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Presence of Uto-Aztecan Premolar Trait (Disto-Sagittal Ridge) in a Zoque-Olmec sample from Mesoamerica

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Abstract

The presence of UAP in a Zoque-Olmec sample from the Early Classic Period (1.800 – 1.300 BP) is reported. This has been compared with the frequency of the same trait in other groups from the American continent.

Introduction

Dental features that relate to shape have been referred to as phenotypic expressions or epigenetic polymorphisms (Berry 1976). Initially, some of these features were considered to be rare variations of the normal dental form found in isolated populations. However, as more observations were accumulated, and the minimal but persistent occurrence of these features in different human groups was confirmed, it became possible to estimate their frequencies of occurrence across vast regions of the American continent, spanning at least 15,000 years of human history in this part of the world.

Since the mid-twentieth century, some researchers have developed sets of dental traits that are of comparative value in anthropology. In some cases, methodological proposals have been developed to standardize the observations, records, and analysis of these traits (Dahlberg 1945; Brothwell 1963; Morris 1965; Turner et al. 1991; Scott & Turner 1997; Scott 2008; Scott et al. 2016).

One of the features that we have analyzed is called the Uto-Aztecan Premolar Trait or Disto-Sagittal Ridge (hereafter UAP). Currently, it is considered to be an exclusively human trait as it has not been reported in other species such as primates, apes, or Homo ancestors. It typically appears in some pre-Hispanic populations (Scott & Turner 2017) as well as in present-day living indigenous populations (Rodriguez Florez 2012). Few isolated cases of this same trait have been reported in Asia, Africa, and Europe (see Scott et al. 2022), but the majority of cases occur in the Americas.

As described in Scott and Irish (2017), the UAP can be recognized by observation of "*the distal margin of the buccal cusp rotates away from the sagittal sulcus. If straight lines are placed along the major axis of the buccal cusp and on the midline between the two cusps, the angle of divergence varies from 6° to 11°. The Uto-Aztecan premolar is evident when this divergence is two to three times greater than normal (35–45°). The rotation is almost invariably accompanied by a pit between the distal marginal ridge of the buccal cusp and a crest from the essential ridge of the buccal cusp to the distal border*."

Following the above, the variable included in the ASUDAS (Arizona State University Dental Anthropology System) standard as Uto-Aztecan Premolar or Disto-Sagittal Ridge (Turner et al. 1991) has been converted into asymmetric binary variables for a given population (Sjøvold 1973; Harris & Sjøvold 2004). The presence of the UAP trait is counted as 1. This value takes into account sex (male, female, or indeterminate) as well as symmetry (right, left, or both). The reference plaque of ASUDAS exhibits one of the most common variants of the UAP trait in Pima Indians. However, numerous studies on the presence of the UAP trait have revealed additional variants beyond the ASUDAS Standard. Various UAP variants have been identified, including twisting of the buccal cusp distally without any pit or groove but with the presence of a sagittal sulcus (Kobori et al. 1980; Reyes et al. 2008), fossae without a sagittal sulcus (Scott et al. 2018), a strong, open groove dividing the buccal cusp into two (Johnson et al. 2011), a form with a sagittal ridge and an occlusal open pit (Delgado et al. 2010; Rodriguez Florez 2012), and an exaggerated proportion in the distal (a) and buccal (b) surfaces (Scott et al. 2016; Johnston & Sciulli 1996). Another possible variant of the UAP is manifested as a mirror expression on the mesio-buccal surface of the protocone in second premolars. This variant is called “reversed UAP” and has been reported in very few cases (see Scott et al. 2022, page 1097). Additionally, a very rare variant of UAP in first lower premolars has been reported in the literature (Morales 2016).

Morris (1981) can be employed to facilitate the determination of the presence of this trait. The Morris method for identifying the UAP trait consists of observing the angle of rotation of the protocone. The UAP can be determined by taking the buccal vs. lingual cusp angle and multiplying it by 2X to 6X, with angles ranging from the low 20s to 60 degrees (see Scott et al. 2022). This technique can be useful in identifying UAP in teeth with severe occlusal or interproximal wear.

Materials and Methods

During a postdoctoral research stay at the IIA-UNAM (Instituto de Investigaciones Antropologicas, Universidad Nacional Autonoma de Mexico), I had access to numerous bone collections that are preserved there. The observation of the collections was based on establishing a database containing all observations of the morphological features suggested in ASUDAS (Turner II et al. 1991). The entire array of additional morphological features, apart from UAP, observed in the referenced collections is not included in this report.

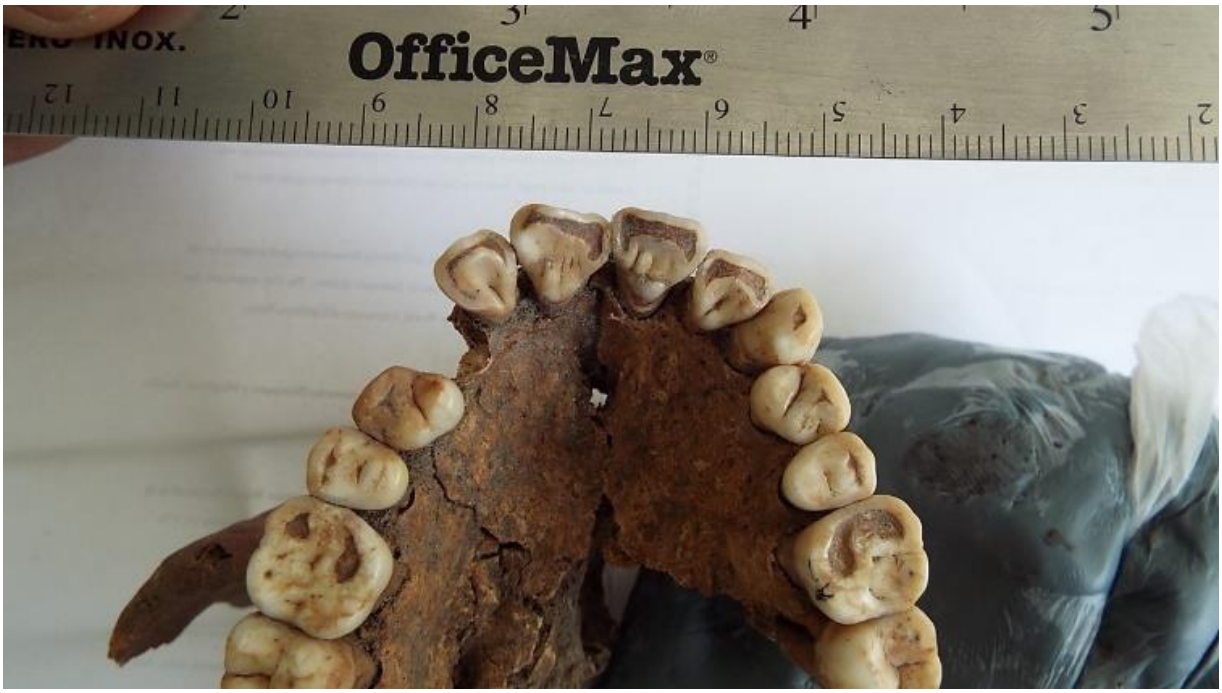

Figure 1. Presence of UAP trait on both upper first premolars (bilateral).

Within these observations, the UAP was taken into

account, finding only one case that is described in this article. Table 1 displays all the collections observed directly by the author until encountering a case with UAP. The archaeological report analyzing the site indicates that it is a Zoque-Olmec population (1.800 – 1.300 BP) that existed during the Early Classic Period in the La Joya region of Mexico (Velasco 2009). For observation and recording, the ASUDAS plaque, a photo from the original publication by Johnston & Sciulli (1996), and descriptions on Scott and Irish (2017), and Scott et al. (2022) were used. Figure 1 illustrates the registered form and its possible variants. The variant recorded in this research is similar to the one presented in Scott et al. (2018).

Results

Out of all the samples observed, only one individual presented the UAP trait: Individual 1 from Burial 6, Area C1, Box 4 belonging to El Dorado – El Conchal Norte, Veracruz. Measurements of the skull (Buikstra & Ubelaker 1994) enabled us to determine that the individual was an adult woman (mastoid process, supra-orbital margin, glabella and mental eminence below grade 3) aged between 20 and 30 years old (moderate exposure of dentin on the occlusal surface of front teeth and minimal dentin exposure on back teeth, including the upper second premolars, where UAP trait is observed). Figures 1 and 2 shows the presence of the trait on both sides of the maxilla in the case reported for El Dorado (bilateral). As mentioned earlier, the UAP variant found closely resembles the one reported by Scott (2018). It can be identified as a pit or groove on the distal surface of the buccal cusp of the premolar, clearly dividing this area into two, but without being connected by an additional enamel support or bridge over it on the occlusal surface. It resembles a fold or crease towards the distal side of the buccal cusp (protocone). It is noteworthy that the premolars indicated in this sample appear to be rotated towards the distal, and their anatomical position results in a greater contact facet and interproximal wear with their neighboring tooth (upper second premolar). This observation suggests that if the individual had lived longer, the process of interproximal wear would likely have made the observation of the trait difficult and inaccurate, or even in very advanced ages, it would be impossible to record. The sole observed case of UAP corresponds to 1 individual out of the 16 available individuals rescued during excavations at this archaeological site. The calculated percentage (6.25%) facilitates the comparison of this sample with others reported for the Americas.

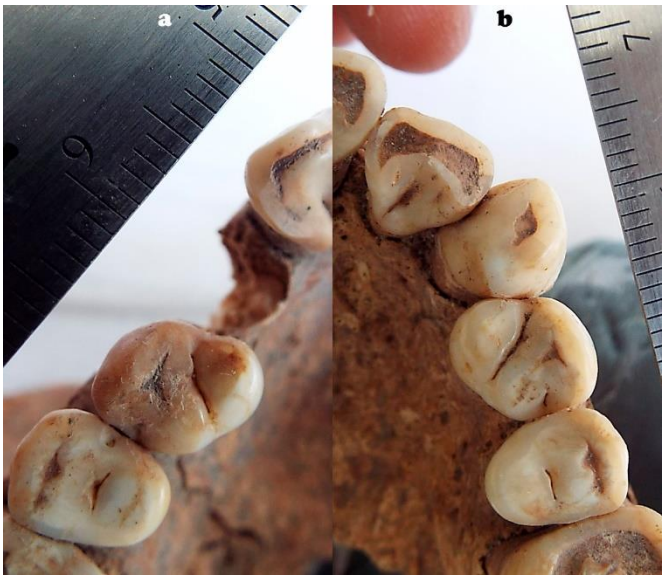

Figure 2. Detailed view of UAP in El Dorado, Veracruz.
a. upper right first premolar with UAP in 48°, b. upper left first premolar with UAP in 49°.

Discussion and Conclusions

A geographic and cultural time comparison with a set of pre-Hispanic American population data available in the literature shows us how the frequency of occurrence of this trait in past populations can be considered uncommon. The percentage expressed in the El Dorado sample (6,25%) is similar to other samples previously reported such as Black Earth IL with 6,45% (Powell 1995), Lower Red River TX with 6,90% (Lee 1999), Azapa Valley 8 and 71 with 6,67% (Sutter 1997), Coahuila with 6,45% (Delgado et al. 2010), and North of Mexico with 6,67% (Scott et al. 2022). For Mexico we find some reports from the Formative or Pre-Classic period in Cuicuilco and Tehuacan (Delgado et al. 2010), and Monte Alban (Haydenblit 1996), Classic Period in the sample of El Pantano (Corduan 2007), and the Post-Classic or Late Period in the samples of Casas Grandes Chihuahua (Morris et al. 1978), Coahuila (Delgado et al. 2010) and different regions of Mexico without chronology yet (Scott et al. 2022) that express the

presence of UAP in different percentages with a variable range between 1.6% and 6.67%. Table 2 shows the set of published samples that have expressed the UAP trait to date. This relationship of proportions in different samples and periods of Mesoamerica can be included as a complementary indicator of influence and biological relationship associated with scenarios of regional cultural dispersion.

On population relationships between preceramic groups from the Great Basin in North America and regions further south such as the Arizona-Sonora border, southern California, and New Mexico, Kobori et al. (1980) suggests that during the Middle Holocene (5000-3000 BP) there must have been an area of biological and cultural influence that allowed the spread of the UAP trait in this great geographical area. Despite these indicators, pedigree studies in Pima Indians suggest that the appearance of UAP in a population can also occur randomly and not by contact (Scott et al. 2018).

Table 1. Samples observed in the Collections of IIA-UNAM.

Sample	Period	N
Naharon, (Quintana Roo)	Pre-Ceramics	1
El Pit 1, (Quintana Roo)	Pre-Ceramics	1
Muknal 1, (Quintana Roo)	Pre-Ceramics	1
El Templo, (Quintana Roo)	Pre-Ceramics	1
Chan Hol 1, (Quintana Roo)	Pre-Ceramics	1
Chan Hol 2, (Quintana Roo)	Pre-Ceramics	1
Mujer del Peñon III, (México DF)	Pre-Ceramics	1
Los Grifos, (Chiapas)	Pre-Ceramics	1
Cerro de las conchas, (Chiapas)	Pre-Ceramics	2
Cenote Canun, (Quintana Roo)	Pre-Classic	2
Barriales, (Veracruz)	Pre-Classic	7
Teteles de la Ermita, Maltrata (Veracruz)	Pre-Classic	1
Rancho Verde, Maltrata (Veracruz)	Pre-Classic	10
Rincón de Aquila, Maltrata (Veracruz)	Pre-Classic	6
Xochipala, (Guerrero)	Pre-Classic	4
Cueva Piñuela	Pre-Classic	1
Chiapa de Corzo, (Veracruz)	Pre-Classic	5
La Libertad, (Chiapas)	Pre-Classic	7
Tenam Rosario, (Chiapas)	Pre-Classic	2
Temamatla, (Cuenca Mex.)	Pre-Classic	2
Xico, (Cuenca Mex.)	Pre-Classic	3
Terremote, (Cuenca Mex.)	Pre-Classic	3
Chinkultic, (Chiapas)	Pre-Classic	1
Capacha, (Colima)	Pre-Classic	1
Teteles de Ocotitla, (Tlaxcala)	Pre-Classic	13
Tequexquinahuac, (Texcoco)	Pre-Classic	1
Piramide La Joya, (Veracruz)	Classic	44
Ixcoalco Cadereyta, (Veracruz)	Classic	2
Valle de Zapotitlan, (Puebla)	Classic	2
Cenote Calaveras, (Quintana Roo)	Classic	7

Cenote San Antonio, (Quintana Roo)	Classic	3
Xenote Sifa, (Quintana Roo)	Classic	1
Tantoc, (San Luis Potosí)	Classic	8
Aquila, (Veracruz)	Classic	1
Guadalcazar, (Veracruz)	Classic	3
La Campana, (Colima)	Classic	2
Aquiles Serdan, (Chiapas)	Classic	1
Tetitla (Teotihuacan)	Classic	5
Ocozocoautla (Chiapas)	Classic	1
La Ventanilla	Classic	12
Coneta, (Chiapas)	Classic	2
Reforma 1993, (México DF)	Classic	2
El Cerrito, (Chiapas)	Classic	14
Potrero-Mango, (Chiapas)	Classic	2
El Dorado, El Conchal Norte (Veracruz)	Classic	16
Ahuinahuac, (Mezcala)	Classic	12
Miramar, (Chiapas)	Classic	11
Mirador, (Chiapas)	Classic	8
Cuevas Bag – Cueva Colmena, (Chiapas)	Classic	1
Coapa, (Chiapas)	Classic	1
Barrio comerciantes, (Teotihuacan)	Classic	3
Maltrata, (Veracruz)	Post-Classic	33
Barra de Chachalacas, (Veracruz)	Post-Classic	15
Guajilar Co 59, (Chiapas)	Post-Classic	1
Pueblo Viejo de Teposcolula, (México DF)	Post-Classic	28
San Agustín	No data	2
La Nopalera (Guerrero)	No data	1
Tierra Blanca, (Tabasco)	No data	2
Jonuta, (Tabasco)	No data	2
Atasta, (Tabasco)	No data	1
Mazapa, (Estado de México)	No data	4
Tlalpizahuac (Estado de Mexico)	No data	1
Valparaiso, (Zacatecas)	No data	3
Huatusco, (Veracruz)	No data	2
Chultun, (Chiapas)	No data	1
Xchen Jical Jocosik, (Chiapas)	No data	1
San Francisco Mazapa, (Teotihuacan)	No data	2
Popolnah, (Yucatán)	No data	1
Subtotal México	68 samples	343

From a chronological point of view, it is evident how an average of cases that increases considerably during the Late Period is sustained. We can appreciate how 8 samples correspond to the Pre-ceramic Period, 10 to

the Archaic Period, 12 to the Formative Period and 43 to the Late Period. An additional 14 samples do not report chronology yet, but this distribution may not change ample when they are included with precise chronologies. The Late Period in the Americas (last 1500 years before Spanish contact) was a scenario of permanent contact and exchange between societies from different regions of the continent, specially by the Pacific's and Caribbean coasts (Rodriguez Florez 2013, 2016). It is possible to observe that the presence of the UAP trait in America is prolonged at least 6000 years BP and it has always been an intermittent trait among archaeological samples (see Table 2). The distribution of the occurrence of the UAP in the reported groups corresponds to the population growth observed for the Late Period in Central and South America (Meggers & Evans 1983; Meggers 1992).

Table 2. List of American published samples with UAP present.

Country	Sample	Period	n	k	%	Reference
United States	Buckeye Knoll, TX	Preceramics	28	1	3.57	Johnson et al. (2011)
United States	Windover	Preceramics	48	5	10.42	Powell, (1995)
Chile	Chuchipuy, La Herradura, Punta Teatinos	Preceramics	79	1	1.27	Delgado et al. (2010)
United States	Morhiss	Preceramics	24	2	8.33	Taylor, (2012)
United States	Anderson, TN	Preceramics	18	1	5.56	Powell, (1995)
United States	Black Earth, IL	Preceramics	31	2	6.45	Powell, (1995)
United States	Harris Creek at Tick Island, FL	Preceramics	57	5	8.77	Powell, (1995)
United States	Pt. Pines early	Preceramics	38	1	2.63	Delgado et al. (2010)
Chile	Azapa Chinchorro	Archaic	26	2	7.69	Sutter, (1997)
Brazil	Corondo - Minas Gerais	Archaic	34	1	2.94	Delgado et al. (2010)
United States	Cedar Park Mound	Archaic	3	1	33.33	Taylor, (2012)
United States	Eva, FL	Archaic	14	1	7.14	Powell, (1995)
United States	Bird Island	Archaic	12	2	16.67	Powell, (1995)
United States	California	Archaic	91	1	1.10	Delgado et al. (2010)
United States	Ohio Valley - Hopewell	Archaic	41	1	2.44	Johnston & Sciulli, (1996)
United States	Southwest - Mimbres	Archaic	241	2	0.83	LeBlanc et al. (2008)
United States	McClamory	Archaic	14	4	28.57	Sassaman, et al. (2015)
United States	Bering sinkhole	Archaic	4	2	50.00	Taylor, (2012)
United States	Silo	Formative	8	1	12.50	Taylor, (2012)
United States	Ernest Witte 2	Formative	41	1	2.44	Taylor, (2012)
Mexico	Cuicuilco & Tehuacan	Formative	59	1	1.69	Delgado et al. (2010)
Mexico	Monte Alban	Formative	50	1	2.00	Haydenblit, (1996)
Guatemala	Uaxactun	Formative	7	1	14.29	Scherer, (2004)
Guatemala	Barton Ramie	Formative	17	1	5.88	Scherer, (2004)
Venezuela	Las Locas	Formative	25	1	4.00	Reyes et al. (2008)
Ecuador	Cotocollao	Formative	27	1	3.70	Delgado et al. (2010)
Ecuador	Ayalán	Formative	74	1	1.35	Delgado et al. (2010)
Ecuador	Tumaco-La Tolita	Formative	76	1	1.32	Rodriguez-Florez & Morales, (2013)
Ecuador	Tumaco-La Tolita (Tola de la Balsa)	Formative	41	1	2.44	Morales, (2016)
Mexico	El Pantano	Formative	44	2	4.55	Corduan, (2007)
United States	Southwest - NA 10806 Arizona	Late	14	1	7.14	Morris et al. (1978)
United States	Wupatki Pueblo	Late	40	2	5.00	Morris et al. (1978)
United States	Clements	Late	4	1	25.00	Taylor, (2012)
United States	Hunt Farm	Late	4	1	25.00	Taylor, (2012)
United States	Sanders	Late	26	1	3.85	Taylor, (2012)
United States	Parcell	Late	2	1	50.00	Taylor, (2012)
United States	Upper Red River, TX	Late	26	1	3.85	Lee, (1999)
United States	Belle Glade Mound	Late	32	1	3.13	Benitez, (2019)
United States	Highland Beach Mound	Late	21	1	4.76	Benitez, (2019)
United States	Lower Red River, TX	Late	29	2	6.90	Lee, (1999)
Mexico	El Dorado - Veracruz	Late	16	1	6.25	This research
Mexico	Casas Grandes Chihuahua	Late	94	1	1.06	Morris et al. (1978)

Guatemala	Aguateca	Late	10	1	10.00	Scherer, (2004)
Colombia	Soacha - Portoalegre	Late	57	1	1.75	Delgado et al. (2010)
Ecuador	Cotacachi	Late	41	1	2.44	Rodriguez-Florez & Morales, (2013)
Chile	Azapa 140	Late	57	1	1.75	Sutter, (1997)
Chile	Azapa 71	Late	45	3	6.67	Sutter, (1997)
Chile	Azapa 8	Late	15	1	6.67	Sutter, (1997)
United States	Chelly & Kayenta	Late	59	1	1.69	Delgado et al. (2010)
United States	Chavez Pass	Late	24	1	4.17	Delgado et al. (2010)
United States	New Mexico	Late	128	1	0.78	Delgado et al. (2010)
United States	Grasshopper	Late	124	5	4.03	Delgado et al. (2010)
United States	Arkansas	Late	97	4	4.12	Delgado et al. (2010)
United States	Alabama	Late	159	3	1.89	Delgado et al. (2010)
United States	Ohio Valley - Proctorville	Late	35	1	2.86	Johnston & Sciulli, (1996)
United States	Ohio Valley - Buffalo	Late	176	3	1.70	Johnston & Sciulli, (1996)
United States	Southwest - Awatovi	Late	21	2	9.52	Morris et al. (1978)
United States	Gran Quivara - New Mexico	Late	71	2	2.82	Morris et al. (1978)
Mexico	Coahuila	Late	31	2	6.45	Delgado et al. (2010)
United States	Pima Indians	Late	2400	18	0.75	Delgado et al. (2010)
United States	Papago Indians	Late	190	3	1.58	Kobori et al. (1980)
United States	Papago Indians	Late	200	2	1.00	Morris, (1965)
United States	Hopi Indians - ASU	Late	166	2	1.20	Delgado et al. (2010)
United States	Hopi Tewa - Arizona	Late	162	1	0.62	Kobori et al. (1980)
United States	Navajo - Keam´s Canyon	Late	159	3	1.89	Delgado et al. (2010)
United States	Navajo - Tuba City	Late	158	6	3.80	Delgado et al. (2010)
United States	Navajo - Ramaj	Late	94	1	1.06	Delgado et al. (2010)
United States	Yuma Indians	Late	56	2	3.57	Delgado et al. (2010)
United States	Yuman Indians	Late	100	2	2.00	Delgado et al. (2010)
United States	Lower Red River, TX	Late	6	1	16.67	Lee, (1999)
United States	Bannock	Late	1	1	100.00	Kobori et al. (1980)
Colombia	Kamentsa (living)	Late	56	1	1.79	Rodriguez-Florez, (2012)
Chile	Queilen, Cucao, Achao (Chiloe)	Late	201	3	1.49	Rivera, (2012)
North America	Artic	?	703	1	0.14	Turner II unpublished (Scott et al. 2022)
North America	Northwest	?	171	1	0.58	Turner II unpublished (Scott et al. 2022)
North America	Arkansas	?	105	4	3.81	Turner II unpublished (Scott et al. 2022)
North America	Southwest Anasazi	?	674	4	0.59	Turner II unpublished (Scott et al. 2022)
North America	Southwest Zuni	?	113	2	1.77	Turner II unpublished (Scott et al. 2022)
North America	Southwest Mogollon	?	221	7	3.17	Turner II unpublished (Scott et al. 2022)
North America	Southwest Sinagua	?	27	2	7.41	Turner II unpublished (Scott et al. 2022)
Mesoamerica	Mesoamerica	?	233	4	1.72	Turner II unpublished (Scott et al. 2022)
Mesoamerica	North of Mexico	?	75	5	6.67	C. Ragsdale unpublished (Scott et al. 2022)
Mesoamerica	West Mexico	?	66	3	4.55	C. Ragsdale unpublished (Scott et al. 2022)
Mesoamerica	Central Mexico	?	185	4	2.16	C. Ragsdale unpublished (Scott et al. 2022)
Mesoamerica	Southern / Gulf Coast	?	46	2	4.35	C. Ragsdale unpublished (Scott et al. 2022)
Brazil	Brazil	?	164	1	0.61	Turner II unpublished (Scott et al. 2022)
Ecuador	Ecuador	?	101	2	1.98	Turner II unpublished (Scott et al. 2022)
TOTAL	97 samples		9563	183	1.91%	24 references

About the evolutionary origin of the UAP trait is still not fully clear. This type of rare morphological features in human dentition may be the result of an adaptive response in the enlargement of the enamel areas in the crowns, in response to severe masticatory forces during the Pleistocene and early Holocene times (Mizoguchi 1985; Trinkaus 1987; Scott & Turner II 1988; Rodriguez Florez et al. 2006). Morris et al. (1978) proposes its appearance as the result of a single mutation, with hereditary potential at some point in Preceramic times (Scott & Turner 1997; Scott et al. 2018). The UAP trait appears relatively selectively neutral because it does not affect occlusion or make a tooth more caries susceptible, therefore the nature of selective pressures is not clear (Morris et al. 1980; Rodriguez Florez, 2013). Some pedigree analyses in Pima Indians demonstrate that UAP is heritable, is not X-linked, and follows a polygenic model of inheritance, possibly autosomal recessive (Morris et al. 1978; Scott & Turner 1997; Delgado et al. 2010). Pedigree studies conducted on other similar traits such as Carabelli's trait in upper molars, and the Shovel-Shape trait in upper incisors suggest a similar anthropological nature and value (traits that constitute the ASUDAS system). It is believed that these are heritable and selectively neutral morphological expressions, generated by random evolutionary processes such as founder effects and genetic drift on a global scale within modern human groups, at least over the last 40,000 years (Scott and Turner II, 1997). Despite the strong genetic control of this type of trait, their bilateral or unilateral expression can be affected by geographic isolation and environmental forces (Lauc et al. 2003; Rodriguez Florez 2012; Rodriguez Florez & Colantonio 2008).

Another aspect to consider is methodological. The ASUDAS plaque shows only one variant of the trait (Pima Indians), but Johnston & Sciulli (1996) and other authors mentioned above show other variants also considered UAP. If we consider these variants, together with the mesiobuccal opening angle measurement technique initially proposed by Morris (1981), it is possible that the frequencies of UAP occurrence increase increases or appears as a new biological indicator in some samples. Table 3 shows an example of the inclusion of some unpublished samples taking all these arguments into account.

Table 3. Additional unpublished samples with possible UAP occurrence.

Country	Period	Sample	N	ASUDAS	Johnston & Sciulli, 1996	Morris 1981	K (%)
Colombia	Preceramics	Aguazuque	83	Negative	Positive	Positive (33°)	1 (1,2)
Colombia	Late	El Copey	122	Negative	Positive	Negative	1 (0,82)
Mexico	Classic	Cenote Calaveras	6	Negative	Positive	Positive (30°)	1 (16,6)

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