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Chapter 6

BIOLOGICAL TRANSFORMATION AMONG HISTORICAL POPULATIONS THAT INHABITED THE SYRIAN LOWER EUPHRATES VALLEY: FROM THE EARLY BRONZE AGE TO THE MODERN PERIOD

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ABSTRACT

Intensive excavations in the Near East, which have been carried out for over 100 years, show that this region merits to be called a cradle of civilization. However, there are still many questions concerning the general quality of life, subsistence strategies and interactions between people and their environment. In this respect, the Syrian lower Euphrates valley is considered one of the most interesting places. One can assume that political and economic changes had an important impact not only on the living and health conditions, but also on the dietetic and hygienic habits of the local population. This means that changes in the socioeconomic status should be reflected in the fluctuations of enamel hypoplasia, dental caries, or the extent of tooth wear.

Studied materials were collected from 2005–2009 at Terqa – modern Tell Ashara, Tell Masaikh and Jabel Mashtale – in the Deir ez-Zor province (SE Syria) during an archaeological expeditions. The specimens were assigned to six periods: the Early Bronze (EB): 2650–2350BC; the Middle Bronze (MB): 2200–1700BC; the Neo-Assyrian (NA): 900–700 BC; the late Roman (LR): 200–500AD; the Islamic (I): 600–1200AD and the modern (MI): 1850–1950AD.

One hundred and ninety-six individuals of both sexes were examined with a total of 3292 teeth. The present paper focuses on dental caries, enamel hypoplasia and dental wear, which were observed in the populations of the Syrian lower Euphrates valley.

The oldest historical periods (EB, MB) were characterized by a low frequency of dental caries and linear enamel hypoplasia (LEH). However, the dental wear was quite significant. However, in the younger chronological periods there were increases in both dental caries and enamel hypoplasia, although the dental wear was rather slight. This means that presented studies detected a trend of changes in the socioeconomic status, which was connected with changes in dietary habits and oral hygiene behavior.

INTRODUCTION

Research into the dynamics of the anthropological features changing over time and space frequently increase our knowledge about the living and health conditions of a given population throughout the ages. Intensive excavations in the Near East, which have been carried out for over 100 years, show that this region merits to be called a cradle of civilization [1, 2]. There is much information available about the political history, architecture and the history of handicrafts. However, there are still many questions concerning the general quality of life (i.e., diseases, level of nutrition, patterns of activity), subsistence strategies and interactions between people and their environment. In this respect, the Syrian lower Euphrates valley (or Middle Euphrates valley in Syria) is considered one of the most interesting places. One can assume that political and economic changes had an important impact not only on the living and health conditions, but also on the dietetic and hygienic habits of the local population. The source of this information is the assessment of physiological stress indicators. Poor living conditions cause a reaction of the body, which can manifest itself in both the bone (e.g., *porotic hyperostosis*, *cribra orbitalia*, Harris lines) and dental material (e.g., enamel hypoplasia, dental caries, periodontal disease). The assessment of physiological stress on bone material is particularly interesting, but, due to the high fragmentation of archaeological material, it is not always possible to test these stress indicators

[3, 4, 5]. However, odontological material is usually well-preserved in archaeological sites, so studies of such material are frequently used in anthropological research [5, 6]. Odontological research can provide much valuable information, facilitating improved knowledge of health conditions and an understanding of the direction of biological transformations within a given population over the centuries. This is possible due to the morphological reaction of hard dental tissues to changing living conditions. In this respect, particular attention is focused on the analysis of dental caries, enamel hypoplasia and dental wear.

Dental caries, being a progressive process that causes demineralisation and, consequently, proteolytic decay of the hard tissues of a tooth, resulting in the formation of carious lesions, is one of the diseases of the masticatory organ most frequently observed in the historical material [7, 8]. Dental caries have a multifactorial etiology. At least four factors are required to cause dental caries (dental plaque resulting from the accumulation of bacterial deposits, a cariogenic diet, which forms the basis for bacterial changes, the susceptibility of the dental tissues to decalcification, and the length of time that the pathogenic factor had an influence on the teeth), which reflect the person's state of health, hygiene and eating habits [9, 10]. Thus, a study of carious infection gives rise to the possibility of understanding the adaptations and health conditions of a population throughout time.

Enamel hypoplasia is the most common irregularity observed in the teeth, and is expressed as lines, grooves, or pits resulting from the death or reduced functioning of the ameloblasts and a consequent failure in the formation the enamel matrix [11, 12]. It is treated as a nonspecific indicator of stress, but, even so, many authors consider it the most reliable tool in anthropological research [13, 14]. In the etiology of hypoplastic changes in tooth enamel, three main classes of factors have been listed: general (systemic), local, and genetic. The presented characteristics of the distinct types of enamel hypoplasia are an important prerequisite for attempts aimed at reconstructing the level of health and, indirectly, also the economic and social status of the examined population. In this respect, the changes classified as general-systemic hypoplasia are most relevant [15, 16].

The term 'dental wear' refers to the loss of hard tissues of the teeth, which is not due to dental caries or dental trauma. According to the classic division, there are four types of dental wear: abrasion, attrition, abfraction, and erosion [17, 18]. Abrasion is the most common type of wear. It is due to the interaction between teeth and exogenous objects (e.g., toothpicks, pipes, dental floss) or substances (e.g., vegetables that have not been thoroughly washed can bring traces of soil into contact with teeth) [19, 20]. Attrition wear is caused by the excessive functioning of parafunctional forces and bruxism. Abfraction is the loss of dental enamel, especially at the cement-enamel junction (CEJ), due to flexural forces, usually from cyclic loading [19, 20]. Dental erosion is an irreversible loss of hard tissue resulting from the exposure of tooth surfaces devoid of plaque to chemical substances. Thus, erosion is the gradual dissolution of dental tissues caused by acidic agents. This process does not involve bacteria [18, 21, 22, 23]. Archaeological collections are very often destroyed and fragile; thus, the unambiguous classification of dental wear is often impossible. In this context, the division of dental wear into two general groups (mechanical and chemical origin) is justified. The basis of the above division is the origin of dental wear.

The present paper focuses on dental caries, enamel hypoplasia and dental wear, which were observed in the populations of the Syrian lower Euphrates valley representing six cultures dated from the Early Bronze Age to the modern Islamic period.

ARCHAEOLOGICAL CONTEXT

Until 2010, excavations were being carried out in the area of the Syrian lower Euphrates valley on the site of Tell Hariri (ancient Mari) and on several sites near the town of Tell Ashara, namely, in Terqa (34°55'20"N 40°34'05"E) and Tell Masaikh (34°58'23"N 40°33'13"E)

The first archaeological site – Terqa – is situated on the western bank of the Euphrates, about 60 km north-west of Mari. The excavations in ancient Terqa (modern Ashara) have been taking place in the third and second millennium levels of the ancient city, belonging to the Mari culture and state, famous not only for the local temple of the god Dagan, Lord of the valley, but also for the autonomy and creativity of its society and culture, which existed to the end of Mari power. The first mention of Terqa came at the end of the 19th century, when cuneiform tablets with information about the temple of Dagan were found [24]. At the beginning of the twentieth century, short-term excavations were led by the world-renowned German archaeologist Ernst E. Herzfeld, who found a few cuneiforms tablets, from the beginning of the 2nd millennium, with Zimri-Lim's inscriptions, king of Mari. The next archaeological research expedition in 1923, led by François Thureau-Dangin, found another tablet with inscriptions, but ultimately did not produce the intended results. It enriched the collection of the Louvre's priceless objects from the 2nd and 3rd millennia. Unfortunately, from these excavations, we do not have any information on anthropological material. Probably, even occasionally found human remains were neither cataloged nor examined.

In the thirties of the last century, archaeological excavations in Terqa were eventually suspended for two reasons. First, there was a spectacular discovery in Mari in 1933, which was certainly the most important archaeological place in the region. Secondly, Terqa was still inhabited, which largely limited the excavation. Systematic studies had been undertaken since 1975 by an American expedition led by Georgio Buccellati and Marilyn Kelly-Buccellati from the University of California in Los Angeles [25, 26, 27]. Since 1987, the archaeological research was carried out by Olivier Rouault from the University of Lyon II. In 1996, with the consent of the Syrian authorities, the scope of the research and excavation was extended beyond the site of the ancient Terqa to an area of about 10 km around it. Then, the excavation work began on the site in Tell Masaikh. These excavations initially had the nature of a rescue, but soon evolved into regular scientific research [27, 28]. At Tell Masaikh, the remains of a settlement from the Chalcolithic (c. 4500BC) and the Middle Bronze Age, as well as a huge governor's palace from the times of the Assyrian empire's days of glory (c. 800–650BC) were discovered. In 2004–2005, the excavations were again extended, this time south of Terqa to Jabel Mashtale. This archaeological site is dated to the end of the 2nd millennium, but further exploration has been suspended, at least temporarily, because the area is populated [29]. The head of the excavations at these sites is Maria Grazia Masetti-Rouault (École Pratique des Hautes Études – Sorbonne).

The time when Terqa was founded is debatable, with its origins probably being nomadic or half-nomadic tribes whose ethnic background is still disputable [2, 30, 31]. At the beginning of the 2nd millennium, Terqa was probably an autonomous city and an important religious center in this area. Later on, during the 3rd millennium, the city and its region became part of the territory controlled by the neighboring kingdom of Mari, until its destruction by the armies of Hammurabi in 1759BC. After the demise of Mari, Terqa took control of the region, being the capital of the kingdom of Hana until the end of the Bronze Age [1, 2, 32]. During the Iron Age, the city and the whole region must have undergone a serious economic crisis [24, 33]. However, in the 9th century, further mentions about Terqa appear again in Assyrian inscriptions; the town was then called Sirqu and became the political center of the region [24]. This is also when another site, the settlement of Tell Masaikh, is mentioned for the first time. The city is referred to as *Kar-Ashurnasirpal* (or *Ashurnasirpal's Quay*) in the inscription of King Assurnasirpal II. In his inscription we can read: “I founded two cities on the Euphrates, one on this bank of the Euphrates (which) I called Kar-Ashurnasirpal (and) one on the other bank of the Euphrates (which) I called Nebarti-Assur” [34]. It thrived in the 8th century BC. In Tell Masaikh, an impressive palace was built for Nergalersh – an Assyrian royal clerk and governor of the province. The governor was responsible before the king for the territorial reorganization of the area. Although there is no unequivocal evidence concerning the abandonment of Tell Masaikh by the Assyrians, most certainly the depopulation lasted at least until the Roman period [35, 36]. At the close of antiquity, when a border running through Northern Mesopotamia separated the Roman Empire and the Parthian state (later the state of the Sassanids), the valley of the Middle Euphrates served as the main route for marching troops and – in times of peace – for commercial exchange between the rival empires [2]. As a result of those events, the whole above-mentioned region situated along the Middle Euphrates was mostly inhabited by warriors and nomadic tribes. One hundred years later (633–640AD), Syria was conquered by the Arabs, and Damascus became the capital of the Islamic world. After the conquest of Mesopotamia, the Syrian lower Euphrates valley was quite densely populated and the whole area enjoyed relative economic stability. However, in the 13th century, a Mongol invasion caused an almost complete extermination of the local resident population [2]. The rebuilding of Terqa took place relatively late, in the 19th and 20th centuries. However, Tell Masaikh does not bear any traces of systematic habitation since the 12th/13th century; instead, an Islamic cemetery, which is still in use, was set up on this site.

MATERIAL

In the present study, we used the material excavated from 2005–2009 from three neighboring archaeological sites: Terqa (TQ), Tell Masaikh (MK) and Jabel Mashtale (ML) (Figure 1). The specimens were assigned to six periods: the Early Bronze (EB): 2650–2350BC; the Middle Bronze (MB): 2200–1700BC; the Neo-Assyrian (NA): 900–700 BC; the late Roman (LR): 200–500AD; the Islamic (I): 600–1200AD; and the modern (MI): 1850–1950AD. The taxonomy corresponds with historical events that, as may be supposed, could have stimulated changes in health status or dietetic and hygienic habits.

One hundred ninety-six individuals of both sexes (124 males, 72 females) were examined: MI: 13 (males: 7, females: 6), I: 82 (males: 48, females: 34), LR: 50 (males: 38, females: 12), NA: 9 (males: 4, females: 5), MB: 33 (males: 20, females: 13) and EB: 9 (males: 7, females: 2) with a total of 3,292 teeth (260 MI, 1453 I, 817 LR, 169 NA, 456 MB, 137 EB) (Table 1). Only those individuals in which it was credibly possible to determine sex and age were selected for analysis. The analyzed sample may seem too small, however, keep in mind that in this area, we have not found a cemetery older than the I period so far. The small number of representatives of the MI population results from the fact that they were provided by the rescue research, which covered the edge of the functioning Muslim cemetery. At present, no examination of material from the most recent period is possible.

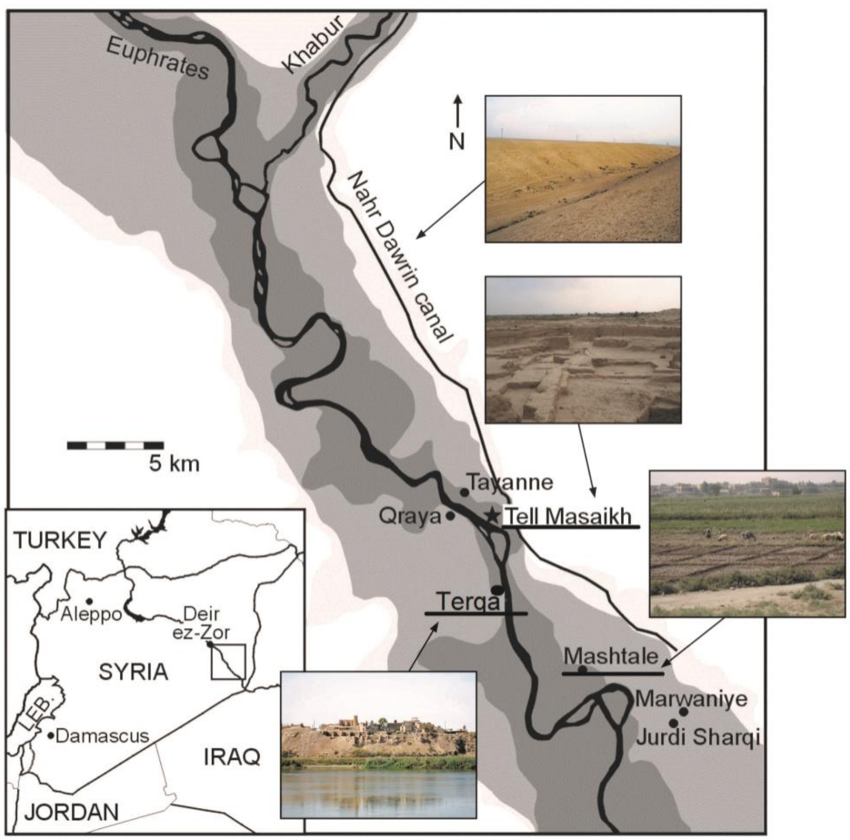

Figure 1. Location of the study area.

Table 1. Number of teeth used in the study

Periods	Maxilla								Mandible							
	M3	M2	M1	P2	P1	C	I2	I1	M3	M2	M1	P2	P1	C	I2	I1
MI	14	17	15	20	15	19	17	16	8	14	17	21	18	18	15	16
I	63	98	105	106	113	97	89	88	51	107	113	83	97	95	65	83
LR	31	61	59	52	52	60	57	40	20	66	69	57	56	37	39	61
NA	9	10	7	13	13	14	13	10	5	9	9	12	14	12	11	8
MB	16	36	35	35	38	35	27	27	13	31	32	23	28	28	23	29
EB	2	9	6	13	9	11	8	9	3	9	7	13	13	10	8	7
Total	135	231	227	239	240	236	211	190	100	236	247	209	226	200	161	204

METHODS

The skeletons were studied in the anthropological laboratory in Tell Ashara. Dental materials were transported to Poland and studied in university laboratories (Cardinal Stefan Wyszynski University, Warsaw). The sex of the individuals was determined on the basis of the Phenice method (which assesses morphological indicators in the pelvic bones) and the morphological assessment of the skull (according to the scoring system for sexually dimorphic cranial features) [37]. The age of the individuals was assessed on the basis of changes in the morphology of the pubis, using the Suchey-Brooks system, and from changes observed on the auricular surface [38]. *Cranial suture* closure and epiphyseal fusion were also employed to *determine* skeletal *ages [38, 39]*.

Before the study, every tooth was cleaned with a brush and, when necessary, washed in alcohol to remove the remaining grime. The present study focused on three issues (dental caries, enamel hypoplasia, dental wear) that require different methodologies; thus, the methodologies for dental caries, enamel hypoplasia and dental wear will be separately presented.

Dental Caries

Teeth were examined using three diagnostic techniques: i) visual, ii) radiographic and iii) fluorescence methods.

i) Visual observation of carious lesions was conducted with the help of a 3x dental magnifying glass and a sharp dental probe. Visual inspection was performed under direct dental unit light.

ii) We used radiographic diagnosis where radiolucency was observed. For this purpose, we employed an x-ray machine (Kodak 2200) at 70 kVp and 7 mA.

iii) A light-induced fluorescence technique for the detection of initial enamel caries on occlusal surfaces was used. For this purpose, we used the VistaCam iX Proof device. By this method, the earliest clinically visible changes (*caries incipiens*), when the enamel was still hard, smooth and glossy, were diagnosed.

Any individual with at least one carious tooth was considered to have dental caries. To a considerable extent, the material from the Syrian lower Euphrates valley was incomplete and bone elements of the maxilla and mandible often lacked delicate alveolar processes. It was, therefore, not possible to assess which (and how many) teeth were lost *ante-mortem* due to caries. Consequently, in one case, it was difficult to estimate how many teeth were lost due to carious lesions, and in a number of other cases, this aspect of the analysis was omitted. Hence, only available teeth were analyzed. The frequencies of caries were calculated on the basis of the proportional correction factor (PCF) of Erdal and Duyar [40, 41]. Since tooth classes (anterior or posterior) have different morphologies, the anterior teeth are usually lost more frequently (e.g., during *post-mortem* deposition) than the posterior teeth. The PCF provides caries rates of anterior and posterior teeth according to their appropriate numbers: three-eighths for anterior and five-eighths for posterior teeth multiplied by the number of observed caries. Significant fragmentary and fracturing of the material from the Syrian lower Euphrates valley was the main reason why the PCF method was chosen.

The location of carious lesions (root, CEJ, crown) as well as their location on the tooth (mesial, distal, labial/buccal, lingual, occlusal surfaces) were taken into account and analyzed. When more than one surface was affected, each surface was analyzed separately.

Linear Enamel Hypoplasia (LEH)

Enamel defects were observed according to a macroscopic method; we used a CL-D 10× magnifying glass with an additional source of light. The research was conducted only on those materials that had at least two teeth with defects. It was assumed that local hypoplasia was not a population-wide factor. The defects were then organized with the use of the Developmental Defects of Enamel Index (DDE): 0 – normal, 1 and 2 – opacity (white or brown patches on the surface of the enamel), 3 – pits, 4 – horizontal grooves and/or lines (LEH), 5 – vertical grooves and/or lines, and 6 – missing enamel on a certain part of the surface [42]. However, in this study, we focused only on LEH (according to DDE No. 4). The frequency of LEH was calculated on the basis of all teeth (posterior and anterior).

The location of LEH made it possible to establish the age when these defects occurred, using the developmental standards of Reid and Dean [43, 44]. This method involves the allocation of hypoplastic defects within a broad developmental phase (the rate of enamel growth is not constant but decreases from the tip to the cervical margin), and it eliminates the need to correlate the specific age with any given hypoplastic defects. Our analyses were narrowed to include only the anterior teeth that were well-preserved [45, 46]. Some defects are most frequently found in the upper part of the crown. So, in the analysis of LEH, the teeth whose crowns were excessively damaged were omitted in order to avoid false results. We analyzed teeth that did not exceed No. 3 according to Smith's scale [47]. Crown heights were measured with a caliper (0.01 mm) from the CEJ to the apex on the vertical plane bisecting the labial surface of the teeth. These measurements were converted into the approximate ages of development based on the timing of enamel formation. We used the standards for northern European populations [44].

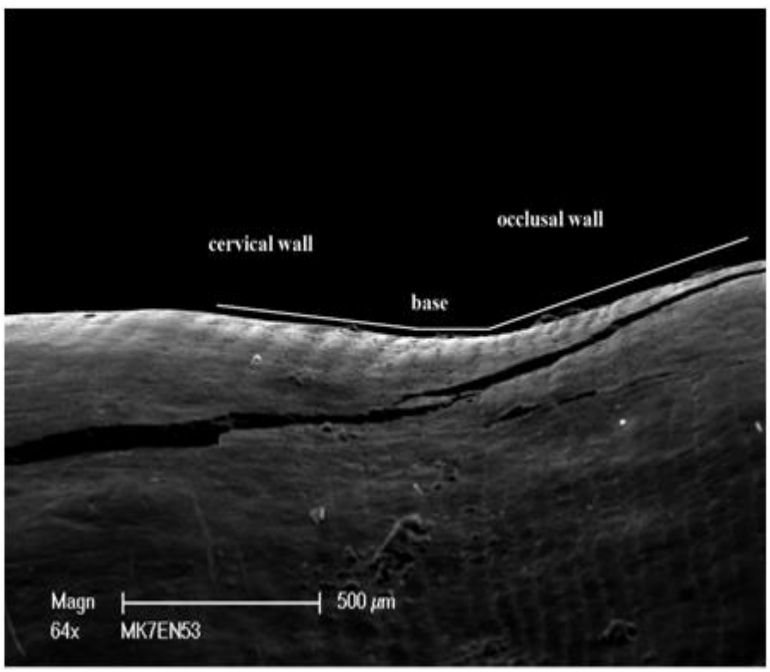

Figure 2. SEM picture of a linear hypoplastic defect with a marked disturbance of 14 perikyma grooves (occlusal wall) *(photograph by J. Tomczyk)*.

In some publications, Scanning Electron Microscope (SEM) analysis is used for counting the number of perikymata to assess the duration of physiological stress [48, 49]. In our observation, we used SEM – PHILIPS XL 20 in magnification of 60x to 100x. The technique is considered to be the standard procedure [14, 46, 49]. In the present study, the left, in the absence of right upper canines, 32 individuals were selected (MB:7, NA:3, LR:12, I:10). The total numbers of the perikymata (including perikymata from occlusal and cervical walls) were counted. According to the authors, the perikymata were built, on average, every 8–10 days, which means that, based on the number of perikymata from the occlusal wall we were able to estimate the average time of disturbance of ameloblasts secretion [46, 49, 50] (Figure 2).

Dental Wear

Dental wear was divided into two groups according to the source of origin: mechanical (abrasion, attrition) and chemical (erosion). Due to damage of the cervical area, abfraction was omitted in this study. The scores of mechanical dental wear for anterior teeth were based on the scale proposed by Smith [47], while, for the posterior teeth, this was based on the scale proposed by Scott [51]. These scales are commonly used in bioarchaeological studies. The three classes of dental wear were separated according to the degree of dentin exposure: i) wear facets that are invisible or very small (Smith's scale, No. 1–2; Scott's scale, No. 1); ii) wear facets that are moderately advanced (Smith's scale, No. 3–4; Scott's scale, No. 2–5); iii) wear facets that are highly advanced (Smith's scale, No. 5–8; Scott's scale, No. 6–10).

Scanning electron microscope is a common method for quantifying changes in occlusal surfaces [52, 53]. Twenty-eight molars (EB:4, MB:5, NA:4, LR:5, I:6, MI:4) were scanned using the SEM technique. For this analysis, we chose only well-preserved material. For the SEM analysis, we chose the Philips XL 20 microscope; in Phase II, nine faces were scanned. An interesting face was enlarged 300x (672x454μm). Dropouts on the occlusal surfaces were counted and measured using the Microware 4.02 program [54]. In accordance with the standards, defects were divided into four categories: i/ *striae* – lines whose width did not exceed 5μm; ii/ *scratches* – lines whose width exceeded 5μm; iii/ *punctures* – non-linear structure, size did not exceed 20μm in diameter, and iv/ *pits* – non-linear feature more than 20μm in diameter.

The phenomenon of dental erosion has been the focus of many researchers' attention, but there are no unambiguous methods for its identification and assessment as far as archaeological material is concerned [18, 21, 22]. An interesting method was proposed by Bell [55]. This method is based on the observation that erosive loss on the occlusal surfaces is deeper than mechanical loss because, in the case of the former, chemical substances penetrate into the dental tissue. The method consists of measuring the breadth and depth of the loss on the occlusal surface on the cheek-lingual plane. The calculated index makes it possible to determine whether the loss is chemically or mechanically induced. An index above 0.25 points indicates an erosive loss, and below that value, a mechanical loss. The measurement of the depth of a cavity on the occlusal surfaces was taken via periodontological probe with a specially prepared scale (0.01mm). The greatest width of defects in the buccolingual plane were measured using a calliper (0.01mm). From these measurements, an index (depth x width) was calculated. A numerical value of less than 0.25 was considered to be mechanical wear, while more 0.25 represented dental erosion. Dental erosion of the anterior teeth was omitted in the present analysis.

All statistical analyses were performed using the R Project for Statistical Computing. Differences with $p \leq 0.05$ were considered statistically significant.

RESULTS

Dental Caries

Among the 196 individuals, 114 had at least one carious lesion, which meant that the frequency of dental caries was observed in 58.1%. The least frequent dental caries were observed in the EB and the MB periods (33% and 39%, respectively). The most frequency dental caries were observed in the NA period; here, all the individuals were affected by this disease. Carious lesions affected 61.5% of the individuals from the MI period and 66% of those from the I period. The differences between the chronological periods are statistically significant ($\chi^2=15.86; p=0.0072$) (Table 2).

In turn, the percentage of dental caries was calculated on the basis of all examined teeth. Out of 3,292 teeth, dental caries were detected on 270 teeth, which means that, taking into account the PCF [40, 41], 8% of teeth were infected. The lowest intensity of dental caries was detected in the EB period (2.9%). In the NA period, there was a dramatic jump in intensity to 16.5%, followed by a gradual decline in the MI period (5.7%). Variations in the intensity of dental caries among chronological periods are statistically significant ($\chi^2=51.89; p<0.0001$) (Table 2).

Table 2. Frequency and intensity of dental caries in chronological periods

	Individuals (frequency)					Teeth (intensity)				
Period	Male	Female	p	Total	p	Male	Female	p	Total	p
MI	4/7 *57.1%*	4/6 *66.6%*	1	8/13 *61.5%*		5/171 *3%*	10/89 *13%*	.0064	15/260 *5.7%*	
I	33/48 *69%*	21/34 *61.7%*	.5999	54/82 *66%*		82/767 *10.2%*	42/686 *6%*	.0019	124/1453 *8.5%*	
LR	20/38 *52.6%*	7/12 *58.3%*	.7297	27/50 *54%*	.0072	42/639 *6.6%*	27/178 *15%*	.0003	69/817 *8.4%*	.0001
NA	4/4 *100%*	5/5 *100%*	-	9/9 *100%*		11/66 *16.3%*	17/103 *17.1%*	.9780	28/169 *16.5%*	
MB	6/20 *30%*	7/13 *54%*	.1707	13/33 *39.4%*		14/255 *5.5%*	16/201 *7.6%*	.2908	30/456 *6.6%*	
EB	3/7 *43%*	0/2 -	.2568	3/9 *33.3%*		4/119 *3.4%*	0/18 -	.4298	4/137 *2.9%*	
Total	70/124 *60.3%*	44/72 *64.1%*	0.523	114/196 *58.1%*		158/2017 *7.7%*	112/1275 *8.6%*	0.3336	270/3292 *8.2%*	

Dental caries can appear on anatomically different parts of a tooth. Therefore, the analysis performed took into account the location of caries on the root, CEJ and crown (approximal and occlusal surfaces). In the study population from the Middle Euphrates valley, dental caries occur most often on the CEJ (110/270; 41.0%), occlusal surfaces (90/270; 33.3%), and approximal surface (68/270; 25.1%), and least often at the root (2/270; 0.7%). It is worth noting that the observed differences are statistically significant ($\chi^2=25.03; p=0.0015$).

Table 3. Dental caries location on different parts of the tooth

Localization on the teeth	Period					
	MI	I	LR	NA	MB	EB
Root	2/15 *13%*	0/124 -	0/69 -	0/28 -	0/30 -	0/4 -
CEJ	5/15 *34%*	39/124 *31%*	29/69 *42%*	22/28 *79%*	13/30 *44%*	2/4 *50%*
Approximal surface	2/15 *13%*	34/124 *28%*	22/69 *32%*	2/28 *7%*	7/30 *23%*	1/4 *25%*
Occlusal surface	6/15 *40%*	51/124 *41%*	18/69 *26%*	4/28 *14%*	10/30 *33%*	1/4 *25%*
p	.2093	.0626	.1324	.0001	.2592	.6873
Localization on the crown	MI	I	LR	NA	MB	EB
Buccal	0/15 -	16/124 *13%*	6/69 *9%*	9/28 *32%*	5/30 *17%*	0/4 -
Lingual	0/15 -	3/124 *2%*	2/69 *3%*	0/28 -	1/30 *3%*	0/4 -
Mesial	3/15 *20%*	24/124 *19%*	18/69 *26%*	6/28 *22%*	5/30 *17%*	0/4 -
Distal	4/15 *27%*	29/124 *24%*	25/69 *36%*	9/28 *32%*	12/30 *40%*	3/4 *75%*
Occlusal	8/15 *53%*	52/124 *42%*	18/69 *26%*	4/28 *14%*	7/30 *23%*	1/4 *25%*
p	.1225	.0001	.0001	.1674	.0038	-

In the MI and I periods, occlusal surfaces were infected with caries most often (40% and 41%, respectively), while the CEJ (34% and 31%, respectively) and approximal surfaces (13% and 28%, respectively) were affected to a lesser degree. However, in the LR period, the CEJ (42%) and approximal surfaces (32%) showed caries most frequently, in contrast with occlusal surfaces (26%), which showed fewer signs of caries. It is extremely interesting that, in the NA period, almost all cases (79%) of dental caries were located at the CEJ. Approximal surfaces and occlusion areas were infected only in 7% and 14% of cases, respectively. In the MB and EB, most frequently, dental caries were located on the CEJ (44% and 50%, respectively) (Table 3).

The location of caries on the tooth crown was also taken into consideration regarding the mesial, distal and occlusal surfaces, as well as the labial/buccal and lingual surfaces. Our analysis proved that dental caries were located most often on the surface of functionally active (90/270; 33%), distal (82/270; 30%), and further mesial surfaces (56/270; 20%). They were least often detected on the buccal (36/270; 13%) and lingual surface (6/270; 2%) – the differences were statistically significant ($\chi^2=24.74; p<0.0000$). In the MI and I periods, dental caries were most frequently observed on the occlusal surface (53%, 42%, respectively); the approximal surfaces (mesial and distal) were significantly less likely to be infected. In the subsequent chronological periods, dental caries on the occlusal surface steadily decreased, while the lesion on the approximal surfaces clearly increased (Table 3).

Linear Enamel Hypoplasia

Among the 196 individuals, LEH was observed in 136 individuals, which means that these defects included 70% of the population. LEH was observed in 90 males (72%) and 47 females (65%) (Table 4). The number of individuals afflicted with LEH in the chronological periods was significant because it extended above the level of 50%. However, the differences between the chronological periods were not statistically significant. The highest numbers of individuals diagnosed with LEH were observed in the EB (77%) and the LR periods (76%). While, the lowest number of individuals with LEH was found in the NA period (55%). It is interesting that enamel hypoplasia was most often observed among females from the oldest chronological periods (EB, MB). While, in younger chronological periods (MI, I, LR, NA), the enamel hypoplasia was most commonly observed among males. However, in any case, these numbers were not statistically significant.

We studied the frequency of LEH on teeth of individuals from different chronological periods. The highest prevalence of LEH was founded on the teeth from the NA (32%) and LR (29%) periods. The lowest prevalence was observed in the MI period (20%). The observed differences were statistically significant ($\chi^2=11.33. p=0.0491$) (Table 4).

Table 4. Frequency and intensity of LEH in chronological periods

	Individuals (frequency)					Teeth (intensity)				
Period	Male	Female	p	Total	p	Male	Female	p	Total	p
MI	5/7 *71.4%*	3/6 *50%*	.6576	8/13 *61.5%*	.7454	41/171 *24%*	13/89 *14.6%*	.0772	54/260 *20%*	.0491
I	35/48 *73%*	23/34 *67.6%*		58/82 *70.7%*		210/767 *27.3%*	153/686 *22.3%*	.0256	363/1453 *25%*	
LR	30/38 *79%*	8/12 *66.6%*		38/50 *76%*		168/639 *26.2%*	67/178 *37.6%*	.0030	235/817 *29%*	
NA	3/4 *75%*	2/5 *40%*		5/9 *55.5%*		21/66 *32%*	33/103 *32%*	.9760	54/169 *32%*	
MB	12/20 *60%*	9/13 *69.2%*		21/33 *63.6%*		80/255 *31.3%*	38/201 *19%*	.0025	118/456 *26%*	
EB	5/7 *71.4%*	2/2 *100%*		7/9 *77.7%*		28/119 *23.5%*	4/18 *22.2%*	1	32/137 *23.3%*	
Total	90/124 *72.5%*	47/72 *65.2%*	.4321	137/196 *70%*		548/2016 *26.7%*	308/1276 *25.2%*	.0523	856/3292 *25.5%*	

The next step in the study was to reconstruct the age of appearance of LEH. In these analyses, 595 anterior teeth were used. In all the analyzed chronological periods, the LEH was mostly formed in a range between 2.5 and 2.9 years of age. It is interesting that, during the NA and LR periods, time of formation of LEH lasted a little longer than in other chronological periods, which began already in the range 2.0–2.4 years of age. Moreover, in the EB period, an additional LEH appeared between 3.5–3.9 years of age (Figure 3).

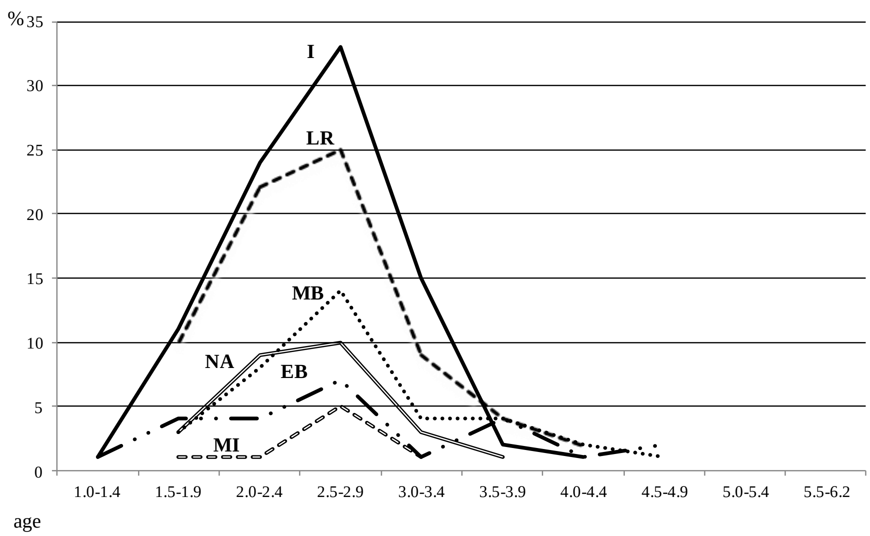

Figure 3. Percent of enamel hypoplasias by development age.

The SEM technique was used to assess the number of perikymata building occlusion walls from LEH. The aim of the study was to assess the average time of exposure to stress. On the basis of data received, the average duration of the exposure to unfavorable conditions in different chronological periods can be estimated. In the I period, the average time of physiological stress was rather short (57 days) compared to other chronological periods. In the MB period, the duration of negative factors was lengthened to 112 days. In the NA period, the number of perikymata from the occlusal wall was the most common, and the average duration of negative factors lasted about 163 days (Figure 4).

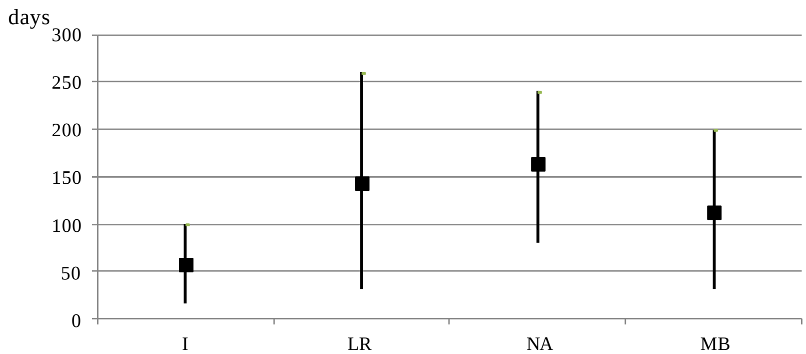

Figure 4. The average duration of physiological stressors in chronological periods.

Dental Wear

Functionally active surfaces of tooth crowns in the dental collection from the Syrian lower Euphrates valley showed the highest number of teeth with the medium stage (No 2) of mechanical dental wear. However, in the EB and MB surfaces, quite a large percentage of severe dental wear (No 3) occurs (32% and 37%, respectively). The observed differences are statistically significant in all periods (Table 5).

Similar analyses were conducted for anterior and posterior teeth separately. The MI, I, LR, and NA periods seemed to be extremely similar as far as anterior tooth wear. The frequency of severe dental wear (No 3) in these periods did not exceed 23%, while the severe dental wear as higher than 30% in the oldest chronological periods (EB: 37%, MB: 30%). The analysis of posterior tooth wear revealed similar regularities. There was a relatively small percentage of severe dental wear (No 3) in the MI, I, LR, and NA periods. Conversely, it increased significantly in the EB and MB periods (56% and 48%, respectively). The observed differences were statistically significant in all periods (Table 5).

In the next step, the SEM analysis of occlusal surfaces was conducted. The analysis of micro-wear revealed that the frequency of deep linear loss (*scratches*) and non-linear loss (*punctures* and *pits*) successively decreased in younger chronological periods, while less linear loss (*striae*) became more frequent (Table 6). Tukey's multiple comparisons of means (F) detected statistically significant differences for all investigated structures; however, this test did not always detect statistical differences between adjacent chronological periods. Yet, the lack of significance could be due to the small study sample.

Table 5. Frequency of anterior and posterior teeth wear (1 – small, 2 – medium, 3 – severe)

Period	Total			Anterior teeth			Posterior teeth		
	1	2	3	1	2	3	1	2	3
MI	24/260 9%	189/260 73%	47/260 18%	21/175 12%	116/175 66%	38/175 22%	3/85 4%	73/85 86%	9/85 11%
	.0001			.0001			.0001		
I	289/1453 20%	885/1453 61%	280/1453 19%	183/916 20%	584/916 64%	149/916 16%	106/537 20%	301/537 56%	130/537 24%
	.0001			.0001			.0001		
LR	241/817 29%	411/817 50%	165/817 20%	153/511 30%	240/511 47%	118/511 23%	88/306 29%	171/306 56%	47/306 15%
	.0001			.0001			.0001		
NA	37/169 22%	105/169 62%	27/169 16%	19/120 16%	80/120 67%	21/120 18%	16/49 33%	24/49 49%	9/49 18%
	.0001			.0001			.0001		
MB	54/456 12%	234/456 51%	167/456 37%	23/293 8%	182/293 62%	88/293 30%	32/163 20%	52/163 32%	79/163 48%
	.0001			.0001			.0001		
EB	16/137 12%	67/137 49%	54/137 32%	10/101 10%	54/101 33%	37/101 37%	10/36 28%	15/36 42%	21/36 56%
	.0001			.0001			.0057		

Table 6. Ferquency of microstructures observe in SEM analysis (Tukey's multiple comparison of means)

	scratches			striae			punctures			pits			length (μm)		
	mean	SD	p	mean	SD	p	mean	SD	p	mean	SD	p	mean	SD	p
MI	3.3	1.40		154.3	11.48		21.5	2.23		1.2	1.03		51.7	5.78	
			1			.000			.998			.987			.000
I	3.3	2.46		99.83	12.53		23.7	4.55		1.9	1.16		42.8	2.23	
			.000			.999			.960			.996			.009
LR	8.6	2.17		101.5	13.51		27.9	11.72		2.4	1.17		36.5	4.23	
			.964			.874			.000			.331			.000
NA	9.5	2.77		92.2	31.59		61.1	19.13		4.6	2.97		27.6	3.93	
			.200			.383			.772			.999			.999
MB	12.1	3.07		76.0	17.18		53.8	15.58		5.0	2.44		27.3	3.65	
			.000			.159			.578			.002			.000
EB	6.0	1.41		55.6	14.40		62.8	9.14		9.3	3.99		37.4	4.90	
F	22.09			29.15			24.91			14.54			44.68		
p	.0001			.0001			.0001			.0001			.0001		

Dental erosion of the molars was observed in 42 specimens (MI: 7/13; I: 12/82; LR: 9/50; NA: 7/9; MB: 8/33; EB: 1/9). The highest number of teeth diagnosed with erosive loss was from the NA (38/49; 77%) and the MI (51/85; 60%) periods, and the lowest from the EB (5/36; 13%) and the MB (30/163; 18%) Ages. Erosion in the LR (98/306; 32%) and the I (199/537; 37%) periods reached similar levels. The differences observed were statistically significant ($\chi^2=30.2, p<0.0001$).

DISCUSSION

The number of specimens with dental caries from the examined periods shows a statistically significant fluctuation. This fact may be indicative of changes in dietetic and hygienic patterns, probably caused by a socio-economic transformation. The lowest frequency and intensity of caries was observed in the EB period. A low frequency of caries shows a good condition of the oral cavity, which is due either to good hygiene or a diet low in cariogenic products. The available information on oral hygiene from the EB period is rather dubious. Some scholars suggest that the people of the ancient Middle East used teeth-cleaning twigs as early as the third millennium [56, 57]. It seems, however, that a low frequency of caries is due to a diet with a relatively low amount of cariogenic products, or to one rich in fats and calcium, which protect teeth against infections [7, 15, 58]. This information is extremely interesting for several reasons. First, the Syrian lower Euphrates valley was inhabited by both settled farmers working the land in the valley, and by nomadic or semi-nomadic shepherds using the steppe areas in close vicinity, and further away, as pasture. Both food-obtaining strategies were complementary at the time, and the exchange between the two groups reduced the risk of famine in the case of a poor crop or a shortage of animals [59, 60]. A low frequency and intensity of caries are indicative of the populations that preferred a diet based on animal products, and much less on crop plants, which means that the populations from the TQ area based their diet mainly on high-calcium products (e.g., milk, cheese, fermented milk beverages, fish, legumes, sesame seeds) and on meat. Archaeozoological analyses conducted by our team indicate that, in the earliest period, there was a predominance of bones of small ruminants (sheep and goats (87%), which do not require fertile grazing lands, but often graze in the steppes) [61]. Small ruminants were primarily kept for meat and fat, as well as for skins and wool. The remains of cattle are not very frequent as compared with other periods (about 13%). The significant frequency of small ruminants indicates a mobile lifestyle of the population and adverse environmental conditions. This piece of information is extremely valuable, given that cattle need green pastures; thus, their number is a good indicator of a local population’s status. The low number of cattle proves that the local populations in the EB period lived in dry and steppe areas. Moreover, the low frequency of caries is also interesting because an important trade route ran along the Syrian lower Euphrates valley, connecting southern and northern Mesopotamia [2, 62]. The low intensity and frequency of caries may suggest that, even though the populations from the Syrian lower Euphrates valley relied on this trade route, their diet did not contain many cariogenic products such as figs, sugar cane, dates or honey.

There was in increase in the frequency and intensity of caries in the MB period. This can be indicative of slight dietetic changes, which saw the intensification of agriculture and the introduction of an increasing number of cariogenic products such as honey or beer. It is possible that the increase in infections was caused by more MB techniques of processing food. This thesis is very probable because, at the beginning of the 2nd millennium, TQ was an important local center and the capital of a small Amorite state. After the destruction of Mari, ancient TQ took control over the whole region [2, 24]. Its privileged status raised the economic and social status of the local population, which translated into an increase in the incidence of caries. In this period, as showed by archaeozoological studies, the frequency of sheep and goats dropped to 75%, but the frequency of cattle increased to 25% [61]. These results may indicate a growth of green areas, and, hence, changes in diet.

A radical increase in both the frequency and the intensity of caries occurred between 900 and 700BC, which is identified as the NA period. This means that, in those days, the diet must have been high in plant products, including crops, which are very cariogenic and contain simple carbohydrates. These could have come either from natural sources rich in simple sugars, such as sugar cane, figs and dates, or from processed products [63, 64, 65, 66]. All of them, however, require intensified field irrigation. Many sources indicate that the inhabitants of Mesopotamia highly valued beer made from barley, wheat, millet, sago and dates, as well as wine made not only from grapes, but also from dates. These drinks can surely be considered highly cariogenic. In the TQ area, there are still remnants of the Nahr Dawrin irrigation canal (Figure 1). As has already been mentioned, its dating is still disputable [36, 67, 68]. However, the considerable increase in the incidence of caries is an important argument that the canal was used more intensively or was built in the NA period. The “monotype” economy of the NA period, geared toward farming and characterized by a reduction in animal produce, may have caused a drastic increase in caries. The hypothesis about the "monotype" economy seems justified, given that animal products (especially fat) inhibit caries [7, 15, 58]. It is also interesting that the NA period, according to our archaeozoological studies, shows a rise in the rate of the slaughter of young cattle, up to as much as 16.7% [61]. This can be interpreted in two ways: either the population in that period suffered from severe food scarcities and, for this reason, took such radical steps, or it lived in prosperity and could afford to slaughter young cattle. It is not possible to settle that issue definitively on the basis of the current data, given that the main site from the NA period at MK is a governor's palace [29, 36]. Excavation work in the lower part of the city (outside the palace) has only recently started, and it may yield results that should make it possible to answer this question.

The frequency and intensity of caries decreased in the LR period. This fact can be explained, on one hand, by the unstable political situation – northern Mesopotamia became a border region between the Roman Empire and the Parthian state [2, 69, 70]. It can be assumed that the lack of stability led to shortages of products rich in carbohydrates and, thus, to the decrease in the prevalence of caries. However, it must be underlined that it was not only barley, wheat, millet and lentils, but also figs and melons that were identified in our botanical samples [71, 72]. This means that, as far as its quality was concerned, the overall diet remained similar to the one from the NA period. Hence, it may be inferred that the local population still irrigated their fields, but probably to a lesser extent than in the NA period. Small irrigated fields have remained a permanent feature of the Syrian lower Euphrates valley up to the present day.

It is interesting to note that the intensity of caries reaches similar levels (8%) in the I and LR periods, and notably differs from the latest period, the MI (5%). This may be indicative of the fact that the Arab culture was markedly different in terms of dietetic behavior in its early and MI periods. However, dietetic forms of behavior from the LR period continued up to the early Middle Ages. This information is interesting in view of the fact that the LR period is considered to be both politically and economically unstable [2, 69, 70]. Thus, a lower incidence of caries could be expected, if only because of nutritional deficiencies, especially cariogenic ones. However, the population from the Syrian lower Euphrates valley was apparently able to obtain sufficient amounts of cariogenic food in the LR period, despite an adverse economic situation; also, the conquest of the Middle Euphrates valley by the Arabs in the 7th century and the advent of Islam was not reflected by a marked change in dietetic behavior, at least not one important enough to manifest itself in a significant increase in the frequency of caries.

As can be easily observed, caries were most frequent on the CEJ or/and approximal surfaces only in the LR, NA and Bronze periods, whilst in the periods identified with the Muslim cultures (I, MI), the highest frequency was observed on the occlusal surfaces. The analysis of carious location on the tooth crown yielded similar results; in the MI and I periods, carious lesions occurred most often on the functionally active surfaces. Our results are interesting in comparison with other archaeological materials from the Roman and Medieval periods [73, 74]. In the latter research, the most frequent site of the initiation of caries in permanent dentition was the CEJ, in particular, the interstitial surfaces. This means that our observations are comparable with the Roman period, but they do not fit the I period, which is identified with the Medieval period. Food remains on teeth (especially those consisting of fibrous elements that contain starch) lead to the formation of dental plaque, which eventually causes periodontal disease and gum recession and creates favorable conditions for the development of caries, whilst lesions on functionally active surfaces usually accompany a highly processed food diet, rich in simple sugars [15, 75, 76]. Our archaeobotanical research suggests that, during all of the periods in question, there were no major changes in exploited plants [71, 72]. In light of these data, it seems that oral hygiene could be a more appropriate explanation for the specific location of caries in the described periods. Concerning the I and MI periods – identified with the Muslim culture – we have well-documented evidence of the use of sticks made from the Arak tree (*Salvadora persica*) which, cleaved in hot water, can serve as an excellent tooth and tongue brush [56, 57]. Nevertheless, Muslims always could (and still can) buy a *miswāk* in front of a mosque. Up until now, using a *miswāk* has been common practice in the region of TQ (Figure 5). It is, of course, difficult to speculate about the ways in which oral hygiene was maintained after meals in periods older than the I period. It is certain, however, that using a *miswāk*, which, when inserted into the spaces between the teeth, removes food remains, could lead to the noted decrease of the incidence of caries on the CEJ (31% and 34%, respectively) and the increase in functionally active surfaces (41% and 40%, respectively) in the I and MI periods. The results of our research indicate that there was a continuity of dietary habits between the LR and I periods. We can suppose that the populations that inhabited this region in Roman times were well adapted to the disadvantageous economic and political situation. The conquest of the Middle Euphrates valley by the Arabs in the 7th century probably did not cause any significant dietary changes. According to the chemical analysis, general health status clearly improved during the MI period.

Figure 5. A stick of an Arak tree and a prepared ′brush′ *(photograph by J. Tomczyk)*.

The examined series from the Syrian lower Euphrates valley is characterized by a high frequency of specimens with LEH; 70% of examined specimens showed at least two enamel defects. Similarly, the analysis of particular periods revealed a high percentage (>50%) of specimens with LEH, although the differences are not statistically significant. Since LEH is indicative of environmental disturbances caused by food shortages or infections, which usually become more frequent after conversion to agriculture, it can be concluded that all the examined populations from the Syrian lower Euphrates valley used a productive adaptation strategy (as opposed to a hunter-gathering one).

Of much interest are the results pertaining to the frequency of teeth with LEH because the observed differences are statistically important. In the EB and MB periods, LEH affects 23%–26% of teeth. As compared with subsequent periods, this frequency may be indicative of a relatively good health status and appropriate nourishment, which was probably due to the well-being of the local populations. In those periods, one of the two major trade routes ran along the Euphrates valley between the inhabitants of southern Mesopotamia [2, 62]. Along the way, materials, such as wood, metals, minerals and food, were brought south from the Levant and Anatolia. The region, as has already been mentioned, was inhabited by both settled farmers and nomadic or semi-nomadic shepherds [59, 60]. These different economic systems relied on complementary strategies of obtaining food. This "solidarity" strategy of the population from the Syrian lower Euphrates valley is confirmed by a relatively low LEH frequency. It is interesting, however, to note an increase (32%) in LEH in the NA period. Population growth, which must have triggered the intensification of contagious diseases, the growing dependence on agriculture, coupled with the decline of herding, and political instability, probably had an impact on the observed increase of LEH. It was probably in that period that the Nahr Dawrin irrigation canal along the Habur and the Euphrates was built or began to be used more intensively, on which the local population became totally dependent (Figure 1). In the LR period, the frequency of LEH slightly decreased to 29%. In 64BC, the Romans made Syria a province of the Empire [2, 69, 70]. As a result, northern Mesopotamia became a border area between the Roman Empire and the Parthian state (later the Sasanian state). The Middle Euphrates valley again became the main trade and military route [2, 70]. The growth of factors distorting the development of enamel in the NA and LR periods was also recorded in the studies of SEM. In all periods (except for the LR and the NA) LEH most often occurred between 2.5 and 2.9 years of age. This fact shows that the health status of children, in whom LEH developed, was comparable in those periods. It seems, however, that economic instability, which lowers SES, resulted in a slightly accelerated time of LEH occurrence (2.0–2.4 years of age) in the NA and the LR periods. The conducted SEM analyses of the number of perikymata in the occlusal wall revealed that the duration of physiological stress affecting the dental tissue was the longest in the NA and the LR periods. This piece of information further confirms the thesis about adverse conditions disrupting the functioning of ameloblasts.

One hundred years later (633–640AD), Syria was conquered by the Arabs [70]. In those days, the Syrian lower Euphrates valley attracted great attention because an important trade and military route emerged, connecting Baghdad with Syria and Anatolia. This factor significantly raised the socio-economic status of the local population and, hence, its living conditions, which, in turn, resulted in a drop in LEH frequency. The lowest LEH frequency (20%) was observed in the MI period. The low frequency of LEH in the Syrian lower Euphrates valley in the MI period may be explained not only by an appropriate diet, but also by economic and political stability, which made trade with neighboring Iraq possible.

The analysis of mechanical dental wear seems to support two different adaptation strategies among populations inhabiting the Syrian lower Euphrates valley. The first strategy involves individuals in the oldest chronological periods (EB, MB). In comparison, different strategies can be observed in groups from younger chronological periods (NA, LR, I, MI). This conclusion stems from the mechanical dental wear. Anterior and posterior teeth from the Bronze Ages (EB, MB) are characterized by severe dental wear, while teeth crowns from younger chronological periods are characterized by slightly less dental wear. According to the presented studies, the rate of dental wear successively decreased. The teeth from the oldest chronological periods are characterized by faster wear than the dentition belonging to the younger chronological periods.

The analysis of microwear reveals that the frequency of deep linear loss (*scratches*) and non-linear loss (*punctures* and *pits*) successively decreases with younger chronological groups, while lesser linear loss (*striae*) becomes increasingly frequent. A diet that is slightly processed or highly contaminated (e.g., with grains of sand or dust) causes major linear and non-linear losses. This means that the decrease in serious loss was the result of an improving diet or a change in the way meals were prepared. The staple diet of the Middle East population was grain (barley, wheat), eaten as bread or gruel (made from ground corn, water, oil and salt) [63, 64]. Every meal consisted mainly of flatbread, which is definitely abrasive. It is still baked today with flour made from ground corn. Although the very method of preparing (mixing flour with water, leaven and olive oil) and baking bread has not changed at least since the Neolithic period, it is the preparation of flour that has changed. Flour obtained through the use of querns, stone mortars, or pestles made of volcanic rocks was highly contaminated with the remains of unground corn as well as with grains of dust and sand. All this made bread a highly abrasive food. Moreover, contamination occurred in the very process of bread baking. Bread was baked in clay stoves (*tanuur*), made of brown clay mixed with ground chaff. These stoves are not unusual from the archaeological point of view, and are still being discovered in the Middle Euphrates valley from all the periods in question [28, 29, 77]. Since the crust of flatbread is hard and requires strong biting, and then sustained grinding and chewing, this kind of food may be considered especially abrasive. It seems that, around the 1st millennium, the method of processing corn changed when the Olynthus mill was invented and mills became based on a lever mechanism. The invention, which spread all over the Mediterranean area, not only made food preparation easier, but also improved the quality of flour [78, 79]. Although the changes in corn processing were quickly adopted in the Mediterranean basin, there has been little evidence from the Syrian area. Two sites (Hama and Tell Halaf) where Olynthus mills were found are chronologically dubious [80]. The present research suggests that the changes in question happened between the Bronze Age and the NA period. Perhaps future research will make it possible to narrow this time period.

Some very interesting insights are provided by the analysis of chemically-induced loss of tooth substance regarding dental erosion. The highest number of cases diagnosed with erosive loss dates from the NA and the MI periods, and the lowest from the EB period. It is difficult to determine conclusively the cause of that loss, but it may possibly be due to exogenic substances. Acids contained in food (fresh fruit juice: 2.8–4.0 pH, herbal teas: 3.0 pH, honey: 3.0 pH or wine: 2.3–3.8 pH) could have brought about the demineralization of the tooth surface and, thus, erosive loss [21, 81]. The diet of the population in that period may be supposed to have been rich in products lowering the pH in the oral cavity. This fact is especially interesting with regard to the NA period. Due to artificial irrigation, the farming acreage was considerably enlarged, which made the cultivation of fruit trees and plants that like humidity possible, e.g., orange trees, vines, and date palms [63]. This brought about an increase in dental erosion. Besides, it should be noted that dental erosion can be inhibited by products rich in calcium, e.g., milk and milk products [22, 82]. Thus, it would follow that the diet was low in these components in the periods of increased dental erosion. The high frequency of dental erosion in the MI period corresponds with other research on MI populations [82, 83]. If local populations did not obtain erosive products by themselves, they still could be obtained through extensive trade with neighboring populations.

CONCLUSION

Systematic anthropological studies conducted in areas of the Syrian lower Euphrates valley provide extremely interesting information. The dental research of local populations indicates a change of living conditions in subsequent chronological periods. In light of the study, the EB period can be considered a time of 'well-being' in the biological context, while the NA period, identified by important historical events, can be considered a biologically unfavorable period. During this period, the biological stress identified with enamel hypoplasia or dental caries was very intense, which means that new anthropological research can provide new specific information on human communities, which perhaps will force the revision of the old and hackneyed ideas.

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