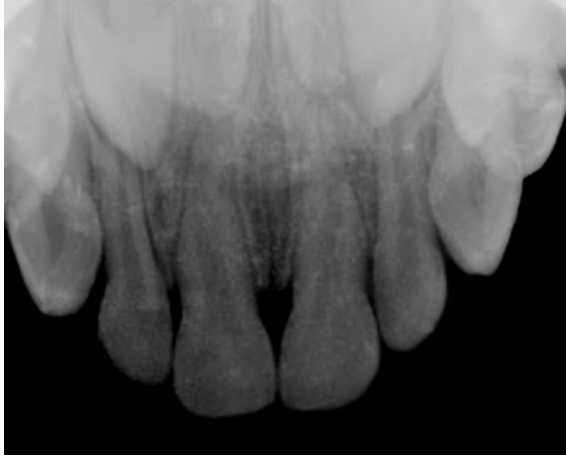


**Fig. 5.** Schematic cross-section of the developing embryonic mouth showing the pathways taken by the formative tissues. The epithelial surface shown as a solid line is ectodermal; the epithelial surface marked as a dashed line is endodermal. The cross-hatched epithelial area degenerates, forming the vestibule of the mouth and freeing the tongue from the floor of the mouth. Modified from Snell (1975).



**Fig. 6.** Occlusal radiograph of the girl’s mandibular anterior region. The *symphysis menti* (top arrow) is patent for several millimeters in the cranial region of the midline. A 3-4 mm patency also is visible on the caudal margin of the symphysis (bottom arrow). The primary left central incisor is congenitally absent—as is its permanent successor—but the other three permanent incisors are forming and are completing crown formation. The missing permanent incisor would have been located almost directly beneath the open suture visible between the primary incisors. (Note that orientation is reversed in this radiographic view, so the child’s left quadrant is to the right side of the picture.)





**Fig. 7.** Occlusal radiograph of the girl's maxilla showing complete tooth formation and eruption of the four primary incisors as well as mineralization of the four succedaneous incisors.

central incisor.

The present case may, however, reflect a local rather than systemic problem, where whatever caused the ankylosis (failure of apoptosis) also caused (A) failure of the incisor to form and (B) arrested fusion of the suture. These defects all involve formation of the first branchial arch, and their common locus at the midline may be due to inadequate mesodermal penetration into this arch's midline (Godbersen *et al.*, 1987). Similar cases (reviewed in Eastlack *et al.*, 2000) report additional midline defects in various individuals, such as dermoid cysts, ectopic salivary glands, bifid tongue (or aglossia), congenital absence of mandibular incisors, and cleft lower lip. Again, these conditions suggest incomplete fusion of the first branchial arch as the common etiological problem (Gardner and Moss, 2005; Mendis and Moss, 2007).

### Syndrome

We initially speculated that this girl's triad of (1) missing central incisor, (2) ankyloglossia and (3) persistent symphyseal suture constituted some sort of midline developmental defect, with incomplete left-right differentiation of the face. The symptoms probably involve a simpler, less dramatic situation. Scrutiny of the girl's maxilla revealed nothing unusual: Both maxillary incisors (primary and permanent) are of normal size and morphology, and the intermaxillary suture is obvious (Fig. 7). These left-right features argue against a problem with embryonic division as found in various sorts of holoprosencephaly (*e.g.*, Krauss, 2007; Shiota *et al.* 2007).

### OVERVIEW

The case described here has three developmental defects, namely (1) pronounced ankyloglossia, (2) congenital absence of a primary lower incisor (and its

permanent successor), and (3) incomplete fusion of the *symphysis menti*. The common etiology of these problems is speculated to be incomplete embryonic fusion of the left and right first branchial arches that should have occurred during week 5 postconception.

These dental and bony anomalies are readily identifiable in the skeletal record, and we would be interested in hearing about similar cases.

### ACKNOWLEDGEMENT

We are grateful to our former resident, Dr. Jonathan Gooch, for bringing this case to our attention.

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## Obituary: Shelley Rae Saunders (1950–2008)

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Shelley Saunders, a distinguished physical anthropologist and well loved professor at McMaster University in Canada, finally succumbed in 2008 to the cancer that had haunted her through the last decade and a half of her life. She was no pushover for the disease, which struck first in the early 1990s, and was thought to have been cured, but which returned again, resulting in the loss of both of her kidneys in 2003. This necessitated daily haemodialysis that constrained her ability to travel, but had no material effect on her research output and her teaching until the cancer reappeared in her pancreas more than four years later. Her audacious battle was emblematic of the way she approached life. She resisted, uncomplaining, with great fortitude and with all of her might until the very end. Shelley did not need urging not to go gently into that good night, nor to rage, rage against the dying of the light. Nevertheless, she was taken in the early autumn of her life; there are few of whom it can so sincerely be said, she had so much more to give.

In many respects Shelley was a renaissance scholar in our field, as a glance at her bibliography will show. Her primary focus was on dental and skeletal biology and bioarchaeology and forensics, but her scope of interest was very broad. She also published on evolutionary theory, demography, isotopic and palaeodiet studies and was a pioneer in ancient DNA. Her honours are legion and her career is marked by a long series of “firsts”. She was the first biological anthropologist to be elected to the Royal Society of Canada, a signal honour. She was in the first tranche of Tier 1 Canada Research Chairs, a federal grant, tenable for seven years, awarded to outstanding researchers acknowledged by their peers as world leaders in their fields. Shelley initiated the Children and Childhood in Human Societies research network. She founded and established an ancient DNA laboratory at McMaster, now called the McMaster Ancient DNA Centre, and she created and later expanded the McMaster Anthropology Hard Tissue and Light Microscopy Laboratory to study growth and development. Although set up to investigate both bones and teeth, concentration in the last decade or more had been on teeth, with particular emphasis on odontochronological analysis in deciduous teeth. She was the recipient of many academic awards, but despite her elite stature in Canada she was



**Fig. 1.** Shelley at work in her laboratory (photo courtesy of the *Hamilton Spectator* newspaper).

an extraordinarily humble person—quiet, reserved, gentle, kind, and scrupulously fair—more likely to talk about the achievements of her many students than about her own.

Devotion to her students was one of Shelley’s hallmarks. She loved to teach and was indeed an educator of distinction, someone who relished training bright

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**Fig. 2.** A younger Shelley in front of an unidentified Mesoamerican pyramid.

minds. She was dedicated to getting undergraduates engrossed in learning and discovery. She invented innovative ways to achieve this, and was famous amongst students for her Bone Groan quizzes, for her dental Jeopardy games, her Bioanth Bingo and skeletal crossword puzzles. However, Shelley's greatest enjoyment came from working with and developing her graduate students, and she took enormous pride in their accomplishments. Her skilled supervision and devoted mentorship earned her the President's Award for Excellence in Graduate Supervision at McMaster and her former students now teach at universities across Canada, the United States and Europe. One of her last acts demonstrates her commitment to students. At her behest, just days before her death, she and her family established the Shelley Saunders Graduate Scholarship with a generous donation of \$500,000, which was supplemented by contributions from friends and well wishers of another \$50,000. This fund will sponsor annually two graduate students who wish to pursue research in dental or skeletal biology at McMaster. The Canadian Association of Physical Anthropologists, of which she was an active member through her whole career, has also established a grant in her honour to

provide supplemental research funding for graduate students.

Shelley grew up in Toronto and New Jersey and met Victor Koloshuk, her beloved husband of 37 years, while they were both undergraduates. She received her Ph.D. in Anthropology from the University of Toronto in 1977, defending her dissertation while pregnant with their first child, Robert. After the birth of their second child, Barbara, and after teaching anatomy at McGill and contract teaching at the University of Toronto, she was offered a tenure-track position in the Department of Anthropology at McMaster University in 1981. She went on to become the central pillar of McMaster's program in physical anthropology and her numerous research projects over the years received international recognition. Among the most notable was a complex, multidisciplinary project that she directed on a large nineteenth-century cemetery from St. Thomas' Anglican Church in Belleville, Ontario, which presented the rare opportunity to work with skeletal and dental material associated with individuals of known age-at-death. Shelley's projects also took her to Europe, for instance to the University of Bordeaux where she was involved in the analysis of a medieval population from south-western France, or the Czech Republic where she conducted histological analysis of ancient Egyptian pharaonic samples. She developed a particularly rich collaboration with Italian colleagues from the Pigorini Museum in Rome on the Imperial Roman site of Isola Sacra. She was also familiar to the Canadian media through her work in forensic anthropology for the Hamilton Regional Forensic Pathology Unit and a number of local and Royal Canadian Mounted police forces, where some of her cases often received considerable attention. Shelley had a very prolific publication record, amongst which were six co-edited volumes, the latest, *Biological Anthropology of the Human Skeleton*, co-edited with Anne Katzenberg, was published in March of 2008. She served on the editorial board of the *American Journal of Physical Anthropology* from 1994 to 2000 and was North American Editor of the *International Journal of Osteoarchaeology* until shortly before her death.

Shelley was a great teacher, a nonpareil researcher, an expert biological anthropologist, a wonderful colleague, an avid gardener and opera fan, and before dialysis curtailed it, someone who loved to travel. She possessed all of the qualities required for distinction in any field: keen intelligence, great tenacity, the capacity for hard work, terrific organising and planning skills, and an ability to extract the best from those around her. She will be remembered with deep affection by a host of current and former graduate students, friends, and colleagues. Her contributions to our field will also be sorely missed.

## Shelley R. Saunders

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*Compiled by:*

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# Minutes of the Dental Anthropology Association Business Meeting April 3, 2009, Chicago, Illinois

Meeting began: 7:06 P.M

Attendance: 24 members

## President's Comments:

Brian Hemphill welcomed all of the attendees to the meeting, and he introduced several points of business in his opening remarks. The four principal items mentioned were: the election of a student representative to the Executive Board; making the DAA a 503c (defining the DAA a non-profit organization); the lack of submissions of articles to *Dental Anthropology*; and, fourthly, possible methods of correcting this, such as soliciting dental anthropology articles following the AAPA meetings.

## Reports:

### Editor:

Two issues of *Dental Anthropology* were published in calendar year 2008 (volume 21), for a total of 64 pages. Six original articles were published, one short communication, and eight other reports. These latter reports include two obituaries of long-time Association members, Daris R. Swindler (1925-2007) and Ebba During (1937-2007).

For the past few years, *Dental Anthropology* has been e-mailed to all members in a PDF format that supports color photographs, and members also have the option of obtaining a printed (hard-copy) version of the journal. (It is necessary to alert the DAA Secretary-Treasurer and/or mark the option on the annual dues form so we'll know you want also to receive the print version). The majority of the members have opted for just the PDF version of the journal, and members are reminded that all of the past issues are available for complimentary download from the Association's website, which is hosted by the Department of Anthropology at the Ohio State University.

The submission policy for *Dental Anthropology* is now handled almost exclusively by e-mail rather than by mailings, which has greatly facilitated the publication process, making it easier for authors and the editor's office. Submission information is listed in each issue on the inside of the back cover of the journal.

## Secretary-Treasurer's Report:

Total membership: 146 members; approximately 60 international members; and 15 institutions.

Proposal for discontinuing processing credit cards through Wells Fargo. The DAA, from December 2007 to December 2008, deposited \$515.00 from credit cards and paid \$582.00 in fees. As of April 1, 2009, the processing fees have gone up again.

It was proposed and accepted by the Executive Board to hire an outside contractor to set up a PayPal account, membership database, etc.

In addition, USPS mailing fees have risen dramatically over the past two years without any corresponding increase in dues in the DAA. Many of the mailing requests are from outside the United States, so the Association has lost money on these subscriptions for 2008 and 2009.

## New Business:

1. Proposal: Raising Annual Dues and additional Shipping and Handling Fees for paper copies.

### NEW FEES:

|                     |         |
|---------------------|---------|
| Regular members:    | \$25.00 |
| Student members:    | \$15.00 |
| Shipping surcharge: | \$ 5.00 |

It was discussed that perhaps raising the student fees to \$15 would be burdensome to the students. Students present at the meeting, stated that the increases in fees are reasonable. By comparison, fees for the Paleoanthropology online journal are \$30.00 for regular members and \$25.00 for students.

Proposal to raise annual dues and additional shipping surcharge charges was voted upon and accepted. Fees will increase beginning in the calendar year 2010.

## 2. Dahlberg Award

This year, a lack of submissions prevented awarding of the Albert A. Dahlberg in 2009. Students are encouraged to submit for the first place prize of \$200.00 and publication in the *Dental Anthropology*. Timely information is published in the journal each year describing the competition.



### 3. Discussion regarding the 2010 symposium in Albuquerque, New Mexico

The symposium will be organized by G. Richard Scott and Joel Irish. It will be an invited symposium in honor of Christy G. Turner (Arizona State University). The topic will be dental morphology. There was discussion of an additional dental morphology workshop to be held that year as well.

### 4. DAA Anniversary

2011 will be the 25th Anniversary of the creation of the Dental Anthropology Association and of *Dental Anthropology*.

Suggestions for celebration:

- special anniversary edition of *Dental Anthropology*
- special issue from the AAPA/DAA meetings

### Elections

#### 1. Student Representative – 3 year term

Four nominees: Michaela Huffman, Chad Willis, Katie Kolpan, and Wendy Black

Elected: Wendy Black

Motioned passed to retain Executive Officer

#### 2. Executive Officer:

One nominee: Heather Edgar

Elected: Heather Edgar

#### 3. New DAA Officer:

This office would be in charge of the designing and maintaining the DAA website

Volunteers to aid Communication Officer: Chris Schmitt and Heather Edgar

One nominee: Sarah Martin

Elected: Sarah Martin

#### 4. Secretary-Treasurer

One nominee: Loren Lease

Elected: Loren Lease

### Adjournment:

Meeting adjourned at 8:35 P.M.

Respectfully submitted,  
Loren Lease  
Secretary-Treasurer

## DAA Subscription

The secretary-treasurer of the **Dental Anthropology Association** is Dr. Loren R. Lease of Youngstown State University.

Dr. Loren R. Lease  
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*Dental Anthropology* now is published electronically and e-mailed to all members as a PDF. The PDF is published with color illustrations, though the printed version is in black-and-white. If you **also** want to receive a hard copy, be sure to make this clear on the membership form at the DAA website or contact Loren.

Speed communication about your membership by contacting Loren directly (other officers may not have current membership lists).

Electronic versions (as PDF files) of the back issues of *Dental Anthropology* are available *gratis* at the Association's web site that is maintained at The Ohio State University: The web site's home page is:

<http://anthropology.osu.edu/DAA/index.htm>



# RESEARCH COMPETITION in DENTAL ANTHROPOLOGY

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## THE ALBERT A. DAHLBERG PRIZE

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The Albert A. Dahlberg Prize is awarded annually to the best student paper submitted to the *Dental Anthropology Association (DAA)*. Dr. Dahlberg was a professor at the University of Chicago, one of the founders of the International Dental Morphology Symposia, and among the first modern researchers to describe variations in dental morphology and to write cogently about these variations, their origins, and importance. The prize is endowed from the Albert A. Dahlberg Fund established through generous gifts by Mrs. Thelma Dahlberg and other members of the association.

Papers may be on any subject related to dental anthropology. The recipient of the Albert A. Dahlberg Student prize will receive a cash award of \$200.00, a one-year membership in the Dental Anthropology Association, and an invitation to publish the paper in *Dental Anthropology*, the journal of the association.

The student should submit a printed copy (or electronic PDF) of their paper in English to the President of the *DAA*. Manuscripts must be received by January 31 of the year that the prize will be awarded, in this case January 31, 2010. The format must follow that of *Dental Anthropology*, which is the same as the style of the *American Journal of Physical Anthropology*. The Style Guide to Authors is available at the web site for the *AJPA* (<http://www.physanth.org>).

The manuscript should be accompanied by a letter from the student's supervisor indicating that the individual is the primary author of the research and the paper. Multiple authorship is acceptable, but the majority of the research and writing must be the obvious work of the student applying for the prize. Send enquiries and submissions to the President of the *DAA*:

Professor Brian E. Hemphill  
Department of Sociology and Anthropology  
9000 Stockdale Highway  
California State University, Bakersfield  
Bakersfield, California 93311-1099 U.S.A.  
*e-mail:* [bhemphill@csub.edu](mailto:bhemphill@csub.edu)

The *DAA* reserves the right to select more than one paper, in which case the prize money will be shared equally among the winners. They also reserve the right to not select a winner in a particular year.

The winner of the Albert A. Dahlberg Student Prize will be announced at the Annual Meeting of the *DAA*, which is held in conjunction with the annual meeting of the American Association of Physical Anthropologists. In 2010, the meeting will be held in Albuquerque, New Mexico, April 14-17.

## NOTICE TO CONTRIBUTORS

*Dental Anthropology* publishes research articles, book reviews, announcements and notes and comments relevant to the membership of the *Dental Anthropology Association*. Editorials, opinion articles, and research questions are invited for the purpose of stimulating discussion and the transfer of information. Address correspondence to the Editor, Dr. Edward F. Harris, Department of Orthodontics, University of Tennessee, Memphis, TN 38163 USA (E-mail: eharris@utmem.edu).

**Research Articles.** The manuscript should be in a uniform style (one font style, with the same 10- to 12-point font size throughout) and should consist of seven sections in this order:

|                  |                |
|------------------|----------------|
| Title page       | Tables         |
| Abstract         | Figure Legends |
| Text             | Figures        |
| Literature Cited |                |

The manuscript should be double-spaced on one side of 8.5 x 11" paper (or the approximate local equivalent) with adequate margins. All pages should be numbered consecutively, beginning with the title page. Submit three (3) copies—the original and two copies—to the Editor at the address above (or see Electronic Submission, below). Be certain to include the full address of the corresponding author, including an E-mail address. All research articles are peer reviewed; the author may be asked to revise the paper to the satisfaction of the reviewers and the Editor. All communications appear in English.

**Title Page.** This page contains (a) title of the paper, (b) authors' names as they are to appear in publication, (c) full institutional affiliation of each author, (d) number of manuscript pages (including text, references, tables, and figures), and (3) an abbreviated title for the header. Be certain to include a working E-mail address and/or telephone number.

**Abstract.** The abstract does not contain subheadings, but should include succinct comments relating to these five areas: introduction, materials, methods, principal results, and conclusion. The abstract should not exceed 200 words. Use full sentences. The abstract has to stand alone without reference to the paper; avoid citations to the literature in the abstract.

**Figures.** One set of the original figures must be provided (or e-mailed) with the manuscript in publication-ready format. Drawings and graphics should be of high quality in black-and-white with strong contrast. Graphics on heavy-bodied paper or mounted on cardboard are encouraged; label each on the back with the author's name, figure number, and orientation. Generally it is preferable to also send graphs and figures as computer files that can be printed at high resolution (300 dpi or higher). Most common file formats (Windows or Macintosh) are acceptable; check with the Editor if there is a question. The hard-copy journal does not support color illustrations, but the PDF version does. Print each table on a separate page. Each table consists of (a) a table legend (at top) explaining as briefly as possible the contents of the table, (b) the table proper, and (c) any footnotes (at the bottom) needed to clarify contents of the table. Whenever possible, provide the disk-version of each table as a tab-delimited document; do not use the "make table" feature available with most word-processing programs. Use as few horizontal lines as possible and do *not* use vertical lines in a table.

**Literature Cited.** *Dental Anthropology* adheres strictly to the current citation format of the *American Journal of Physical Anthropology*. Refer to a current issue of the *AJPA* or to that association's web-site since the "current" style is periodically updated. As of this writing, the most recent guidelines have been published in the January, 2002, issue of the *AJPA* (2002;117:97-101). *Dental Anthropology* adheres to the in-text citation style used by the *AJPA* consisting of the author's last name followed by the year of publication. References are enclosed in parentheses, separated by a semicolon, and there is a comma before the date. Examples are (Black, 2000; Black and White, 2001; White *et al.*, 2002). The list of authors is truncated and the Latin abbreviation "*et al.*" is substituted when there are three or more authors (Brown *et al.*, 2000). However, *all* authors of a reference are listed in the Literature Cited section at the end of the manuscript.

**Electronic Submission.** Electronic submission *instead of* sending hard copies of articles is strongly encouraged. For articles that undergo peer review, the editor will request submission of the final revision of a manuscript in electronic format, not interim versions. Files can be submitted on a 3.5" diskette, or a 100-megabyte Iomega Zip disk or a compact disk (CD), either in Windows or Macintosh format. **Files can also be sent as E-mail attachments.** Microsoft Word documents are preferred, but most common formats are suitable. Submit text and each table and figure as a separate file. Illustrations should be sent in PDF or EPS format, or check with the Editor before submitting other file types. Be certain to label any disk with your name, file format, and file names.

# Dental Anthropology

Volume 22, Number 2, 2009

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